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Cognitive Aspects of Emotional Expression Processing

Patricia Margaret Le Gal, B.Sc.

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Abstract

This thesis investigates the hypothesis that emotions play an influential role in cognition. Interference between facial emotional expression processing and selected tasks is measured using a variety of experimental methods.

Prior to the main experimental chapters, the collection and assessment (Chapter 2, Exp. 1) of stimulus materials is described. Experiments 2-11 then concentrate on the likelihood of interference with other types of information from the face. Findings using a Garner design suggest that, although identity processing may be independent of expression variation, expression processing may be influenced by variation in identity (Exps. 2-4). Continued use of this design with sex (Exps. 6-7) and gaze direction (Exps. 9-10) information appears to support the (mutual) independence of these facial dimensions from expression. This is, however, in contrast to studies that indicate the modification of masculinity judgements by expression (Exp. 5), and the interaction of gaze direction and expression when participants rate how interesting they find a face (Exp. 8). Further to this, a search task (Exp. 11) shows that slower responses to an angry (cf. happy) face looking at us, may be due to the presence of an aversive mouth.

Experiments 12-15 test for interference in the field of time perception: complex interactions between expression and encoder and decoder sex are indicated. Finally, Experiments 16-17 find that exposure to a sequence in which the majority of faces are angry depresses probability learning, and that prior exposure to varying quantities of angry and happy faces affects our later memory for them.

Overall, there is evidence that exposure to emotional expressions may affect other (selected) cognitive processes depending upon which expressions are used and which experimental methods are chosen. It is suggested that future investigations would benefit from techniques that describe the temporal profile of an emotional response.

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Emotion and cognition: an integrated approach

The ability to interpret the emotional state of another person from their facial expression comes easily for most of us. There are exceptions, and if we are visually impaired we may rely on other things about that person such as tone of voice or touch. If we suffer certain neurological impairments we may have difficulty in interpreting both our own and others' emotional expressions, and our relationships with others can be affected badly (e.g., autism). So too, when cognition goes wrong we are reminded, often dramatically, of accompanying emotional consequences (see Baddeley's, 1997, description of the case of Clive Wearing, a musician who suffered an encephalitic brain infection that left him severely amnesic and emotionally devastated). There is however, an asymmetry about emotion and cognition research. Reviews about the state of emotion research are likely to contain many references to the primary role of emotion in cognition and vice versa, but texts on cognition promote theories of perception, attention, learning, memory, and problem solving that rely on evidence from experiments that incorporate affective stimuli only rarely.

Research into emotions has had a controversial history and they were once considered the antithesis of rational thought. (See Oatley, 1994, for a résumé of the history of concepts of emotion in psychology.) Darwin (1872/ 1948) provided modern emotional expression investigators with a biological and evolutionary context, and Oatley attributes Paulhan (1887, as cited in Oatley, 1994) as establishing a cognitive context for emotion research. Observations about how many types of expression there are, how they originate and how they are recognised, and ideas about emotions intruding on cognition when goal attainment is frustrated, are still very much the currency of contemporary research (e.g., Ekman and Davidson, 1994).

Some researchers go so far as to say that emotion processing is different from, and partially independent of, cognition (e.g., Le Doux, 1995, 1998; Zajonc, 1980, 1984; Zajonc, Murphy, and Inglehart, 1989). That is, the processes that trigger emotion can be understood at a mechanical, neurophysiological level and that any computational or information processing analysis is unnecessary. Le Doux (1995) makes the point that the question of whether emotion depends on cognition depends to a large extent on how cognition is defined. If cognitive processing is restricted to only those functions mediated by complex association cortex, then emotion may not necessarily be dependent on prior cognitive processing. If, however, cognition is broadly defined to include sensory information processing, then emotional processing (in the amygdala) is highly dependent on cognitive processing. Others (e.g., Smith and Lazarus, 1993; Lazarus, 1982, 1991) place cognitive appraisal (conscious or unconscious) at the very heart of emotion processing, and consider that evaluative processes are not only enough for emotion processing to proceed, but that they are necessary. Yet others (e.g., Gray, 1990) suggest that the brain systems which mediate emotion overlap to such an extent with those that mediate cognition, it is difficult to maintain any clear distinction between them. In this view emotional and cognitive processing are very close, if not indistinguishable. Much of the motivation for this thesis is to look for evidence of what Le Doux (1995) describes as the "other side of the cognitive-emotional dyad" (p. 225)

that is, the influence of emotional processing on selected aspects of cognition. Emotional expressions are considered, in the experiments carried out here, to provide information to the viewer that is processed either unconsciously or consciously. Its effects on behaviour are also assumed to be accessible to measurement using the methodological tools that have been developed, for the most part, by cognitive psychologists. Such an approach leaves to one side the sticky question as to whether or not emotion *is* cognition.

Information related to the recognition of emotional expressions is reviewed below. After this there is a review of the standing of emotional expression processing in relation to the analysis of other types of information from the face. This is followed by a brief description of an influential attempt to integrate what we understand of the functions of emotions into a cognitive framework (Oatley and Johnson-Laird, 1998). Next, the example of how our knowledge of emotional disorders has grown by focusing on the mechanism of attention, is used as an illustration of what there is to gain by taking an integrated approach. Finally, the aim, and an outline of this thesis and the experiments that follow are presented.

Emotional expression processing

Production

Although the main subject of this thesis is concerned with processes internal to the *receiver* or *decoder* of expression information, many early investigators in expression research have been concerned with how and why we *produce* or *encode* emotional expressions. The ideas of these investigators have been formative in the course of later research, and by considering the process of production we may achieve some insight into how we receive expression information. Therefore, a brief outline of some of the earliest work on expression production is presented, prior to a more extensive consideration of the literature on expression recognition.

Early in the 19th Century, work by Bell (1844, as cited in Bruce and Young, 1998) focused in some detail on how the muscles of the face moved to signal emotion. Darwin (1872/ 1948), while admiring Bell's discoveries, found his explanation of how expressions were created (by a Creator) unsatisfactory, and contended instead that expressions have been gradually acquired. Darwin's primary interest in expressions was driven by the desire to uncover evidence of human evolution, and he viewed expressions as behavioural vestiges of our animalistic origins. He pointed out that it is possible to assign uses for almost all the facial muscles independently of expression.

Darwin (1872/1948) proposed three main principles for the origin of expressions. The first is by the process of *service* when actions that are repeated often become 'habits'. Examples are reflex actions, such as spitting something out that tastes nasty, or leaping backwards from the strike of a snake (even in circumstances where you know there is a protective barrier between the snake and yourself). A single reflex probably varies slightly in its expression and Darwin suggested that any variation conveying an advantage would be preserved. In this way it would be possible to end up with actions once gained for one purpose being modified for another. It is almost impossible to control reflex actions and Darwin accords differing degrees of automaticity to different expressions. The second principle is *antithesis* when opposite movements are voluntarily performed in response to opposite expressive impulses and become established. According to this principle, the use of different muscle groups in response to different expressive impulses (e.g., affirmation cf. negation) may be to a large extent voluntary while maintaining clearly distinct physiological origins, as for a reflex. A consequence of this distinctive origination is the generation of signals that function as opposites that are also very different from each other. This is important for social animals where clear communication between members of the same community is essential. The third Darwinian principle is that of *direct action* of the nervous system on the body. An example of this is blushing. Shyness and shame were thought by Darwin to be the expressive impulses behind this particularly human form of emotional

expression. Blushing is seen in instances when various parts of the body are not properly under voluntary control. The functional physiological basis for blushing is not at all clear. For other expressions, such as anger where the snarl is proposed as originating from the teeth-bared aggressive impulse to bite, the action impulses associated with production and discrimination, are more easily understood. Darwin's observations and ideas have influenced almost all subsequent work on the production and recognition of emotional expressions.

Less well known ideas are those of Waynbaum (1907/ 1994; see also Zajonc, 1994), who was interested in what 'psychic' states are induced in us by our perceptions of the world. Waynbaum proposed that the muscles of the face act primarily as a regulatory mechanism for the supply of blood to the brain. The carotid artery splits at the neck into two branches, one to supply the brain and the other to supply the face, with the supply of oxygen to the face not so critical as that to the brain. Blanching and blushing for example, are secondary outcomes caused by the relocation of blood away and towards the face. The muscular actions of the face are responsible for the direction of blood flow and expressions evolved as signals to conspecifics because of their correlation with internal states. Darwin and Waynbaum (in contrast to other eminent scientists of the time) both proposed that facial emotional expressions are useful secondary outcomes linked to physiological adaptations necessary for survival. As such, expressions are recognised and interpreted consistently by others, and function as signals of the sender's intentions.

Discrimination and recognition

Emotional expression processing is assumed to include the discrimination and recognition of expressions and the matching of these to different internal emotional states in the other person. The appraisal of this information with reference to our selves, the other person, and the interaction between us, is also included. There are (at least) two persistent themes that emerge as people have tried to figure out the relationship

between what is shown on the face and how others feel and think about what they see. Both are connected transparently to the ideas of early thinkers. Firstly, consistency in the production of expressions provokes the hypothesis that consistency of recognition also occurs. Secondly, differing degrees of automaticity of production allow the possibility of differing degrees of automaticity for discrimination, recognition and appraisal.

Some expressions are more easily discriminated than others. McAndrew (1986) found that exposure times of 12 ms were required to name happy and sad expressions, that surprise required between 12 ms and 25 ms, disgust required 25 ms, the time exposure for anger at between 12 ms and 300 ms was the most variable, and fear required 300 ms for stable recognition. Jenkins (1997), using psychophysical detection methods and a set of expressions that included happy, sad, surprised, angry, fearful and disgusted expressions, found that although happy, surprised and sad expressions were all easy to label, and happy and surprised expressions were easy to detect, sad expressions were the hardest to detect. People just could not discriminate sad expressions from neutral ones of the same person. She found fear and disgust, on the other hand, were not difficult to detect, but were more difficult to label (for this stimulus set). This indicates that there may be no simple relationship between the ease of visual discrimination of expressions and their recognition. This makes the data from some recognition experiments difficult to interpret because stimulus characteristics, irrelevant to the task instruction but relevant to how the participant solves the task (e.g., the difference between and open and closed-mouth smiles; brightness and contrast levels), have not always been controlled for. Experiments in which very few expressions have been used, where the stimulus exposure is very brief, and experiments with infants (for this last see Oster, Daily, and Goldenthal, 1989, for a review), are susceptible to this ambiguity.

Emotional expression recognition research has become concentrated on the debate about whether or not there are a set of basic expressions that are recognised by members of diverse cultures as conveying the same emotional meanings. The universal recognition of expressions would support Darwin's proposition that different emotional expressions are determined genetically. By extension, if this were true, then we may have discrete neural substrates dedicated to the recognition, and possibly the production, of discrete expressions.

Ekman (e.g., 1980, 1992a, b) has become the foremost protagonist since Darwin to assert the universality of a limited set of expressions. He is careful, however, not to exclude environmental influences as fundamental in the development of an expressive repertoire. He points out that the confusion about the universality of some expressions may result from culturally specific display rules preventing the sender from showing the true extent of their fear, sadness, or other emotion.

In a summary publication Ekman (1980) reviews the early studies he carried out with colleagues on the cross-cultural recognition of happiness, sadness, anger, disgust, fear and surprise. In one of these studies, still photographs of Caucasians posing expressions were shown to members of a preliterate community in New Guinea who had no previous contact with Western culture. Given three alternative photographs and one story (e.g., 'Her friends have come and she is happy') which matched the target expression, high recognition rates were achieved for all except fear and surprise. When the New Guineans were asked to pose expressions to an emotion-story and videotapes of these expressions were shown to American college students, the students were likewise able to recognise the intended emotion (Ekman, 1972, as cited in Ekman, 1980; Ekman and Friesen, 1971). A second study (Friesen, 1972, as cited in Ekman, 1980) was carried out to show the masking influence of display rules on what we show on our faces when in the company of others. Similar expressions were found on the faces of Japanese and American viewers while watching disgust inducing films on their

own. More positive expressions were found on the faces of Japanese viewers when the films were viewed in the presence of the interviewer. Ekman (1980) claims this as evidence supporting both the existence of universal expressions and the modification of these expressions by display rules.

The evidence supporting the proposition that there are categories of expressions common across cultures has been challenged on methodological grounds (Russell, 1994), with suggestions that appropriate precautions were not taken during the translation of instructions and that insufficient alternatives were offered in the forced choice recognition format used. Interpretative objections have centred on the limitations of language, with the suggestion that inferences about what an expression means in any one culture is limited by the vocabulary available to describe it. Also, there are notable differences present between cultures in how expressions are interpreted. For example, Darwin notes that the Dyaks of Borneo express agreement by raising the eyebrows, and negation by slightly contracting them: Eyebrow raising in Western cultures is interpreted most commonly as a component of surprise. In a recent collection of papers (Ekman and Rosenberg, 1997), measurements of the face were taken as dependent measures using the Facial Action Coding System (FACS) developed by Ekman and Friesen (1978; as cited in Ekman and Rosenberg, 1997). These measurements were then used to determine the relationship of face muscle action units to clinical characteristics (e.g., depression, the tendency to commit suicide), or to predict recognition scores, with inferences made by observers excluded entirely. Although this approach yields interesting data, it side-steps the issue of how and in what context the communicative message is received, especially as there is no absolute correspondence found between action unit clusters and recognition (Gosselin, Kirouac and Dore, 1997). We are not yet at the stage where it can be said *definitively* what the core correspondences are between facial action and expression recognition. An expression continues to be what most people say it is in the circumstances in which it is received.

Identifying those expressions that generate consistency of recognition and matching them to discrete physiological profiles has also been part of the project to find evidence supporting their genetic basis. Emotion-specific patterning in response to contracting facial muscles in ways specific to angry, fearful, disgusted, sad, and happy expressions has been found for measures of heart-rate, finger temperature and skin resistance (Ekman, Levenson, and Friesen, 1983; Levenson, Ekman, and Friesen, 1990). However, as Ekman (1992a) himself points out, such evidence does not exclude the possibility that the link between expression and physiology is learned and established through co-occurrence.

Russell and his colleagues (1980; Russell and Bullock, 1985, 1986), and before him, Schlosberg (1952, 1954), have attempted to explain the inconsistency of expression recognition and the confusions that are made between expressions by suggesting that they are perceived dimensionally. Russell's idea is that each expression can be assigned values along scales that describe how pleasant (or unpleasant) or how arousing (or boring) it is. These dimensions, if arranged orthogonally to each other, then describe the total emotion space, and expressions are situated at characteristic places within it. If the expressions rated in this way are all highly 'prototypical' then they are situated on the circumference of a circle, with many gaps. Other 'emotional' states, which may not have distinctive expressions, such as calmness or sleepiness have been included to obtain a more perfectly circular structure. It is not clear whether this should be considered a model of expression perception and recognition or, more broadly, a representation of emotional experience that may be predictive of certain effects observed when we interpret emotional states and interactions. The idea of valence and arousal as key emotional dimensions has been used extensively in emotion research, particularly when questions about learning and memory are being explored.

The categorical model of expression perception is often opposed to the dimensional model. Using line drawings of the core set of expressions from the Ekman and Friesen (1975; as cited in Etcoff and Magee, 1992) set of happiness, sadness, anger, disgust, fear, and surprise, Etcoff and Magee (1992) constructed sets of faces that varied continuously between key examples. The happy-sad set, for example, was made up of line drawings of happy and sad faces situated at each end of a continuum of 11 faces. The faces in between were made up of computer generated (morphed) images that showed equal physical adjustments of the lines to render 90% happiness plus 10% sadness, 80% happiness and 20% sadness at one end, and so on until 10% happiness and 90% sadness was modelled at the other end. Three of the sets were created from pairs that are discriminated easily from each other (happy-sad, angry-afraid and angry-sad). These pairs also represent the end-points of Russell's (1980) dimensions (e.g., positive-negative, level of arousal). Etcoff and Magee found that the probability of identifying each of the stimuli did not vary linearly as predicted by the dimensional model but that expressions were identified more readily at the boundaries between categories. This was in spite of the equal physical differences between stimuli. Their discrimination data also showed that pairs across boundaries were distinguished more accurately than those within categories. Etcoff and Magee suggest that, although their data show that within-category discriminations can still be made above chance levels, low-level perceptual processes and further processing add together to support a categorical rather than dimensional organisation of expression perception for all the expressions they tested except surprise.

The results obtained by Etcoff and Magee (1992) have been replicated and verified for happiness, sadness, anger and fear (Calder, Young, Perrett, Etcoff, and Rowland, 1996), and for surprise, disgust, and neutral expressions (Young, Rowland, Calder, et al., 1997) for morphed continuous-tone images. Unless the morphing procedure produces stimuli that are unnatural in the sense that they are not ever seen and we deal with genuine blends of emotional expressions by assigning multiple labels, it seems

likely that expressions are coded perceptually in terms of prototype configurations that correspond to basic emotion categories. Young et al. suggest that our ability to make within-category discriminations is retained because we are interested in making decisions about the level of intensity with which an emotion is expressed and in picking up transitions between emotional states.

The existence of neurological patients with impairments selective for specific expressions supports the idea that the processing of core expressions may be limited to discrete neural substrates. There is evidence, for example, suggesting a role for the amygdala in the processing of fear (Adolphs, Tranel, Damasio, and Damasio, 1994; Broks, Young, Maratos, et al., 1998; Calder, Young, Roland, et al., 1996; Young, Aggleton, Hellawell, et al., 1995; see also Allman and Brothers, 1994). This evidence is however qualified by a report from Hamann, Stefanacci, Squire, et al. (1996) demonstrating that two patients with complete bilateral lesions of the amygdala and additional temporal lobe structures appeared unimpaired in recognising emotional expressions, including fear. Hamann et al. suggest that early developmental damage may be necessary for the impaired recognition of fear and that there may not be an absolute dependence on the amygdala. In addition, however, there is evidence for a role for the basal ganglia in the processing of disgust expressions. This brain structure is damaged in patients either showing the symptoms for Huntington's disease (Sprengelmeyer, Young, Calder, et al., 1996), or who carry the gene (Gray, Young, Barker, Curtis and Gibson, 1997), and these patients show a selective impairment in the recognition of disgust.

Neuropsychological studies are supported by positron-emission tomography measures of in vivo activation of the amygdala which increases for fearful expressions compared with happy expressions (Morris, Frith, Perrett, et al., 1996). The participants

in this study were asked to make gender[1] decisions to more or less intensely fearful or happy faces and appeared unaware that the variable of interest was emotional expression. The authors concluded that activation was automatic on exposure to the stimulus. Breiter, Etcoff, Whalen, et al. (1996) have shown, even more specifically, that the activity in the left anterior amygdala increases during the perception of fearful compared with neutral expressions. However, the situation is not completely transparent, as Breiter et al. also found that similar regions in the amygdala responded to happy compared with neutral faces. Viewing sad faces has also been demonstrated to show a preferential association with the left amygdala (Schneider, Gur, Harper Mozley, et al., 1995). Animal studies too indicate a key role for the amygdala in emotional and social responses to faces (e.g., Rolls, 1992). Phillips, Young, Senior, et al. (1997) used functional magnetic resonance imaging with human participants to examine the neural substrates for the perception of disgust and fear expressions and found that, while fear activated the amygdala, disgust did not. An area in the anterior insula cortex known to be implicated in the appraisal of distasteful stimuli became active for disgusted expressions in this study.

Our understanding of the way emotional expressions are produced and recognised is becoming increasingly detailed. However, although we may not treat all emotions or all expressions in the same way, accounts of expression processing may still benefit from considering the various expressions of sadness, disgust, and so on, as members of a generic category that contains a type of information functionally consistent with the description of another's (and one's own) emotional state. An angry expression is still more like a fearful expression conceptually than it is like the form the lips take to communicate the sound /i/, for example. Some of the later studies mentioned above have used information processing methods borrowed from cognitive psychology to test

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[1] The terms gender and sex are used interchangeably throughout, with references to original studies retaining the usage of the author(s). Sex is the preferred usage for work in this thesis as one biological sexual identity or the other was presented by all actors and participants involved.

for the differences and potential non-equivalence between different emotional expressions. Allied methods have also been used to test for the functional independence of expression information, as a single category or type of information, from other types of information from the face.

The relationship of expression information to other signals from the face

Whether fortuitous leftovers from evolution or not, facial expressions facilitate the communication of messages allied to the survival and well being of the individual and conspecifics. The face is also adapted to send many other types of signal linked to survival, that may or may not convey messages with emotional content. Even if we can hear, speech information is supplemented by the shapes the lips make. We are finely tuned to perceive gender, age, and race differences, all from the face. We know where someone is attending by where they are looking. We recognise the faces of people we have met or who are famous, and can tell them apart from those we do not know. There is evidence to suggest that, counter to our subjective experience of others as integrated communicating human beings, the brain analyzes these functionally different types of information separately from each other. The independent and parallel processing of all these types of information from the face (with the exception of gaze direction analysis) is set out in Bruce and Young's (1986) model of face recognition. As it is of particular relevance to the experiments in this thesis, Bruce and Young's model is described later in Chapter 3. For the time being, some of the evidence relevant to the proposed mutual independence of expression analysis from facial speech, unfamiliar, and familiar face processing is described below.

Neuropsychological evidence for the independence of expression from familiar face, unfamiliar face and facial speech information

People who suffer brain damage selectively may retain some abilities and lose others. This type of evidence is used extensively to support processing independence between different types of facial information (as it is in the studies outlined above

assessing the processing independence between individual expressions). It is known, for example that the ability to recognise facial expressions may be maintained while the ability to recognise familiar faces is lost (e.g., Bruyer, Laterre, Seron, et al., 1983; Schweinberger, Klos, and Sommer, 1995). The opposite impairment, that is, the loss of expression recognition while retaining the ability to recognise famous faces, has also been reported (Kurucz and Feldmar, 1979; Kurucz, Soni, Feldmar, and Slade, 1980). Disorders of familiar face recognition, expression recognition, and unfamiliar face matching have also been shown to dissociate in a single study reported by Parry, Young, Saul, and Moss (1991). Patients AB and HI could no longer recognise faces that were once familiar to them but were still able to recognise emotional facial expressions and match unfamiliar faces, patient VS was impaired only on unfamiliar face matching, and patient JP was impaired on facial expression recognition only (see also Young, Newcombe, de Haan, Small, and Hay, 1993, for similar dissociations).

Campbell, Landis, and Regard (1986) provided evidence of a double dissociation between the interpretation of facial speech and expression. Two women were described who were both in their 60's when they were tested. One could interpret information from the lips to assist speech comprehension and she was susceptible to the McGurk illusion (McGurk and MacDonald, 1976), that is, when /ga/ is transmitted in the visual channel and /ba/ is transmitted in the auditory channel, /da/ or /tha/ is reported as having been heard, but she could not identify emotional expressions (or familiar faces, or say what sex they were). The other woman had no difficulty with emotional expressions (or recognising familiar faces, or what sex they were), but the involuntary combination of auditory and visual speech information shown by the McGurk effect did not happen with her, and she was impaired at some lipreading and lipspeech matching tasks.

Experimental evidence for the independence of expression from familiar face, unfamiliar face, facial speech, and sex information

In addition to the neuropsychological evidence cited above, experimental studies suggest that independence is sustained for expression and familiar face processing (Bruce, 1986; Campbell, Brooks, de Haan, and Roberts, 1996; Young, McWeeny, Hay, and Ellis, 1986). Young et al. asked participants to decide whether or not faces presented simultaneously were the same or different (person or expression). Familiar faces were responded to more quickly than unfamiliar ones, but whether the faces were familiar or not did not affect expression matching. Campbell et al. using a similar task replicated these findings, and found, in addition, no effect of familiarity on judgements to pictures of faces mouthing sounds. Etcoff (1984), using a card-sort version of Garner's (1974) selective attention paradigm, asked participants to put cards with different expressions (happy or sad) or identities (woman A or woman B) into piles. The time taken to do this for each task when irrelevant information was varied in a filtering condition, compared with when the irrelevant information was held constant in a baseline condition, did not increase significantly. This was interpreted as indicating that expression and identity analysis proceed independently under these conditions.

The proposed independence of expression and sex analysis relies on the independence of each from identity processing. Parallel processing of the sex and familiarity of a face was confirmed by Bruce, Ellis, Gibling, and Young (1987) when they showed that, even if the sex of a face was ambiguous, participants were no slower to categorise these faces as familiar or unfamiliar. An earlier finding suggested that knowing the identity of someone may facilitate knowing their sex (Bruce, 1986), but this is thought to occur via semantic identity-specific associations established for known faces, rather than via a perceptual mechanism. Evidence for the independence of facial speech and gender information comes from a study by Green, Kuhl, Meltzoff, and Stevens (1991). Green et al. found that susceptibility to the McGurk effect was not affected by the mismatching of face and voice gender, despite the incongruence

between faces and voices being detected easily by participants. McAndrew (1986), who tested how long an expression needed to be exposed to the viewer before it could be recognised, also tested how long was needed to determine the sex of a face. Most expressions established stable recognition thresholds at 12-25 ms (fear required longer), with the threshold for sex information also 12-25 ms in this study.

The story of simple independence is becoming more complex

The evidence outlined above is consistent with the formation of separate structural codes for the analysis of these different types of information (Bruce and Young, 1986). However, there are recent studies that have shown that, although the identity of familiar faces may maintain independence from expression and facial speech, the analysis of these last may be modified by the viewer's previous experience of whose face is being viewed. Schweinberger and Soukup (1998, Exps.1 and 2) used a speeded-classification version of Garner's selective attention paradigm and found that expression classification was indeed slowed by irrelevant identity variation in the filtering condition. Their Experiments 3 to 5 showed similar interference from identity for facial speech classifications. Schweinberger and Soukup's finding of an effect of identity on facial speech supports previous observations made by Walker, Bruce, and O'Malley (1995) who used moving clips of familiar and unfamiliar faces to test for susceptibility to the McGurk illusion. When familiar face clips were matched with unfamiliar voices participants showed reduced susceptibility compared with when unfamiliar face clips and voices were matched.

Asymmetrical relationships between expression and identity and sex and identity have been reported in a study by Ellis, Young, and Flude (1990). In an experiment in which participants first made a sex, expression or familiarity decision to a face, later familiarity decisions were speeded (primed) for all three types of previous exposure. However, later sex decisions were not primed from previous sex or familiarity decisions, nor were later expression decisions primed from previous expression and

familiarity decisions. Saying whether a face was familiar or unfamiliar therefore did not speed either sex or expression decisions to faces. The implication is that identity information is processed automatically during the first exposure to a face, no matter what the decision required. A similar asymmetry between facial speech and identity has been reported by Campbell and de Haan (1998). Identity decisions were primed by faces seen previously during a speech-reading task, but speech-reading was not primed by identification.

The motivation of a large part of this thesis is linked to the evidence outlined briefly above for although the weight of the evidence is currently in favour of the independence of expression from other types of information from the face, it is the intention here to take another look at the asymmetrical relationship between expression and identity reported by Schweinberger and Soukup (1998, Exps. 1 and 2). The interference found by Schweinberger and Soukup is surprising in that, if it is the invariant features of the face that are attended to when building a representation of identity compared with the constantly changing components of an expression, intuitively, a relationship would not be expected. Clarification of the relationship between expression and sex would also be helpful as this has not yet received much explicit attention. In contrast to the comparison between expression and identity information, expression and sex information may be the same. For example, the discrimination of anger and surprise depends partly on attention to the area between the eyelid and eyebrow and this is one of the key areas of the face implicated in sex discrimination. Intuitively, a relationship here would be expected. In addition, as our current understanding of the relationship between gaze direction analysis and any of the above is lacking, the independence of expression and gaze processing is also explored. In this case, it might be expected that the interpretation of an expression would be affected greatly by the gaze direction of the encoder and vice versa. The difference between someone with an angry expression looking at you compared with someone angry looking away could, quite reasonably, have a critical effect on your response.

Within the confines of the cognitive laboratory tasks used in the evidence considered so far, expression is treated as recognisable on the basis of configural properties alone. While this may well be sufficient to answer certain questions, the emotional response of the participant is not emphasised in this type of enquiry. The experimental participant is not really expected to take fright at an angry face appearing on the monitor, or be pleased or alerted if happy or surprised faces are seen. If, however, the emotional response is foregrounded, evidence of an affective response in the decoder might be revealed. Outlined below are some approaches that have grappled with this type of enquiry.

The function of emotion in cognition

It is no longer sufficient to study cognition in the absence of emotional processes if our intention is to produce a unified theory of behaviour, a theory that "aspires to explain the whole cognitive person" (Simon, 1994, p. 8). A network that represents and transforms knowledge is impressive, and inhuman. There is great public interest in this aspect of human science, and commentators on the irrepressible 'progression' of science (e.g., Melvyn Bragg in the magazine programme *in Our Time*, BBC Radio 4, 29.04.99) ask questions that are at once obvious and seemingly intractable: Will computers ever feel/ be conscious/ know how to prioritise all that information they have at the end of their virtual neurons to take real decisions? It is difficult to think of computers experiencing emotional states. It does not help, Simon points out, that the fields of cognition, on the one hand, and motivation and emotion on the other, have been assigned to different groups of psychologists.

It also does not help that the vernacular understanding of emotion includes both those emotions described as 'basic' and those that philosopher and evolutionary psychologist Griffiths (1998) describes as the higher cognitive emotions like love, envy, revenge, and so on. Griffiths suggests that, for the time being, and to allow the

formation of empirical questions, a distinction be made between those emotions that can be shown to be cladistic (have systematic phylogenetic origins), and those such as love, that require further conceptual work on the part of psychologists. Among those who have looked for an effect of emotion on cognition, attention, memory, and problem solving have been targeted as mechanisms likely to reveal any impact (e.g., Bower, 1981; Eysenck and Keane, 1995; Oatley and Johnson-Laird, 1987, 1998; Reid, Gilbert, and McGrath, 1998).

An influential theory

Oatley and Johnson-Laird (1987) have produced an influential cognitive theory of emotion based on the evolutionary ideas about emotions and emotional expressions. They propose that emotions are functional and communicative and that facial expressions are part of the expressive behaviours that accompany actions based on signals within the brain. This signalling system specifies modes of processing that are influenced by goal priorities. When there is a significant juncture or interruption in a plan, then an emotion will function to supply the mechanism that will accomplish and maintain the transition. There is a basic set of emotions specified as including happiness, sadness, anger, fear and disgust. The mechanisms underlying fear, for example, facilitate the detection of threat in the environment and help the organism to respond promptly and effectively to threatening situations.

In a revised version of their theory, Oatley and Johnson-Laird (1998) modify the way they conceptualise those emotions that make up the core set to exclude disgust. They suggest that the feelings of happiness, sadness, anger, and fear are basic and universal. While these emotions are usually experienced as brief and relatively intense with a knowledge of their cause, they can also be experienced as free-floating states and so form the basis of moods or temperaments (for an alternative conception of how emotions relate to moods see Griffiths, 1998). A free-floating form of fear could also be anxiety: that of sadness, depression. A further five innate, biologically based emotions

are described: attachment, parental love, sexual attraction, disgust, and interpersonal rejection. These five differ from the previous four in that it is deemed necessary for them to have objects. (Note that even the most basic accounts of emotional organisation are to a large extent fluid.) According to Oatley and Johnson-Laird (1998), each kind of emotion has its own distinctive cognitive organisation. These are attentional characteristics, biases of memory, and characteristics of problem solving. Attention, in particular, has been focused on as a key mechanism mediating motivation and cognition (e.g., Derryberry and Tucker, 1994).

Emotion and attention

Attention can be described as the mechanism that allows us to withdraw from some objects in the (internal or external) environment and concentrate on others. It can be 'captured' either involuntarily or 'focused' by the application of mental effort. A distinction is made in the literature between preattentive processes that occur in parallel and are unselective, and selective attention that functions to control the order of processing and reduces interference. Yantis (1998), for example, with regard to visual attention, makes a distinction between stimulus-driven selection when some salient attribute of the stimulus captures the viewer's attention and goal-driven visual selection which is controlled by the observer's deliberate strategies and intentions. These processes coordinate to yield coherent performance, and experiments show that attentional control results from an interaction between the properties of the image and the observer's intentions. If emotions function to alter attention, then emotional manipulations in the laboratory, even minor ones such as exposure to a black and white still image of a hostile face, might be expected to have an effect on some measure of attention.

Tasks used in the assessment of attention have included: dichotic listening techniques (Cherry, 1953) where the participant's ability to focus on a message presented to one ear while ignoring the message presented to the other is tested; visual

selective attention tasks (such as those pioneered by Stroop, 1935, and Garner, 1974) where the participant's ability to focus on the visual information relevant to the task and ignore irrelevant information is tested; visual search tasks (see Wolfe, 1998, for a review) in which the participant has to find a target in the presence of distractors; eye movement studies (see Hoffman, 1998, for a review) where the viewer's eye movements are tracked to determine the focus of overt orienting to the stimulus; and choice reaction time tasks (e.g., Welford, 1952) in which the participant responds quickly to the identity of the stimulus making one of a number of responses depending upon the identity of the stimulus. In the majority of cases the stimuli used in attention experiments are affectively neutral.

Selective attention and emotional stimuli - a 'case study'

A notable exception to the use of neutral stimuli is where the Stroop (1935) task has been used extensively by researchers interested in the relationship between vigilance for threatening stimuli and emotional disorders (for a review see Williams, Mathews, and MacLeod, 1996). Participants in the original task developed by Stroop are asked to name the colour of the ink in which either a row of 'Xs' or a colour word is printed. The colour word, for example, may be 'red' printed in green ink or 'brown' printed in red ink. The time taken to do this task is substantially longer when naming the ink colour of words antagonistic to the meaning of the ink colour (such as in the examples given above) compared with when the words are meaningless. The adaptation of this task to the 'emotional' Stroop has involved using concern-related words (e.g., cancer, disease, etc., for people who are anxious about health), and comparing colour-naming time to neutral words matched for frequency (e.g., basket). People with anxiety (nearly always) and depression (sometimes) show biases for certain types of affectively significant words compared to people without these emotional disorders. The main interference effect has been replicated many times with increasingly detailed differences revealed depending on the severity of the disorder, the types of words used, contextual effects, therapeutic treatment, and so on (see Mathews, 1994; Mogg and

Bradley, 1998, for recent reviews). Experiments using expressive faces instead of words are few. There is however recent evidence (Bradley, Mogg, Millar, et al., 1997) to suggest that although non-clinical participants with higher than normal levels of depression show no bias either towards or away from negative emotional expressions, participants with low levels of negative affect, show an attentional bias away from threatening expressions and towards positive ones. The use of the Stroop task has yielded rich returns in understanding the underlying biases of emotional disturbances. The attentional tool chosen for use in a large number of experiments in this thesis is Garner's selective attention task, and a detailed account of the method and inferences that may be drawn from particular patterns of result when this task is used is given later, in Chapter 3.

Thesis aim

The central aim of this thesis is to look for interference (in non-clinical populations) between emotional expression processing and the processing of other types of information. If emotions are central in cognition, then maybe they should be expected to pervade other aspects of face processing more than they apparently do. Also, in some cases the information base (as for sex and emotional expression) seems to overlap partially, or implication is linked (as for gaze direction and expression). Time perception and probability learning are known to be core cognitive abilities on which very little experimentation has been carried out with affective stimuli (see later for reviews of the relevant literature): They are targeted specifically to determine how well they withstand the impact of threatening expressions.

Thesis organisation

The very first task was to film a large number of people posing expressions to provide a stimulus set from which experimental materials could be drawn. Chapter 2 is devoted to a description of how these expressions were elicited, edited, and rated.

After this, there are three chapters that are concerned with the relationship between expression information and other types of information from the face. As the face communicates multiple signals, it seems logical to start by exploring possible interactions here. Schweinberger and Soukup's (1998) suggestion that the situation between expression and identity processing may be more complex than simple independence is taken up. It is of interest to see whether, or how far, Schweinberger and Soukup's findings generalise, and the method they used is replicated in Chapter 3 to test the independence of expression and identity information. Chapters 4 and 5 continue the use of this method together with other experimental techniques to look at expression and sex, and expression and gaze respectively. Garner's methodology is scrutinised in Chapter 6 on the grounds that any results are only as good as the tool used to produce them.

In Chapter 7 a break is made with other types of facial information as potential interactants and our awareness of time passing is targeted as a process that might show interference. In the first experiments in this chapter, participants are asked to make estimates of ten second intervals while viewing expressive faces. In later experiments, stimulus durations of very much shorter (20 - 170 ms) are judged.

The effect of negative expressions on probability learning is explored in Chapter 8. This involves a series of replications of what is, by now, quite an old finding (Rosenhan and Messick, 1966), and it appears to be a relatively fragile phenomenon. The last of these replications is combined with a memory test in an attempt to extend and explain the effect of emotional expression on a form of processing once considered immune to the effects of affect (Hasher and Zacks, 1984; Reber, 1989).

Finally, Chapter 9 contains a summary and an evaluation of the evidence found for interference. The implications of these findings are discussed and suggestions for future research are put forward.

Overview

The integrated study of cognition and emotion is to the benefit of both fields of enquiry. Research on emotional expression since Darwin, including research on recognition and categorical perception, has done much to confirm and refine his original observations. For the purpose of this thesis, the pragmatic assumption is made that emotional expression information is represented and transformed by processes that are accessible to those same techniques used by cognitive psychologists to study affectively neutral information. Discrete emotions may have characteristic attentional, memorial and problem solving profiles and this idea has been used to good effect in our understanding (for example) of how cognitive processing may proceed in people with emotional disorders. In this thesis use will be made of cognitive psychological techniques to look for interference between the processing of emotional expression and the processing of other types of information. Initially, other information from the face will be considered, with further experiments investigating the effects of emotional expression processing on time estimation and learning. Literature and experimental methods relevant to each of the chapters that follow will be reviewed as appropriate. The next chapter deals with the collection and assessment of the stimulus set.

2

Collection and assessment of expressions

The first task was to collect a large number of expressions from which experimental materials could be drawn. This chapter is in two parts. The first describes how expressions were elicited, filmed and assembled for assessment. The second describes the judgement procedure and reports the results of this process. As it was necessary to compile a stimulus set for further use, the opportunity was taken simultaneously to explore some issues relevant to expression collection and assessment generally. These are the issues to do with the use of posed expressions, whether expressions are perceived categorically or dimensionally, and whether or not there are encoder and decoder sex differences. These issues are seen as additionally relevant to the experiments that follow, rather than as central to each chapters' theoretical basis.

Posed vs. spontaneous expressions

Much of expression research is built on the posed expressions of actors and a ready criticism of this work is that the expressions used are not valid ecologically. The actor generates the representation of an expression on their face, and, possibly, holds in mind the representation of an emotional incident once experienced. This is a very different situation from one in which intense emotion is experienced and recognised spontaneously. However,

it was decided to collect posed rather than spontaneous expressions for a number of reasons.

There are several points to be made vindicating the use of posed expressions besides their relative ease of collection and their smaller comparable cost. On the question of validity, Rosenthal (1982) cites evidence to support the idea that producers of clear spontaneous expressions are good at producing clear posed expressions and that decoders who are good at recognising spontaneous expressions are good at recognising posed expressions. Gosselin, Kirouac, and Doré (1998) also report a high level of consistency between posed and spontaneous expressions. People can and do produce facial display signals that they assume will be understood by a viewer in the way they intend whether these are reflective of 'genuine' felt emotions or not (see Bavelas and Chovil, 1997 regarding the signification of emotionally expressive facial displays in dialogue), and viewers do agree which label to apply to posed expressions, even given a still image and a limited selection of alternatives.

While it is granted that the use of posed expressions does not allow for the possibility that some facial expressions of emotion may be difficult, if not impossible, to produce veridically voluntarily (see Ekman, 1993, regarding the difficulty of producing anger, fear, and sadness) and that signals of 'deception' may be either missed or misrecognised by viewers, the rating process is carried out to ensure consistency of recognition. In the present study, in addition to being asked to select a single emotion word out of a list of seven, raters were asked to construct a 'profile' of each expression to indicate how much of each of the seven emotions they thought present. It was assumed that raters would use the profile to signal how good an example of its kind they thought each expression was, and that any marked unnaturalness about the item would be registered here. Selection of an emotion word and the expression profile were both used to establish criterion recognition. As additional points in favour of the use of posed expressions, the origination of the expressions will be replicable and findings comparable to other findings reported in the

literature where much of the work has been with posed expressions. Collecting posed expressions also allows ethical consent to be obtained prior to filming.

Categories or dimensions?

The limited set of seven expressions chosen include anger, disgust, fear, happiness, sadness, surprise, and neutrality. As mentioned in Chapter 1, Ekman (1992a) argues for the universal recognition of emotions from facial expressions for at least five distinct emotions (anger, disgust, fear, happiness, and sadness) and possibly "three or four more" (p. 551). He marshals evidence from cross-cultural studies (although see Russell, 1994 for a methodological critique), and psychophysiology (characteristic patterns of ANS activity are associated with some facial expressions) in support of his position. There is evidence that the amygdala is involved in the expression of fear (Le Doux, 1995, 1998, for reviews) and recent neuropsychological findings suggest separate neural substrates may be implicated in the recognition of fear (Calder, Young, Rowland et al., 1996; Young et al., 1995) and disgust (Sprengelmeyer, et al., 1996). Studies using morphed facial expressions (e.g., Young, et al., 1997) are interpreted as supporting the categorical perception of expressions. Young et al. (1997) in addition, demonstrate that 'neutral' is perceived as a category and not as the midpoint between 'dimensions'. Choosing the seven listed above for collection does not presume any equivalence between members of the set.

The competing 'dimensional' model of the 'emotion space' has been taken into account in the assessment of the stimuli collected in this study. In addition to selecting a categorical label for each stimulus item, raters were asked to make judgements about how much pleasure (or displeasure) and arousal each face was showing. Russell's (1980; Russell and Bullock, 1985) 'circumplex' model places categorical descriptors (happy, sad, angry, etc.) at specific locations around the edge of a judgement space defined by degree of pleasure and degree of arousal (see Figure 1). Using a prototype approach to describe emotions Shaver, Schwartz, Kirson, and O'Connor (1987) suggest that, while emotion words refer to a 'mere handful' of basic-level emotions, a dimensional description is also

meaningful, the two forms of representation revealing different aspects of emotion knowledge.

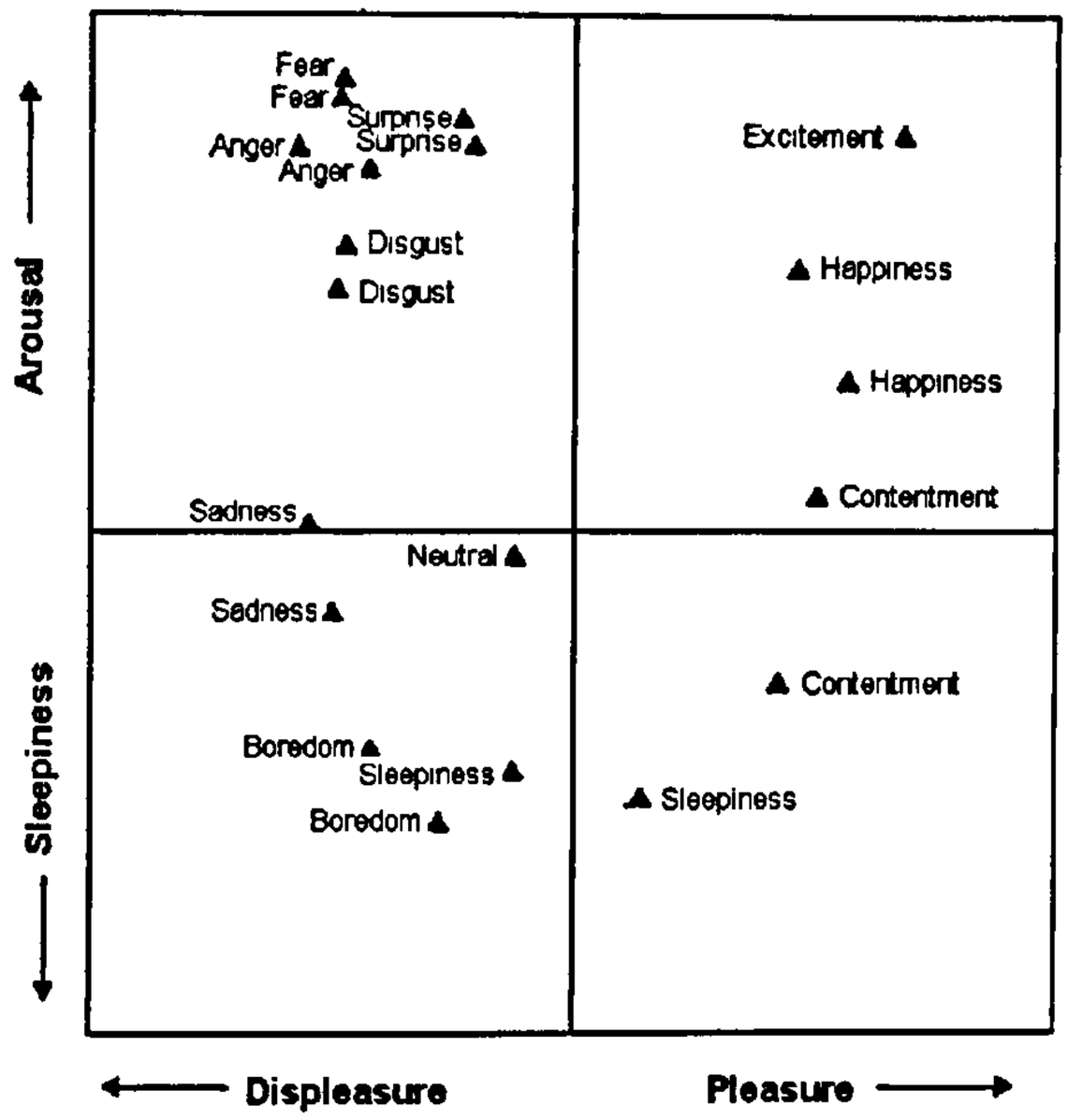

Figure 1. Twenty facial expressions of emotion in a space defined by pleasure-displeasure and arousal-sleepiness axes (from Russell and Bullock, 1985).

Yamada (1993) found that participants asked to produce schematic faces expressing six basic emotions using a computer graphics program (Exp. 1) distorted a schematically neutral face (see Figure 2) in a way that could be described by the two factors of 'curvedness/ openness' and 'slantedness'. The first is strongly correlated with the displacements of the middle points of the eyebrows, upper eyelids, and the upper and lower lips. The second factor is strongly correlated with the endpoints of the eyebrows and the eyes. The results of a judgement study using the faces produced in his Experiment 1 as stimuli were interpreted as indicating that participants used these dimensions to make categorical judgements. Yamada relates the findings from this study to those of theorists deriving dimensions from affective semantic meanings and finds a comfortable correspondence while emphasising that categorisation is the task of placing similar expressions into groups and should be based on the visual information in the face.

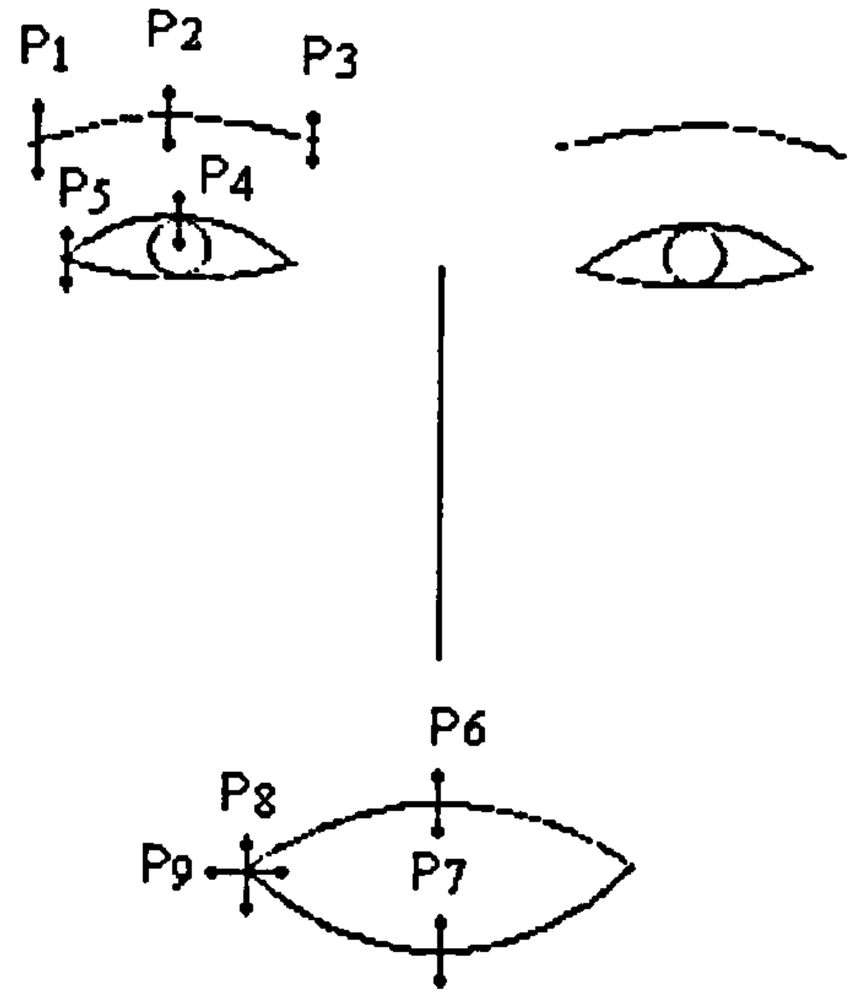

Figure 2. The neutral schematic face used by Yamada (1993). Each feature point (P1 - P9) could be displaced vertically and the outer corners of the lips (P9) could be displaced horizontally to create happiness, surprise, fear, sadness, anger, and disgust.

A number of diverse cognitive effects have been reported for affective stimuli that vary on arousal and valence dimensions with explanations, where they are attempted, invoking either memory, or attention, or both. For example, a study by Bradley, Greenwald, Petry, and Lang (1992) on memory for pictures that varied along affective dimensions for pleasantness and arousal found that reaction times to unpleasant pictures (cf. pleasant) that had not been seen earlier, were longer, but that valence per se did not have a significant effect on long-term memory. Pictures rated as highly arousing regardless of valence were better remembered than low arousal or neutral counterparts. In a study comparing negatively valenced stimuli only, Hansen and Shantz (1995) report emotion-specific effects within the categories of anger, sadness, and fear. They suggest that, in a divided attention task, information congruent with the to-be-remembered category may be schematically processed whereas 'attentionally controlled processing' may be reserved for incongruent information. Rosenhan and Messick (1966) report an effect of the valence of facial expression (angry cf. happy) on implicit learning within a probability learning paradigm and Thayer and Schiff (1975) found that when female viewers were confronted with a female making an angry face they made greater overestimates of the time they were exposed to this stimulus than if the person was making a happy face. There is a high level

of agreement in the literature therefore as to the usefulness of both categorical and dimensional assessments of expressions.

Information on raters' judgement of the relative 'mixture' and 'intensity' of expressions (the 'profile') was also collected using the category rating procedure outlined by Rosenthal (1982). As mentioned above, this measure was used together with the 7-alternative forced-choice question to assess criterion agreement for individual stimuli. Oster, Hegley, and Nagel (1992) used a similar procedure in an assessment of the usefulness of Max formulas (Izard, 1983, as cited in Oster et al., 1992) and the Facial Action Coding System (FACS; Ekman and Friesen, 1978, as cited in Oster et al., 1992) on infant faces and concluded that the more global estimate of negative emotion, 'distress', was of more use as negative affect expressions are not fully differentiated in children. If the production of clearly differentiated expressions is tied to the recognition of clearly differentiated expressions, the potential for the use of this stimulus set in work with children is enhanced by the inclusion of this intensity measure as well as categorical classification and arousal and (dis)pleasure ratings. It is not, however, intended to test infants in the experiments for this thesis.

Sex differences in encoding and decoding expressions

There is some evidence to suggest that females are better at communicating emotion via facial expression than males (e.g., Wallbott, 1988). However, although females may also perceive themselves to be more expressive than males, this is not always confirmed by judges' ratings (Barr and Kleck, 1995). The situation is similar with sex differences and the recognition of expressions as there are studies that have found Female[2] perceivers are better at decoding emotions than Males (e.g., Briton and Hall, 1995). A study by Duhaney and McKelvie (1993), however, who used photographs taken from Ekman and Friesen's (1975) set, did not find any difference between men and women raters for identification of

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[2] Upper case initial letters are used throughout when describing the sex of the decoder or participant with lower case used for stimuli.

expression, or for rated intensity. Stimulus collection and assessment in the current work were balanced for sex of sender and rater to test for sex differences for this particular set of expressions and sample population. Later experiments to test the independence of sex and expression processing also require the collection of approximately equal numbers of male and female faces from which to choose.

Collecting different views for expression and gaze direction studies later

Gaze direction, especially eye-contact, is also acknowledged as one of the principal components communicating social signals from the face (see review by Kleinke, 1986). There are some studies that report an interaction between gaze direction and emotional expression. For example, Dimberg and Ohman (1983) found that an acquired conditioned response to an angry face showed resistance to extinction only if the face was directed towards the participant during extinction. Also, gaze direction has been shown to be defective in addition to emotional expression processing in Young et al.'s (1995) patient DR. Very little is known about gaze direction and how information about this interacts with other types of information from the face. There is the possibility that a study by Campbell, Wallace, and Benson (1996), which revealed an interaction of gaze direction with gender assessment, may be relevant to expression research as there is an overlap between the perceptual cues used for each of expression, gender, and gaze direction determination. Briefly, they found that classifying a face as male or female was affected by whether or not the eyes were averted or looking ahead. Earlier expression research has not always controlled for gaze direction (e.g., Suberi and McKeever, 1977), and this may be of particular importance in recognition accuracy for some of the expressions (e.g., sadness). In addition to filming all expressions at a selection of congruent body and gaze angles, happy, angry, and neutral expressions were filmed at different angles in incongruent head/ gaze directions.

Summary of aims for Experiment 1

1. To assemble a set of facial expressions that achieve criterion levels of recognition for use in experiments carried out later in this thesis

2. To become informed at first hand about what happens (e.g., possible points of compromise) when collecting and submitting expressions for assessment in the 'artificial' experimental context used here

3. To explore Ekman's 'categorical' and Russell's 'dimensional' accounts of expression recognition by using assessment procedures that have been used by each of these researchers in the construction of their models (e.g., alternative forced choice questions and arousal and (dis)pleasure ratings)

4. To ensure the inclusion of equal numbers of male and female expressive faces and Male and Female assessors to test the idea that there may be sex differences in production and recognition

5. To film actors with different head and gaze directions to use in later experiments. (It is proposed to assess only those expressions in which the actors' heads and gaze directions are both oriented towards the camera. That is, not all angles of view of the same expression will be assessed.)

Experiment 1

Part 1: stimulus collection

Participants and consent

Fifty-one actors (25 male, 26 female) were recruited, each for a half-hour filming session, after placing an advertisement in the Stage newspaper. The mean age of the males was 34 years (range: 23 to 52 years) and the mean age of the females was 33 years (range: 20 to 67 years). Two males with facial hair and one black female responded to the advertisement who were filmed and copied to VHS but who have not been included in further assessment procedures to date. All signed a consent form allowing their images to be used in scientific experiments to do with information from the face and all agreed that their image could be used anonymously in publications on this subject. In addition, 40 signed consent for their images to be placed on the Internet. Actors were paid £10 (UK) towards their expenses.

Procedure and apparatus

Filming took place at Birkbeck College (London) in a room approximately 2.8 m long by 2.3 m wide (see Figure 3). Diffuse overhead lighting was provided by a single fluorescent lamp, white walls and no windows. Additional lighting was not used after the first day as the room became too hot and uncomfortable. A plain grey backdrop was used. Moving images of the head and neck were recorded on 8 mm video cassette (Sony Hi8 Super MP) using a portable 8 mm video camera (Sony CCD - TR2000E, 10X zoom) set on a tripod 1.5 to 1.7 m from the face of the actor. The actors were encouraged to 'method' act, using either a remembered experience or the script suggested by the experimenter to generate the emotion, and to allow the expression to follow naturally. In a minority of cases where the actors preferred to 'technique' act this was allowed. (See Carroll and Russell, 1997, for some differences in expressions that may be observed between the two methods.)

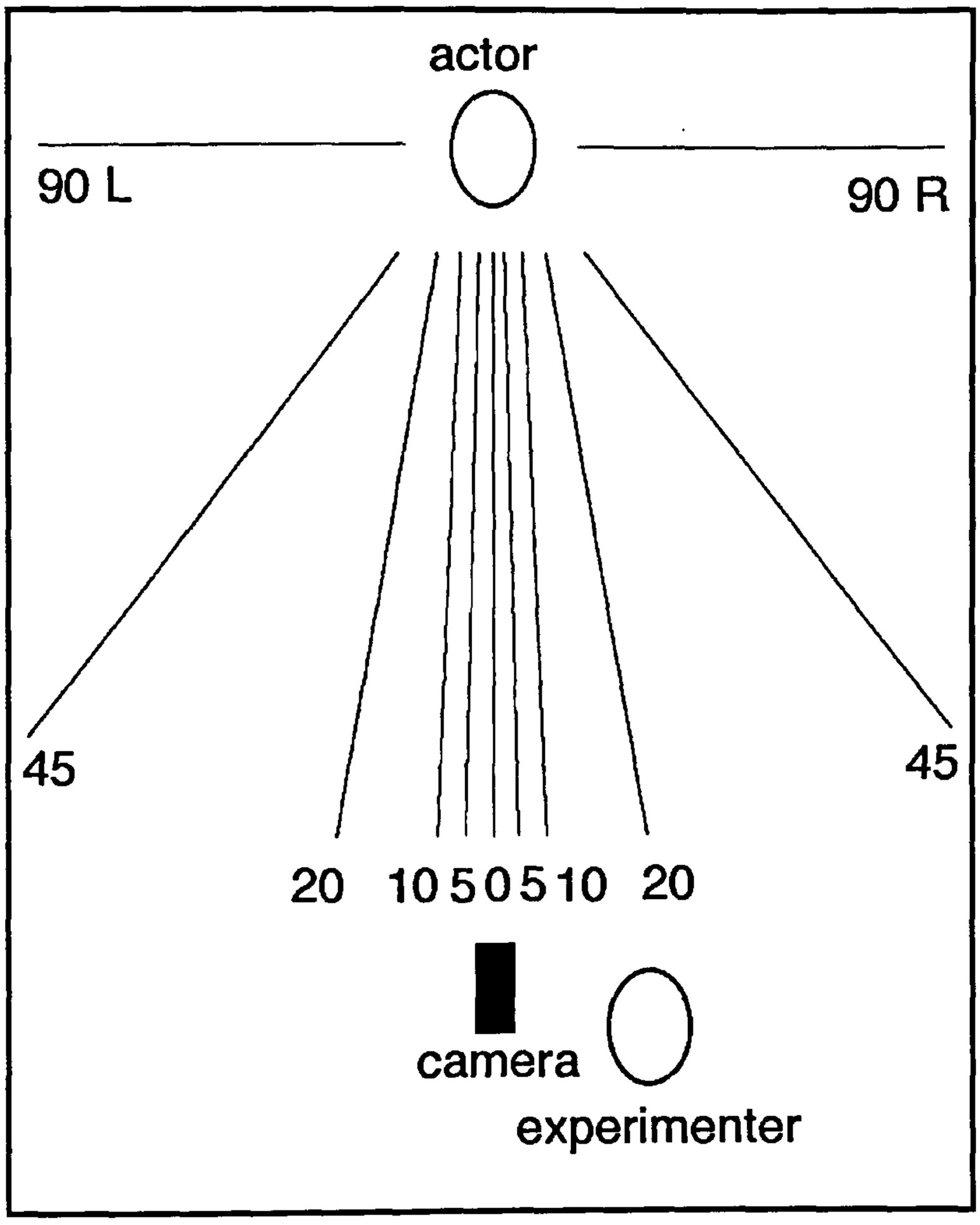

Figure 3. Filming set up for the collection of expressions.

Order of videoing and scripts used for eliciting expressions

The expressions were filmed in the following order: happy, angry, sad, fearful, disgusted, neutral, and surprised. At the first time of meeting it was assumed that display rules might dominate the extent to which emotional responses were expressed and requesting happiness first was designed to make this initial encounter flow more smoothly and set the actor at their ease for the rest of the task. To elicit 'happy': "What I would like

you to do is look through the lens of the camera and focus about 3 inches behind the lens on someone you have been really happy with. It's a kind of uncomplicated happiness I want- choose a situation that's not muddled up with other feelings."

Anger was filmed next while the actors were still reasonably 'fresh' as it seemed to require a lot more energy and body tension than the other emotions (except perhaps fear). To elicit 'angry': "Imagine someone you have once been angry with and confront them with your feelings. This person knows that you are **really very angry**. It's the kind of anger that - if you weren't a civilised person - you would do something." Sadness next provided the actor with an opportunity to 'relax' (an interesting functional connection) and to be slower moving both internally and externally. Many of the actors found it difficult to raise their eyes to the camera. To elicit 'sad': "The kind of sadness I want is inconsolable loss. You can do nothing about the situation that is making you sad. It is hopeless. Almost tears but not quite."

The remaining expressions were organised to place neutral before surprise to, as far as possible, try and avoid the confusion sometimes made between surprise and fear or surprise and delight both by producers of the expression and viewers. To elicit 'fear': "Imagine one of those fast moving machines like a lathe or a paper shredder that churns things up and your watch strap is caught and your fingers are heading towards.....OK?" To elicit 'disgust': "You know... you're walking down the street and next thing you know you have stepped in some dog muck - you lift your shoe to get a good look...that's it." To elicit 'neutral': "Relaxed alertness. You are still there for other people - neither pleased nor displeased. Just doing the day." To elicit 'surprise': "Neither surprise as in someone has thrown you a surprise party or surprise as in someone's pulled a knife on you. Surprise that is more to do with not believing something and startle."

Angle of expressions and gaze directions recorded

All expressions were filmed head, body and gaze to camera (0°), 5°, 10°, 20°, 45°, and 90°L (L = the viewer's left) and then 5°, 10°, 20°, 45°, and 90°R (R = the viewer's right). The actors, who were sitting on a revolving chair, paused and regenerated each expression for every angle. They focused on markers set at eye level around the room. For happy, angry, and neutral expressions in addition, the actors were asked to maintain their head and body orientation towards the camera while turning their gaze to 5°, 10°, 20°R, and 5°, 10°, and 20°L. They were then asked to keep their head and body oriented to 20°R while turning their gaze to the 10°R, 5°R, and 0° markers and similarly so, head and body oriented to 20°L while turning their gaze to the 10°L, 5°L, and 0° markers. As far as possible, the actors were monitored to see that they achieved constancy when moving from one angle to the next. Encouraging words (e.g., good, very good) at the generation of each expression signalled to the actor when to move on. Each actor was filmed according to the same protocol unless they seemed inexperienced, when a shortened version omitting the incongruent gaze sequences for happy, angry, and neutral was used.

Preparation of the materials for assessment

The 8mm videotapes were copied to VHS prior to editing using Apple MacIntosh Media100 software. Unfortunately sporadic overheating of the copying equipment meant that some of the stimuli were lost at this stage. Faces from 43 actors were edited further. (Face Nos. 42 and 43 were combined to create a set of 7 expressions: see procedure and materials section and Table 1 in the results section in Part 2 for further detail.) A two second moving clip (after Rosenthal, 1982) using only the 0° view for each of the seven emotional expressions for each of the actors was selected. Within this interval a single still frame that was judged by the experimenter to represent the 'peak' of the expression was transferred to Adobe Photoshop and printed out (image size, 185 mm x 125 mm) on to an A4 sheet (see Figure 4 for a scaled version of what the raters saw). This gave 294 images (7 expressions x 42 different actors) that were then assembled into 7 different books (A, B, C,

D, E, F, and G) containing 42 images each, such that each actor was seen once in each book and all expressions were seen an (almost) equal number of times.[3]

Figure 4. Face No. 7. An example of an image as seen by raters (scale: 1: 2).

Part 2: stimulus assessment

The outcome of primary importance in this study was how many and which of the stimulus faces would achieve the criteria for agreement with the experimenter as to what emotional expression was intended. Of secondary interest was whether there would be differences in agreement between Male and Female participants to male and female faces.

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[3] The uneveness in this design is created by combining female Face Nos 42 and 43. The details of this adjustment are in Part 2. Scores were converted to percentages and the items concerned were reserved for use as practice stimuli.

Method

Participants

Seventy participants (Ps) (35 M, 35 F) agreed to rate the stimulus faces. They were students, academic and technical staff of Stirling University, and acquaintances of the experimenter. All had normal or corrected to normal vision. None were paid for their participation.

Design

This study had a 2 x 7 x 2 mixed design with sex of participant at 2 levels (M, F), the within subjects variable of expression at 7 levels (angry, disgusted, fearful, happy, neutral, sad, and surprised), and sex of stimulus face at 2 levels (m, f). Dependent measures were, in order as they appear on the rating sheet (see Appendix A for questions and response scales), for each expression:

- Q1. (7-alternative forced choice). Category agreement with the intended expression was scored as recognition accuracy
- Q2. 'Success' ratings were ignored for the purposes of analysis
- Q3. Category ratings (intensity) for the 'blend' of emotions in each face. These were used in conjunction with Q1 responses to score criterion agreement
- Q4. Arousal ratings
- Q5. (Dis)pleasure - pleasure ratings

Procedure and materials

Ps were asked to fill out a response sheet for each of 42 faces in one of the books assembled in Part 1 of this experiment. They were asked not to look forward or back over their responses and to concentrate on their felt experience while making their judgements. If there was any doubt about their understanding the instructions, the experimenter waited while the first response sheet was filled out to respond to queries. Ps were tested individually and different Ps assigned to each of Books A, B, or C etc. saw the faces in a

different order (see Russell and Fehr, 1987, for a description of some of the systematic effects obtained depending on what other expressions are seen).

Ten Ps (5M, 5F) rated each expression. Within each of the folders there were 3 examples each of anger (a), disgust (d), fear (f: note that where f = female and f = fear might be confused, the unabbreviated label will be used), happy (h), neutral (n), sad (s) and surprise (su) from male actors and 3 examples of each of these expressions from female actors except in Book B, where owing to the technical fault during image copying, a 'sad' expression (Face No. 42) was lost, and replaced by an angry expression from an additional female actor (Face No. 43). The 10 Ps who rated Book B therefore saw 4 af (angry female) faces and 2 sf (sad female) faces and 3 of all the others.

<u>Criteria for scoring recognition accuracy, agreement, and misattribution</u>

Responses to both Q1 and Q3 were taken as either agreement or disagreement in the following way: Examples are given as if to a 'fear' face.

- The rater made a response to Q1 that was congruent with their intensity profile. That is fear was selected (Q1) and fear was indicated to be more intense than any other emotion (Q3). This was scored as accurate and as agreement.
- The rater made a response to Q1 that was other than fear (e.g., sad) and rated this emotion as being most intense. This was scored as disagreement and as a 'sad' misattribution.
- The rater made a response to Q1 that indicated they thought the photographer was looking for an expression of fear but, actually, the rater thought that disgust (for example) was more intense. This was scored as disagreement, as a misattribution *and* as if the rater had chosen disgust in Q1 (i.e., as inaccurate).
- The rater chose fear for Q1 and rated fear and disgust as being of equal intensity. This was scored as agreement.
- The rater chose disgust for Q1 and scored fear and disgust as being of equal intensity. This was scored as 50% agreement and as a 50% disgust misattribution.

- The rater chose fear for Q1 but indicated two others as being of higher equal intensity.

There were 3 responses of this type out of a possible total 2940 (10 raters x 42 faces x 7 expressions). These were scored as disagreement and discounted for the purposes of scoring misattributions.

Each stimulus item was considered to have achieved criterion agreement if at least 70% of the raters were accurate at (Q1) and the category rating profile for a particular image (Q3) followed the profile of the emotion of interest of those that reached 70% agreement. For example, a comparison of male Face Nos. 34 and 35 disgust (Figure 5) makes this clear. Both achieved 70% agreement if Q1 alone was considered. However, Face No. 34d follows the composite profile of male disgust faces (see Figure 9), whereas Face No. 35d clearly does not. The former was considered to have achieved criterion agreement (and included in the composite profile) and the latter was not. When there are 7 alternatives, there is a 14.3% probability of an accurate response by chance alone; 67% agreement between rater responses is required to achieve significance at $p = .05$ (Rosenthal, 1982).

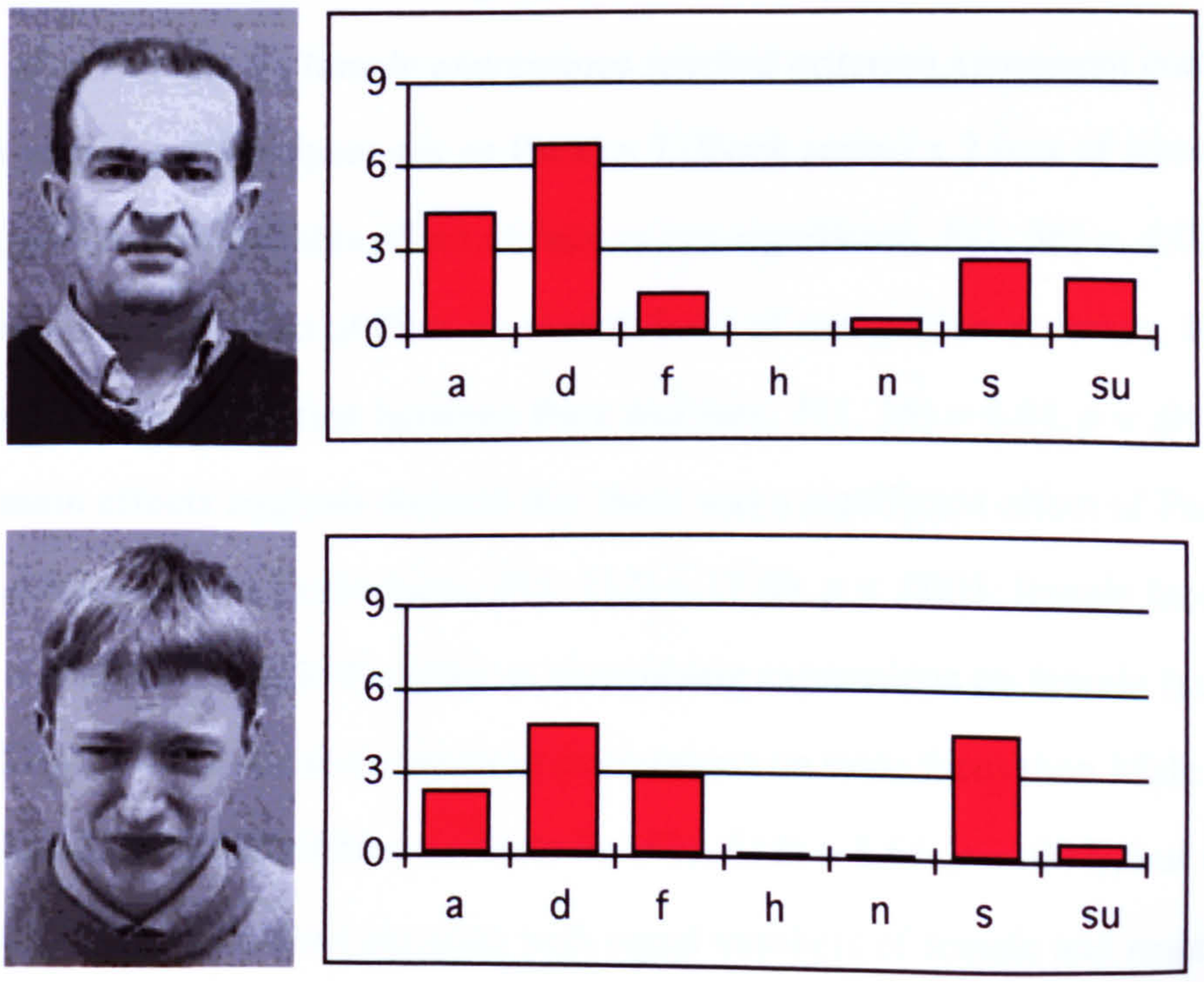

Figure 5. Comparison of Face Nos. 34d (above) and 35d (below) to illustrate criterion agreement. a = angry, d = disgust, f = fear, h = happy, n = neutral, s = sad, su = surprise.

Results

Recognition accuracy for all items.

Correct attributions

Taking the entire stimulus set into consideration 70.5% recognition accuracy was obtained. (Appendix B contains ANOVA summary tables for all experiments in this thesis.) Responses to individual items in the full stimulus set are summarised at Table 1. (Examples of items may also be seen in Appendix D.) Accuracy scores for all items and the rank for each item achieving criterion agreement are given. (Descriptive statistics only have been carried out for individual items.) It is intended that Table 1 be used as a reference table for the rest of the experiments in this thesis. Actors are given a number (leftmost column) and the status of each expression (level of recognition agreement and rank within each expression category) is seen at a glance. Only those expressions that achieved criterion agreement (those that are ranked) are used in the experiments that follow with the exception of some (marked by an asterisk) that are reserved for use as practice or distracter items.

There was slightly better recognition of female expressions compared with male (71.8% cf. 69%) and 91 female expressions reached criterion agreement compared with 88 male. A mixed 2 (Participant sex *or* Psex) x 7 (Book series) x 2 (sex of stimulus face *or* fsex) ANOVA revealed this effect of fsex as just significant, $F(1, 56) = 4.01, p = .05$. There was no main effect of Psex on overall level of recognition accuracy. However, there was a significant interaction between Psex and fsex, $F(1, 56) = 4.44, p = .04$ (Figure 6). A simple main effects analysis showed that there was a significant effect of Psex for both male and female faces (male faces, $F(1, 112) = 17.89, p < .0001$; female faces, $F(1, 112) = 7.73, p = .006$), with Male Ps better at recognising expressions on female faces than Female Ps and Female Ps better at recognising expressions on male faces than Male Ps. There was also a significant effect of fsex on Male Ps ($F(1, 112) = 8.64, p = .004$), but not on Female Ps. That is, Female Ps were accurate with equal numbers of female and male expressions whereas Male Ps were accurate with more female expressions than male expressions in the total set.

Table 1. Recognition accuracy of all stimulus items and rank within each expression of those that achieved criterion agreement (1 = best recognised taking into account intensity profile agreement)

	Expression													
	ANGER		DISGUST		FEAR		HAPPY		NEUTRAL		SAD		SURPRISE	
No.	Acc.	Rank	Acc.	Rank	Acc.	Rank	Acc.	Rank	Acc.	Rank	Acc.	Rank	Acc.	Rank
female														
1	35		90	9=	75		100	1=	80	8=	70	5	60	
2	95	5	100	1=	60		100	1=	60		80	2=	85	11=
3	40		100	1=	20		100	1=	100	1=	60		100	1=
4	70	12=*	100	1=	50		100	1=	100	1=	40		80	14=
5	30		85	12=	25		100	1=	100	1=	90	1	85	11=
6	100	1=	70	16	90	1=	100	1=	95	4	40		75	16
7	90	6=	100	1=	40		70	19=	80	8=	55		70	17=
8	90	6=	80	15	90	1=	70	19=	10		40		90	8=
9	100	1=	60		80	5=	100	1=	90	5=	40		100	1=
10	60		10		35		100	1=	80	8=	30		70	17=
11	35		85	12=	30		100	1=	10		40		100	1=
12	20		90	9=	0		100	1=	60		55		95	6=
13	100	1=	50		10		70	19=	70	13	25		100	1=
14	90	6=	100	1=	80	5=	90	16=	75	12	60		65	
15	90	6=	60		65		100	1=	30		40		100	1=
16	100	1=	65		70	8	100	1=	90	5=	75	4	90	8=
17	80	11	100	1=	90	1=	90	16=	80	8=	0		90	8=
18	40		100	1=	85	4	100	1=	85	7	80	2=	50	
19	35		90	9=	80	5=	100	1=	60		20		85	11=
20	50		85	12=	20		100	1=	60		55		95	6=
42	70	12=*	95	8	0		90	16=	65				80	14=
43	90	6=*												
s.tot.		10		16		8		21		13		5		18
male														
21	100	1=	80	9=	15		100	1=	100	1=	35		80	13=
22	90	8=	85	7=	65		100	1=	90	6=	25		90	6=
23	95	7	45		30		100	1=	90	6=	50		75	16
24	80	10	10		50		100	1=	100	1=	45		95	4=
25	40		75	11	50		95	18	95	5	20		70	17=
26	90	8=	100	1=	60		100	1=	100	1=	90	2	100	1=
27	100	1=	70	12=	45		100	1=	50		100	1	90	6=
28	30		90	4=	0		80	21	60		20		90	6=
29	10		20		35		100	1=	60		70	4=	90	6=
30	5		70		10		100	1=	80	10=	50		0	
31	55	*	100	1=	20		90	19=	70	14=	70		90	6=
32	100	1=	85	7=	80	2=	90	19=	70	14=	70	4=	70	17=
33	100	1=	90	4=	30		100	1=	60		70	4=	50	
34	50		70	12=	10		100	1=	90	6=	15		100	1=
35	40		70		80	2=	100	1=	75	13	10		100	1=
36	30		80	9=	50		100	1=	80	10=	55		90	6=
37	40		30		40		100	1=	80	10=	60		50	
38	100	1=	40		45		100	1=	70	14=	30		80	13=
39	20		90	4=	60		100	1=	90	6=	10		90	6=
40	55		100	1=	40		100	1=	65		80	3	95	4=
41	100	1=	60		90	1	100	1=	100	1=	70	4=	80	13=
s.tot.		10		13		3		21		16		7		18
total reaching criterion		20		29		11		42		29		12		36

* reserved for use as 'practice' or 'distracter' stimuli

When the data were examined, the better recognition of female expressions by Male Ps was found restricted to those stimuli that did not achieve criterion agreement. Those items that reached criterion agreement (by definition almost) were those that were recognised equally well by both Males and Females. There was a significant main effect of Book, $F(6, 56) = 5.59$, $p < .0001$ and a significant Book x fsex interaction, $F(6, 56) = 4.10$, $p = .002$. Female faces were recognised better than male faces in Books A to E, with male faces recognised better in F and G. The three-way interaction was not significant, ($p = .08$).

When a 2 x 7 x 2 mixed ANOVA was carried out with Psex, expression and fsex as variables, a strong main effect of expression was observed as expected, $F(6, 408) = 65.05$, $p < .0001$. In order of most to least accurate recognition for expression the results are as follows: happy, 96.1%; surprise, 81.7%; neutral, 77.4%; disgust, 75.2%; anger, 65.4%; sad, 49.3%, and fear, 48.3%. There was also an interaction between expression and Psex, $F(6, 408) = 2.33$, $p = .03$. (The interaction between Psex and fsex only approached significance in this analysis, $p = .08$, probably due to the almost perfect agreement for happy expressions.) This interaction was not analysed further as only those items achieving criterion agreement (recognised equally well by both Male and Female Ps) were to be selected for future experiments. For interest, Figure 7 shows recognition accuracy for Male and Female Ps to individual emotional expression categories for male and female faces.

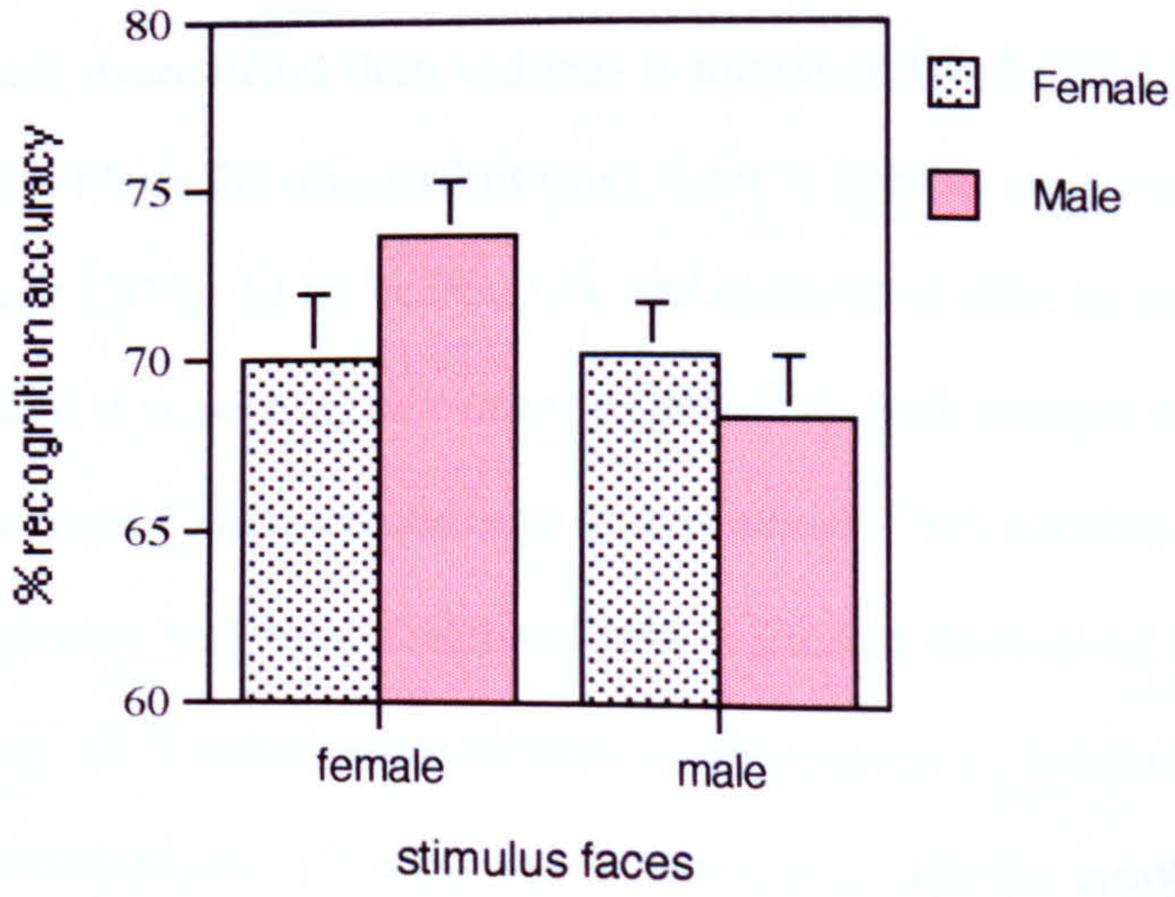

Figure 6. Female and Male assessors' recognition accuracy to female and male expressive faces. Vertical lines represent positive standard errors of the means.

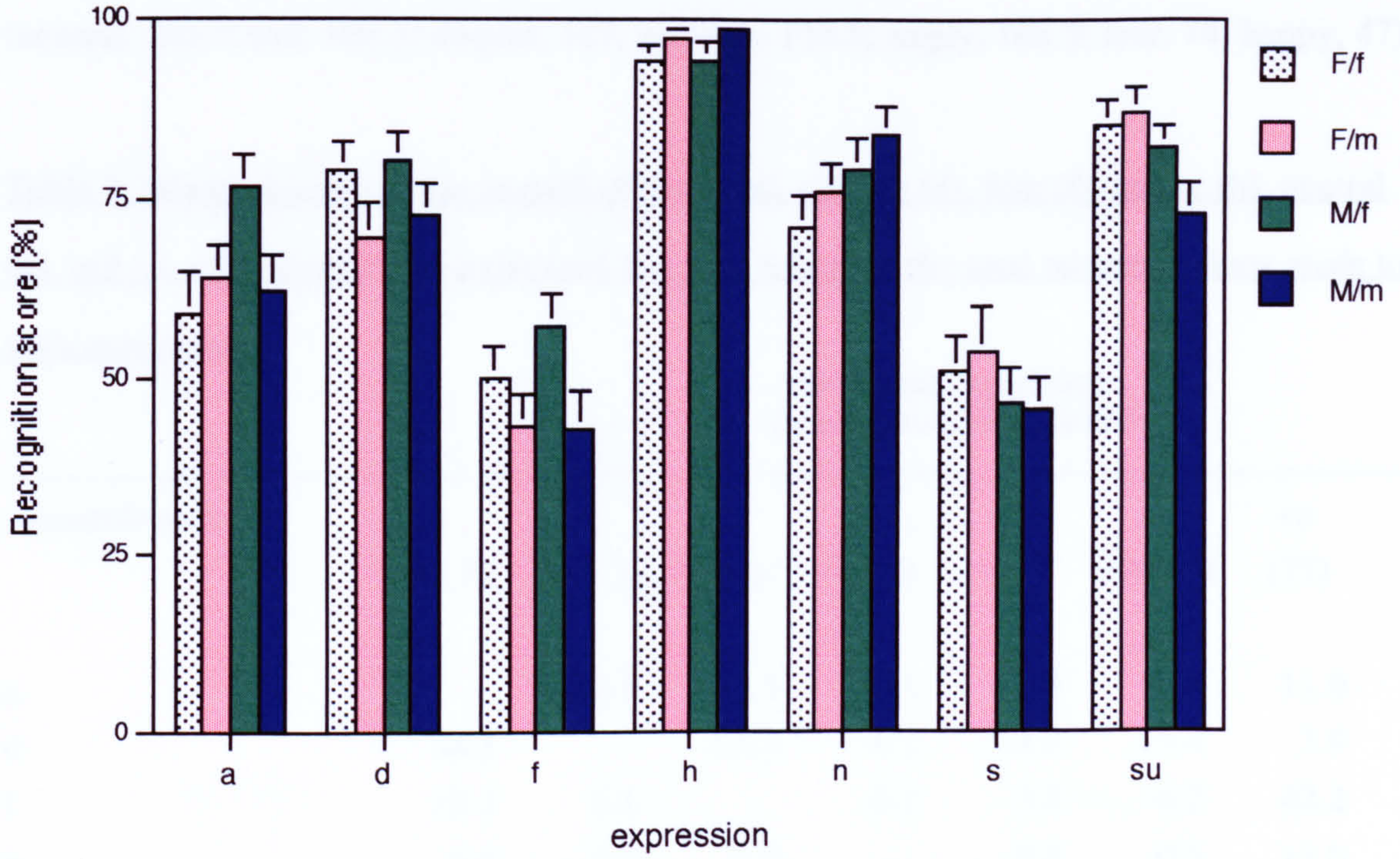

Figure 7. Mean recognition scores for Male (M) and Female (F) participants for each expression category for male (m) and female (f) faces. Vertical lines represent positive standard errors of the means.

Misattributions

Misattributions expressed as a percentage of the total number of misattributions to each expression are included at Table 2. For example, 50 raters said that anger was disgust. There were 146.5 misattributions in total to anger of which the disgust responses make up 34.1%. It can be seen that there is an asymmetry between some of the expressions. Disgust is mistaken as sadness more often than sadness is mistaken for disgust (66.7% or 71 actual misattributions cf. 13.4% or 28 misattributions). Fear is seen as sadness more often than sadness is seen as fear (20%, 44 cf. 6.2%, 13), and sadness is seen as neutral (63.5% , 132.5) more often than it is seen as any other expression, with neutral seen as sadness 46.8%, (44.5) of the time. (This comparison makes sense if the number of misattributions are high. When happiness was misrecognised it was seen as neutral 63.5% of the time, which represents only 10.5 actual misattributions. Happiness is, however, an exception and the next fewest misattributions, 77, were made to surprise.) Of the emotions chosen when

misattributions were made, neutral was chosen most often and happiness least often (neutral, 202.5; sad, 192.5; disgust, 127; surprise, 118.5; angry, 108.5; fear, 74; happy, 47).

Table 2. Misattributions made to each of anger (a), disgust (d), fear (f), happy (h), neutral (n), sad (s), and surprise (su) expressed as a percentage of the total misattributions made to each expression.

misattribution	emotional expression (+ total misattributions)						
	a (146.5)	d (106.5)	f (220)	h (16.5)	n (95)	s (208.5)	su (77)
a	-	14.5	21.1	6.1	15.3	10.8	11.0
d	**34.1**	-	14.3	6.1	14.2	13.4	3.9
f	12.3	6.1	-	6.1	3.2	6.2	**42.2**
h	6.5	0.5	8.2	-	8.4	0.5	13.0
n	22.2	5.6	0.9	**63.6**	-	**63.5**	24.7
s	19.8	**66.7**	20.0	0	**46.8**	-	5.2
su	5.1	6.6	**35.5**	18.2	12.1	5.5	-

Arousal and (dis)pleasure - pleasure ratings

Scatter plots for all items are shown at Figure 8.

Items achieving criterion agreement

Individual items reaching criterion agreement are those that are ranked at Table 1.

Category rating (intensity) profiles for ranked items

Composite profiles for all male and female items in each expression category are set out in Figure 9. It can be seen that, apart from happiness, there is a background level in addition to the target expression of almost all other emotion categories presented for selection, even for those expressions that achieved high levels of accuracy (e.g., surprise, which was recognised approximately 82% of the time has relatively high levels of fear).

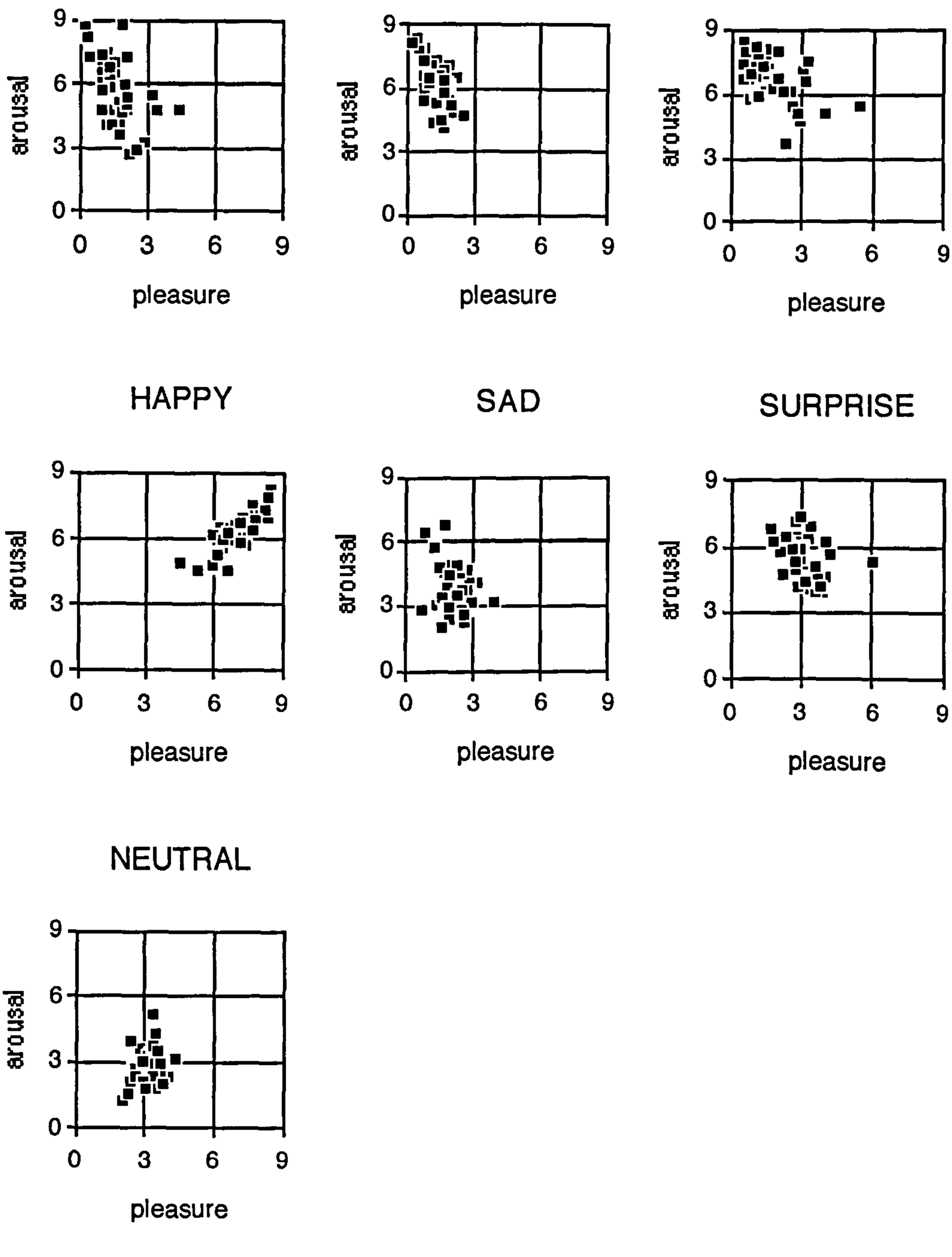

Figure 8. Arousal and displeasure - pleasure ratings indicating the spread for each expression category for all items.

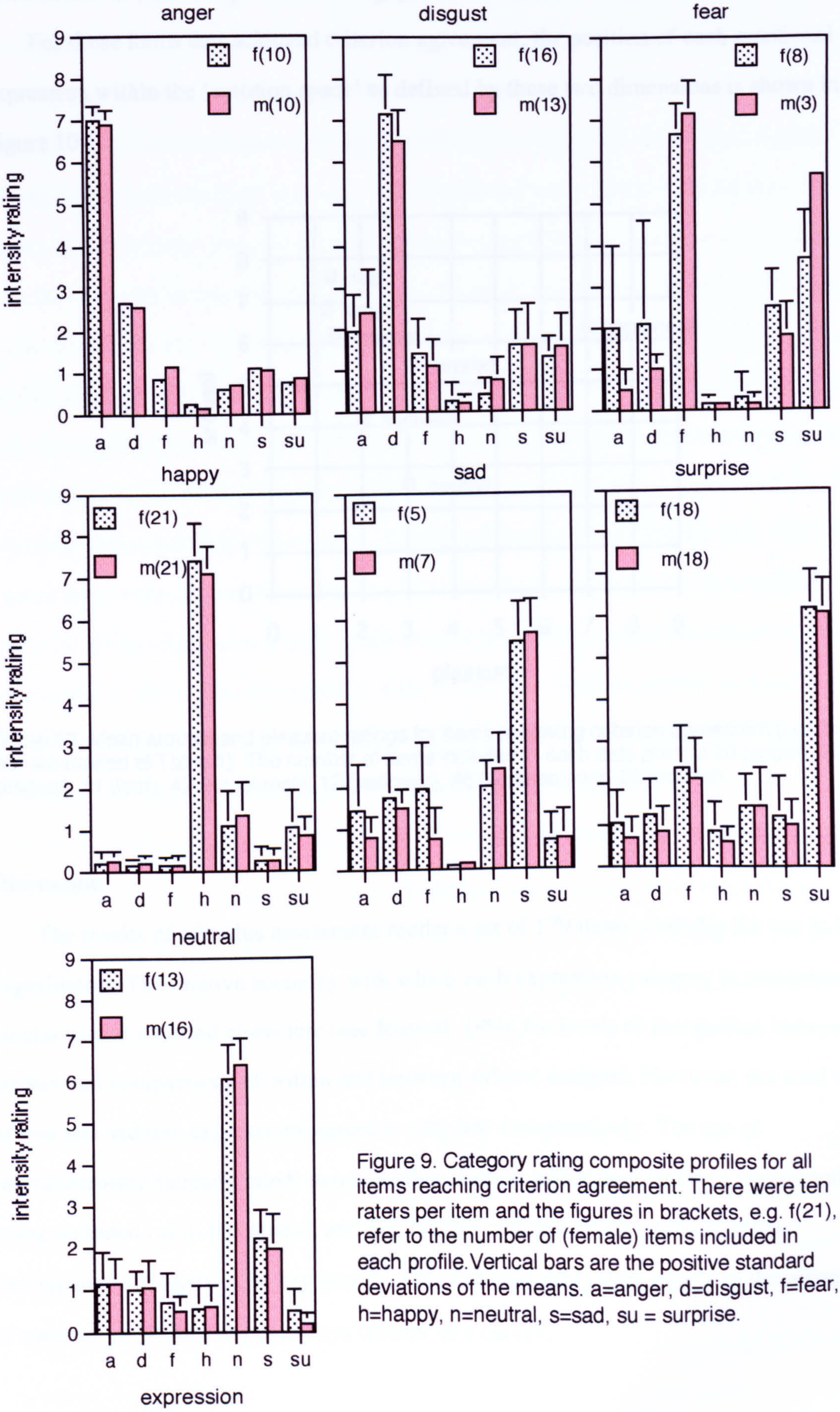

Figure 9. Category rating composite profiles for all items reaching criterion agreement. There were ten raters per item and the figures in brackets, e.g. f(21), refer to the number of (female) items included in each profile. Vertical bars are the positive standard deviations of the means. a=anger, d=disgust, f=fear, h=happy, n=neutral, s=sad, su = surprise.

Arousal and displeasure-pleasure ratings for ranked items

For those items that achieved criterion agreement, the position of each emotional expression within the 'emotion space' as defined by these two dimensions is shown in Figure 10.

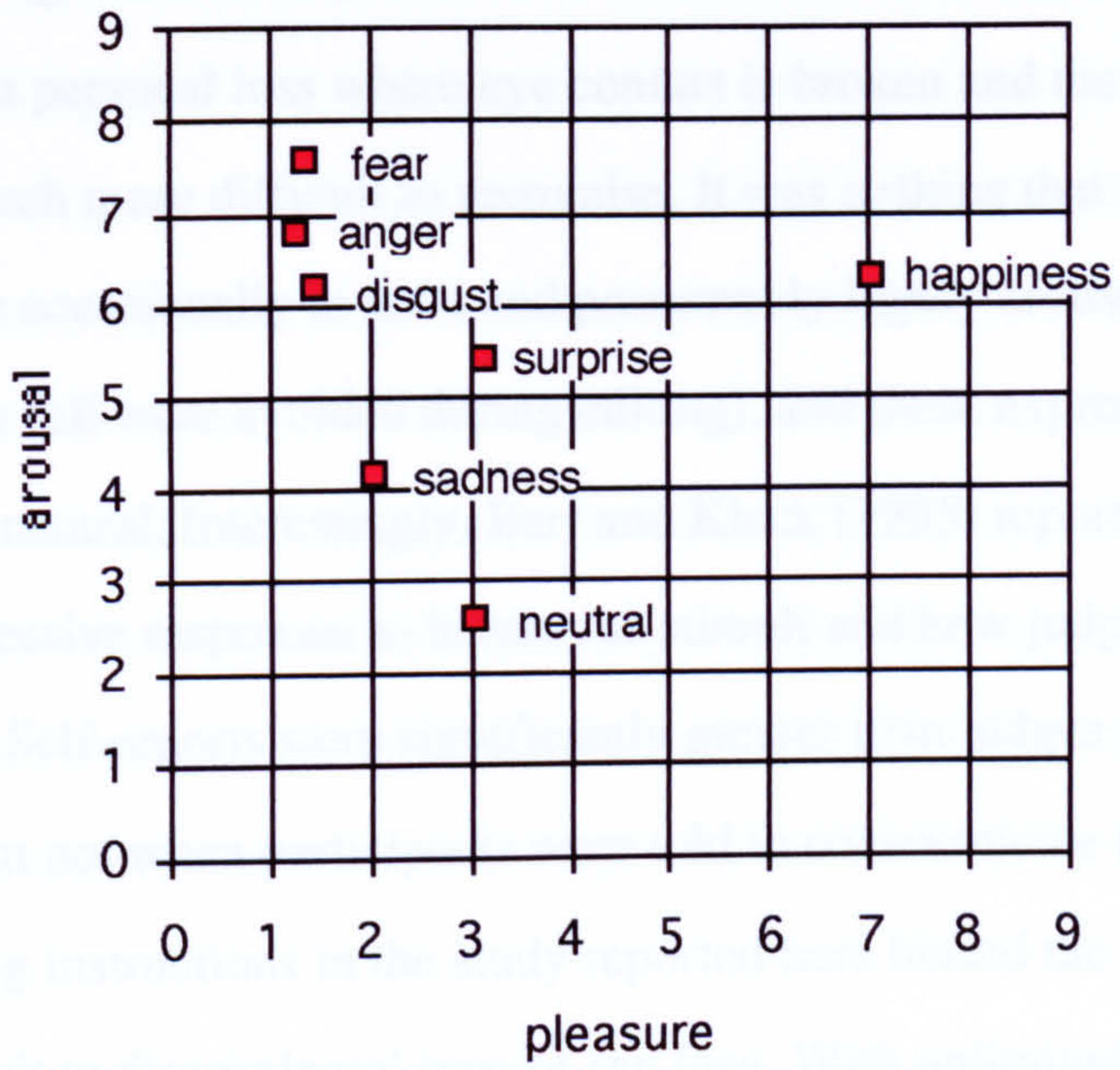

Figure 10. Mean arousal and pleasure ratings for items achieving criterion agreement (i.e., those that are ranked at Table 1). The number of items included in each data point is 20 (anger), 29 (disgust), 11 (fear), 42 (happiness), 12 (sadness), 36 (surprise), and 29 (neutral).

Discussion

The results of stimulus assessment render a set of 179 items available for use in further experiments. The relative accuracy with which each expression category is recognised is similar to that reported elsewhere (see Russell, 1994, for levels of recognition between studies and comparisons of within and between subject designs). However, the total number of fear and sadness expressions agreed is very low comparatively. The use of prestandardised (already rated) items in other studies, rather than all faces photographed being included (as in this study), and the number and type of alternatives offered participants, are likely to be key factors. This last may apply particularly to the recognition of sadness, as 'neutral' is not always offered as a choice.

Sadness being misrecognised most frequently as neutral supports the idea that sadness is difficult to recognise because of the lack of deviation from a neutral face. It is possible also that there are at least two types of sad face. One that has eyebrows drawn up in the middle and a down-turned mouth that requires eye contact with the viewer, signifies sympathy and is recognisable as the 'sad' face described in Ekman and Friesen (1975), and another that is about personal loss where eye contact is broken and the muscle spatial relationships are much more difficult to recognise. It was striking that while filming sadness actors were occasionally in tears and presumably highly aroused (the points at which tears actually fell were avoided during editing), and these expressions were still (mis)recognised as neutral. Interestingly, Barr and Kleck (1995) report a disparity between self-reports of expressive responses to humorous stimuli and how judges rated the intensity of those responses. Self-reports were significantly greater than judges in uninstructed or posed conditions but not when participants were told to communicate their feelings. It is possible the eliciting instructions in the study reported here biased the actors towards producing a 'difficult to discriminate' type of sad face. With unlimited viewing, raters may have been biased towards the recognition of those components that signify sympathy with another's loss rather than those expressing personal loss. The large number of sad misattributions to disgust and fear, both of which have down-turned mouths, would suggest that raters responded to this as a major 'theatrical' cue. Unfortunately the number of fear items is also limited. The difficulty of producing a genuine 'fear' face may be partly responsible (Ekman, 1993), but it may be due to the difficulty of discriminating a still fear face from a still surprise face.

The category rating profiles for items that achieved criterion agreement reported here are in general agreement with Oster, Hegley, and Nagel's (1993) work on adult faces, although Oster et al. have included 'interest' and 'distress' among their categories and 'neutral' is not considered. Showing the 'profile' of an emotional expression enables other expression categories that threaten confusibility to be seen at a glance (e.g., surprise, especially on male faces, rivals a fear attribution). It also enables a quick comparison of

individual stimulus items (individual profiles are not reported here but are available for comparison from the author) selected for further experiments with the relevant accredited set, such that the similarity of the item can be assessed informally.

With regard to the second stated aim of this experiment, that is, to find out just what the process of gathering posed expressions involves, my experience (as the experimenter) has been that a very large amount of control over the representation produced and presented later to the experimental assessor was exercised by the experimenter. Scripts and techniques used to elicit the emotional state and expression, when to start filming, when to stop, when to edit, what sort of transformations were carried out in Photoshop, and so on, were all decided by me. In similar vein, even the options given the raters were restricted. My hope is that the reader is convinced by the assessment procedures used and the transparency of reporting that the stimuli are sufficiently ecologically valid for use in the experiments reported later.

Just as the results for criterion agreement are comparable to those who support categorical expression recognition, the results for arousal and pleasure ratings obtained here are comparable to Russell and Bullock's (1985) for anger, fear, disgust, sadness and happiness. Participants thought that the neutral and surprised expressions of this set however, were somewhat less aroused than the Ekman and Friesen (1976, as cited in Russell and Bullock, 1985) faces used in Russell and Bullock's analysis (Figure 10 cf. Figure 1 of this thesis). Johnsen, Thayer and Hugdahl (1995) also assessed some of Ekman and Friesen's expressive faces dimensionally (they may have been different ones to those assessed by Russell and Bullock), and found differences in absolute position compared with those found by Russell and Bullock and the present study. Methodological differences in each study may have contributed to this (e.g., the range of the rating scale: -25 to + 25 in Russell and Bullock's study; 0 to 4 in Johnsen et al.; 0 to 9 in this study). Although differences in relative position are similar between these studies and my own, they are not always in complete agreement.

The relationships between the categorical classification of an expression, its position inside a 2-dimensional emotion space, and intensity (as shown by category rating), which may influence both categorical and dimensional assignment, are largely unexplored. For example, although all the items of the set assessed here for happiness achieved criterion agreement for 'happy', it is likely raters would have chosen 'ecstasy' or 'euphoria' for some of them, given the choice. Although Izard (1997) claims intensity is a factor contributing to the enormous variety of emotions and expressions, happiness and ecstasy are not considered different categories in semantic studies (e.g., Shaver et al., 1987). Happy items that failed to achieve 100% agreement did tend to cluster towards the centre of the space (Figure 8, HAPPY) where neutral misattributions were made. Note however, that the distribution of neutral dimensional assessments (Figure 8, HAPPY cf. Figure 8, NEUTRAL) does not overlap at all with those for happy expressions. Neither does the mean for neutral expressions lie near the centre of Russell and Bullock's 2-dimensional space (cf. Figure 1). Nor does it lie on a midpoint set between happy and sad or happy and angry expressions. The implication of this is that the mere absence of happiness may be qualitatively different from a face expressing neutrality, with each of the expressions constituting their own categories as found by Young et al. (1997).

Finally, possible sex differences of encoders and decoders are considered briefly. Overall differences between the number of accurate responses to female items compared with male items, though statistically significant, were not substantially different in terms of the number of faces of each sex that achieved criterion agreement (91 f cf. 88 m), and no conclusions are drawn from this data about the greater expressivity of females (cf. Wallbott, 1988). Also, contrary to reports in the literature that claim Female perceivers are better at decoding emotions than Males (e.g., Briton and Hall, 1995), the rates of recognition were almost identical across this sample. These results are therefore in agreement with Duhaney and McKelvie (1993), who used photographs taken from Ekman and Friesen's (1975) set and did not find any difference between men and women raters. However, as Male raters

were significantly better at ambiguous female expressions than they were at male expressions, differences with opposite sex faces may make a difference in the experiments in the chapters to follow. Attempts will therefore be made in each case to distribute Male and Female Ps in equal numbers across conditions. The interaction of book series with sex of face is taken to show that, despite random assignment to book series, female actors whose expressions were easier to recognise tended to co-occur. This is considered to be due to differences in the encoding ability of individual actors as the three-way interaction with sex of participant was not significant. Changing the random order of items within each book for different participants was considered to have made it more difficult, rather than easier, for stimulus items to reach criterion agreement.

Overview

The process of collecting and assessing the expressions has brought alive the numerous issues to do with the communication of emotions via facial expression currently receiving the attention of many investigators: the relationship of eliciting instruction to later recognition, categorical vs. dimensional organisation, gendered encoder and decoder differences, to name but a few. This process has also resulted in a stimulus set from which experimental materials that achieved criterion levels of recognition will be drawn for the rest of this thesis. The following three chapters now address the issue of whether or not emotional expressions influence the processing of other information from the face. The next chapter is concerned specifically with any potential interaction with facial identity.

3

Expression and identity

The notion that a person's characteristic emotional expressions become an indissoluble part of the way that we know that person is intuitively appealing. There is however, substantial evidence to suggest that the brain in fact parcels out different types of information received from the face, such as expression information, who that person is, what sex they are, and so on, to different systems that take care of these analyses independently from each other. The Bruce and Young (1986) model of face recognition, which is consistent with this evidence, is outlined below. Following this, Garner's (1974, 1976) selective attention methodology, which has been used as a tool to investigate the relationship between different types of information from the face, is introduced. Then there is a brief description of Schweinberger and Soukup's (1998) study on expression and identity information. These researchers found that, although identity processing appears to proceed independently of expression, expression processing, contrary to the predictions of the Bruce and Young model, may be influenced by who the person is. There are three experiments in this chapter that replicate and extend Schweinberger and Soukup's (1998, Exps. 1 and 2) findings using Garner's paradigm.

The Bruce and Young model of face recognition

Evidence from everyday errors, studies carried out in the laboratory and work with patients with different types of neurological injuries was assembled and organised by Bruce and Young (1986) to derive their functional model of face recognition. The model attempts to account for the perceptual and cognitive processes involved when we access and retrieve any type of stored information from faces. The model is reproduced here in its original format of a box diagram in Figure 11.

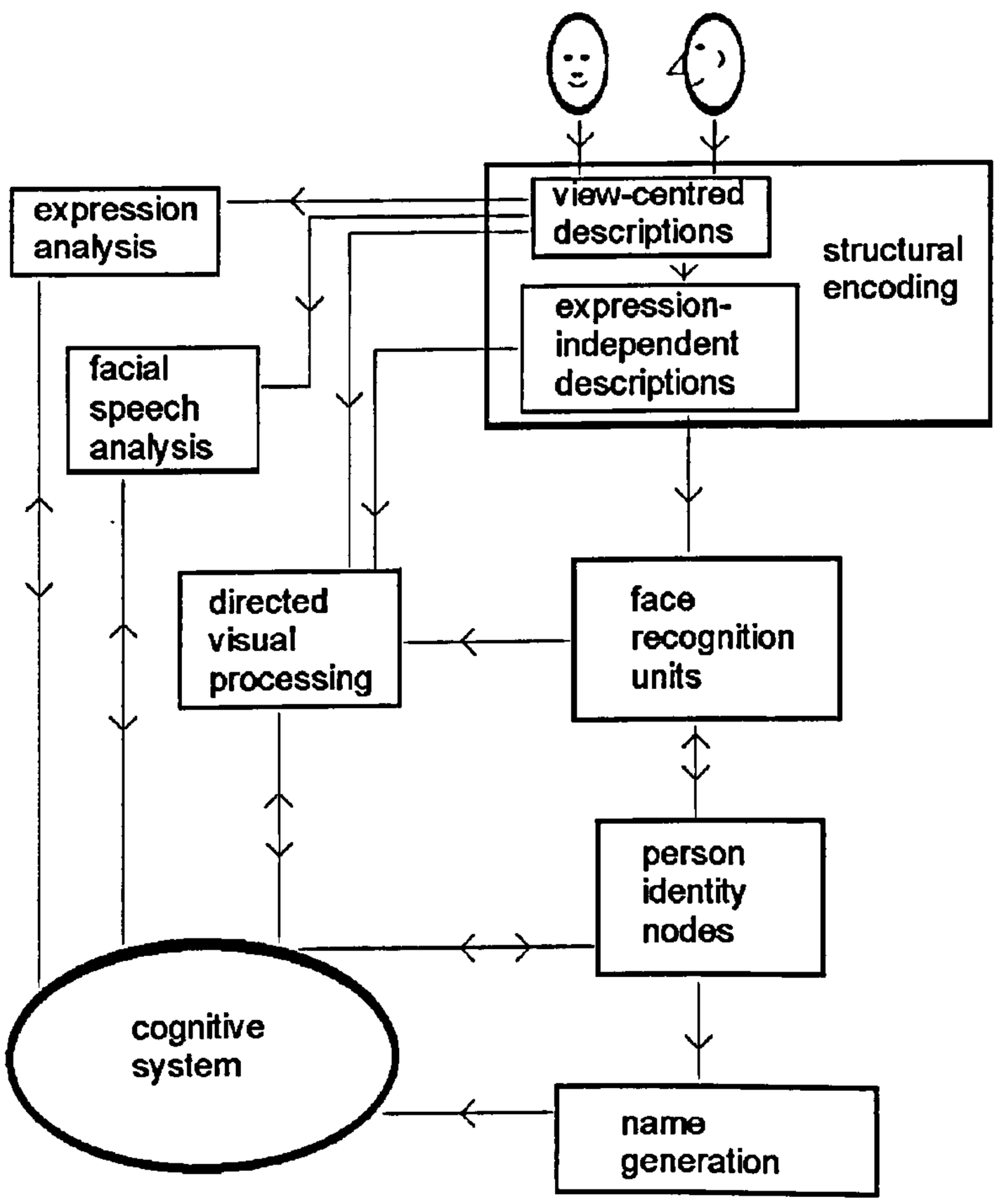

Figure 11. The Bruce and Young (1986) model of face recognition

The main thesis of the model is that a structural encoding process provides descriptions suitable for processing independently different types of information from the face. Through the formation of different types of structural code we can capture those aspects of a face that allow us to tell it apart from other faces. In particular, a

distinction is made between the types of code available for the recognition of familiar faces (identity-specific semantic codes) and unfamiliar faces (visually derived semantic codes). Facial speech analysis and expression analysis are also assigned separate codes on the basis that there was no evidence at the time to suggest that, with the possible exception of characteristic expressions, these types of information were important for recognising faces. In the laboratory, where still photographs are used to test how well and what we remember of the faces presented, there is an additional informational code distinguished by Bruce and Young they suggest viewers use. This is the pictorial code which is specifically concerned with a description of the picture and contains information related to lighting, how grainy the image is, as well as details of pose and expression. Pictorial coding probably does not operate in real life as a face is seldom seen again in exactly the same circumstances. As this type of coding can convey an advantage when pictures of both familiar and unfamiliar faces are repeated, it is particularly important in the interpretation of results obtained from such experiments. Over the past 14 years the model has generated an enormous amount of research and, for the most part, the basic tenet of functionally independent components has been supported.

It is proposed that expression analysis makes use of view-centred codes generated at input and that identity analysis requires the abstraction of a structural code that is able to generalise across views, lighting conditions, age, hairstyle and expression. We can recognise whether someone is happy, sad, surprised, and so on regardless of who they are and, conversely, we can recognise who someone is regardless of their emotional state. Experimental studies support the functional dissociation of these abilities (e.g., Bruce, 1986; Young et al., 1986). Double dissociations between expression and identity recognition have been described in neuropsychological studies (e.g., Calder, Young, Rowland, et al., 1996; Etcoff, 1984; Parry et al., 1991; Schweinberger et al., 1995). Neurophysiological studies support the idea of both

functional and physical separation at the level of neuronal cell populations (Desimone, 1991; Hasselmo, Rolls, and Bayliss, 1989).

Expression perception and recognition is only detailed in the Bruce and Young (1986) model in so far as it proceeds independently from identity processing (and from facial speech and other types of visually derived information to do with age, sex and unfamiliar faces), until the cognitive system is attained. The model is concerned more with delineating the possible hierarchical mechanism by which we identify and name familiar faces and people than with the intricacies of how we analyse expressions. Work on the model since has been largely in the area of familiar face recognition (e.g., Burton, Bruce, and Johnston, 1990; Burton, Young, Bruce, Johnston, and Ellis, 1991; see also Young, 1998). Briefly, a perceptual match to a familiar face is made at the level of the face recognition unit (FRU) which houses the stored structural representation for that person's face. Information is then passed to a person identity node (PIN) which is part of the larger cognitive system storing information about that person. Finally the person is named with the name generation stage the most difficult part of person identification. Naming is thought to be dependent on its own separate name code. The way in which outputs from independent and parallel expression and identity systems are combined (*if* this information is combined) within the general semantic pool called the cognitive system, is unspecified in the model.

From the same stimulus then, the expressive face, different information is taken as the raw material for expression and identity purposes. Expression information is conveyed by the underlying musculature of the face revealing typical shapes (e.g., Ekman and Rosenberg, 1997), and the combination of these shapes creates an overall facial configuration likely to approximate one of a limited number of typical or 'basic' arrangements we then recognise. According to studies on category-specific emotional expression recognition, we use these mutually exclusive spatial arrangements to match to a perceptual mechanism that is tuned to the configuration presented (e.g., Etcoff and

Magee, 1992). Identity information is more likely to be extracted from the underlying bony structure, surface textural detail and shape made visible by shading (Bruce, 1988; 1994; Bruce, Hanna, Dench, Healey, and Burton, 1992).

As in Schweinberger and Soukup's (1998, Exps. 1 and 2) study, the experiments here use faces that are unfamiliar to participants at the start of the experiment, and the extent to which they become familiar throughout the course of the experiment is unspecified. In the Bruce and Young model the processes used to compare unfamiliar faces and to try and remember them (view-centred descriptions plus structural encoding and directed visual processing) are contrasted with those that are used to identify familiar faces (view-centred descriptions plus structural encoding and then the FRUs). Both analyses are proposed to proceed in parallel and to send outputs to decision processes constructed within the cognitive system. These two types of analysis are seen as qualitatively different processes, rather than as varying along a 'familiarity continuum' (cf. Rhodes, 1985). The relationship in the model between expression analysis and directed visual processing, while proposed to be independent, is not pursued as rigorously as that between expression and familiar face analysis or that between familiar and unfamiliar face processing. Both expression and unfamiliar face codes are derived from view-centred descriptions, providing the opportunity at least for some interaction early in analysis if the task facing the participant in the laboratory relies heavily on the use of pictorial coding (i.e., differences between *pictures* of faces). Interference may emerge in this context. Counter to this possibility however, is a report in support of the dissociability of familiar face recognition, unfamiliar face matching and the analysis of facial expressions from Young and his colleagues (Young, Newcombe, de Haan, Small, and Hay, 1993; see also Young, 1998) in patients with selective brain damage.

Garner's selective attention methodology

Garner (1974, 1976) developed a number of experimental tasks to discover the relationship between different types of information that were present in the same multidimensional stimulus. He was interested in finding out whether or not it was possible to attend to one type of information in the presence of irrelevant variation in another. For example, he asked what might be found out about the processing relationship between the dimensions[4] of colour and shape if the objects considered were red and green squares and red and green triangles.

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[4] *Psychological dimensions - a note to clarify terminology*

I take this opportunity to clear up a potential source of confusion regarding the use of the word 'dimension' throughout. The reader has already been introduced to the categorical vs. dimensional debate about expression perception and recognition. During stimulus assessment (described in Chapter 2), the participant was asked to assign each item to an expression category and to indicate values for each item along the psychological scales, or 'dimensions', of arousal and pleasure. The fact that it is possible to assign every expression to a more or less consistent position described by these dimensions when these dimensions are arranged orthogonally, has been used as evidence to support the 'dimensional model' of expression perception (Russell, 1980; Russell and Bullock, 1985). Expression and emotion researchers sometimes use other descriptive dimensions, such as the approach - withdrawal dimension (e.g., Angrilli, Cherubini, Pavese, and Manfredini, 1997), when trying to organise consistencies revealed experimentally.

Garner (1976) uses the concept of a dimension in a slightly different way from those above. He states that a "stimulus dimension is any variable attribute of a stimulus which exists at two or more levels" (p. 98). His use of the term is therefore inclusive of stimuli with scalable properties (e.g., length, size, lightness etc.), stimuli from nominal categories (e.g., left and right on the position dimension), and stimuli that may be both nominal and have continuous physical properties (e.g., red and green on the colour dimension). When expression is considered a dimension in the sense with which Garner uses the term, happiness and sadness are considered to be nominal values. Expression as a dimension within the Garner experiment is comparable at this level to other types of information from the face: For example, the identity dimension, the gaze direction dimension, and so on. That is, expression and identity and expression and gaze-direction have *inter*dimensional relationships. While sad and happy expressions *do* have differing values of arousal or valence (as within Russell's 'dimensional model'), which may be of use in determining whether patterns of interference generalise to other expressions, this is not of primary concern for the purposes of the Garner experiment. Sadness and happiness within the Garner paradigm have an *intra*dimensional relationship. To qualify as a stimulus appropriate for a Garner experiment, a

In Garner's (1974) card sort task (also used by Etcoff, 1984, for facial expression and identity dimensions) the participant is required to sort according to shape (squares in one pile, triangles in the other) or to sort according to colour (red squares and triangles in one pile, green ones in the other). The way the cards are put together prior to sorting is important, and for each of the relevant dimensions the task is carried out three times. For one of these times the cards are arranged so that *the irrelevant dimension* (colour, if sorting according to shape) *is correlated with the relevant dimension* so that in the first part of this task every square seen is red and every triangle is green in the first block, and in the second (so that each card is seen an equal number of times each time the cards are sorted), every square seen is green and every triangle red. For another of these times *the irrelevant dimension* (colour) *is held constant* so that all squares and triangles seen in the first block are red and, in the second block, all are green. For the third time the cards are sorted both *the irrelevant and the relevant dimensions vary orthogonally* so that in each block any card seen may be a red or green square or a red or green triangle. These different stimulus arrangements are known as the *correlated*, *control* and *orthogonal* conditions. The time taken to complete each condition is taken and a comparison across conditions is made to see how much each dimension interacts with the other. In a speeded-response version of this task carried out on the computer, reaction time and errors are measured.

The same arrangement of relevant and irrelevant dimensions applies when faces are used as stimuli. The types of stimulus items used in an identity and expression

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stimulus has two dimensions at any one time that are being compared. In a Garner experiment exploring the relationship between colour and shape perception, a red square and a green circle are multidimensional in the two ways under investigation. They are also multidimensional in more than two ways in that they also have area. Area however, for the purpose of the experiment, is irrelevant and may be made equivalent across stimuli. The properties of faces make them more difficult to deal with in this way as it is impossible to control all dimensions that are not immediately relevant to the test.

comparison are set out in Figure 12. The participants that classify by identity (Dimension 1) are asked when each face is displayed singly "Is this Person X or Person Y?". The participant presses one key for one option and another for the other. Those that classify by expression (Dimension 2) are asked "Is this person happy or sad?". As there are two blocks of trials that make up each condition, in the correlated condition A and D are seen in one of the blocks and B and C in the other. In this way each identity always has the same expression (e.g., all faces of Person X are happy and all faces of Person Y are sad), for the duration of the block. That is, the values on each dimension are made contingent on each other. Note that the correlated condition has the same stimulus arrangement for both identity and expression classification: It is the question to the participant that differs in each case. In the control condition for identity classification, variation in the irrelevant variable (expression) is kept constant. That is, A and C are seen in one of the blocks, and B and D seen in the other. In the control condition for the expression classification task, identity is kept constant, and A and B are seen in one block and C and D seen in the other. In the orthogonal condition any of A, B, C or D are seen in both blocks, and this is the same for both classification tasks.

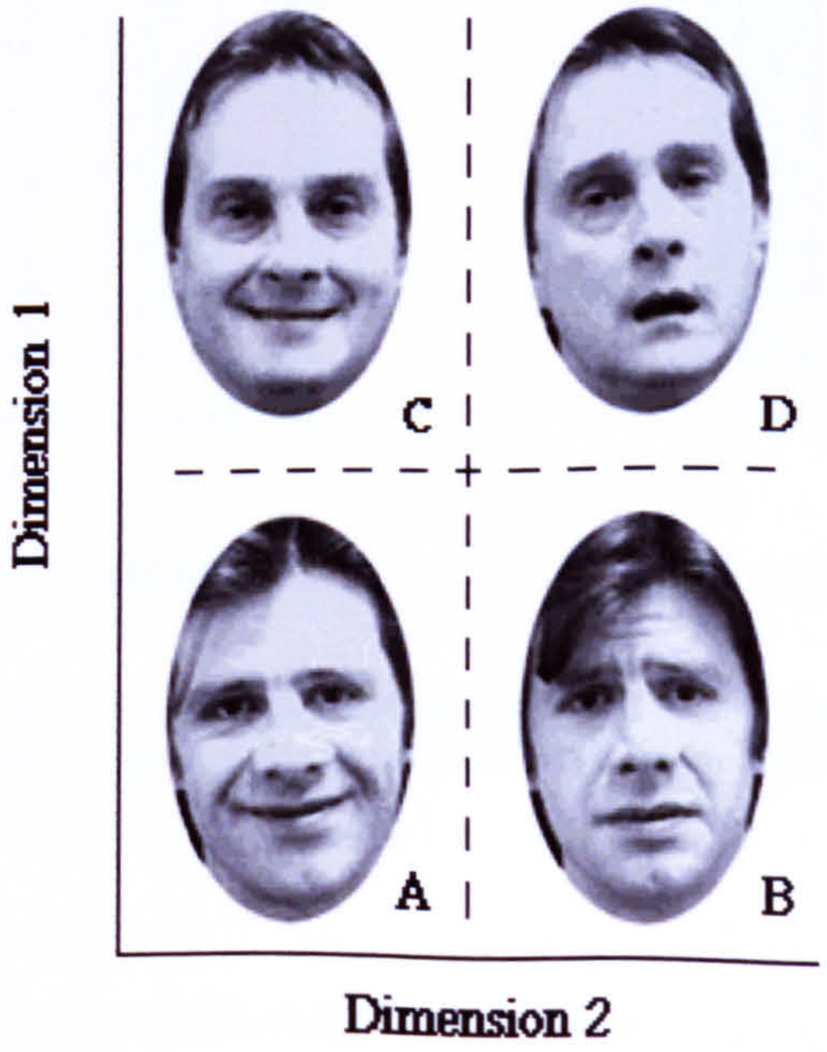

Figure 12. An example of the types of stimulus items used when Garner's methodology is applied to the facial dimensions of identity (Dimension 1) and expression (Dimension 2). Above: Person Y, happy and sad; Below: Person X, happy and sad. See text for additional explanation.

Garner proposed that the outcomes indicate the type of dimensional interaction that takes place. Processes such as *facilitation* when dimensions are correlated or *interference* (an inability to demonstrate selective attention) when dimensions are combined orthogonally are different with *integral*, *separable*, *asymmetric separable* or *configural* dimensions (see Figure 13).

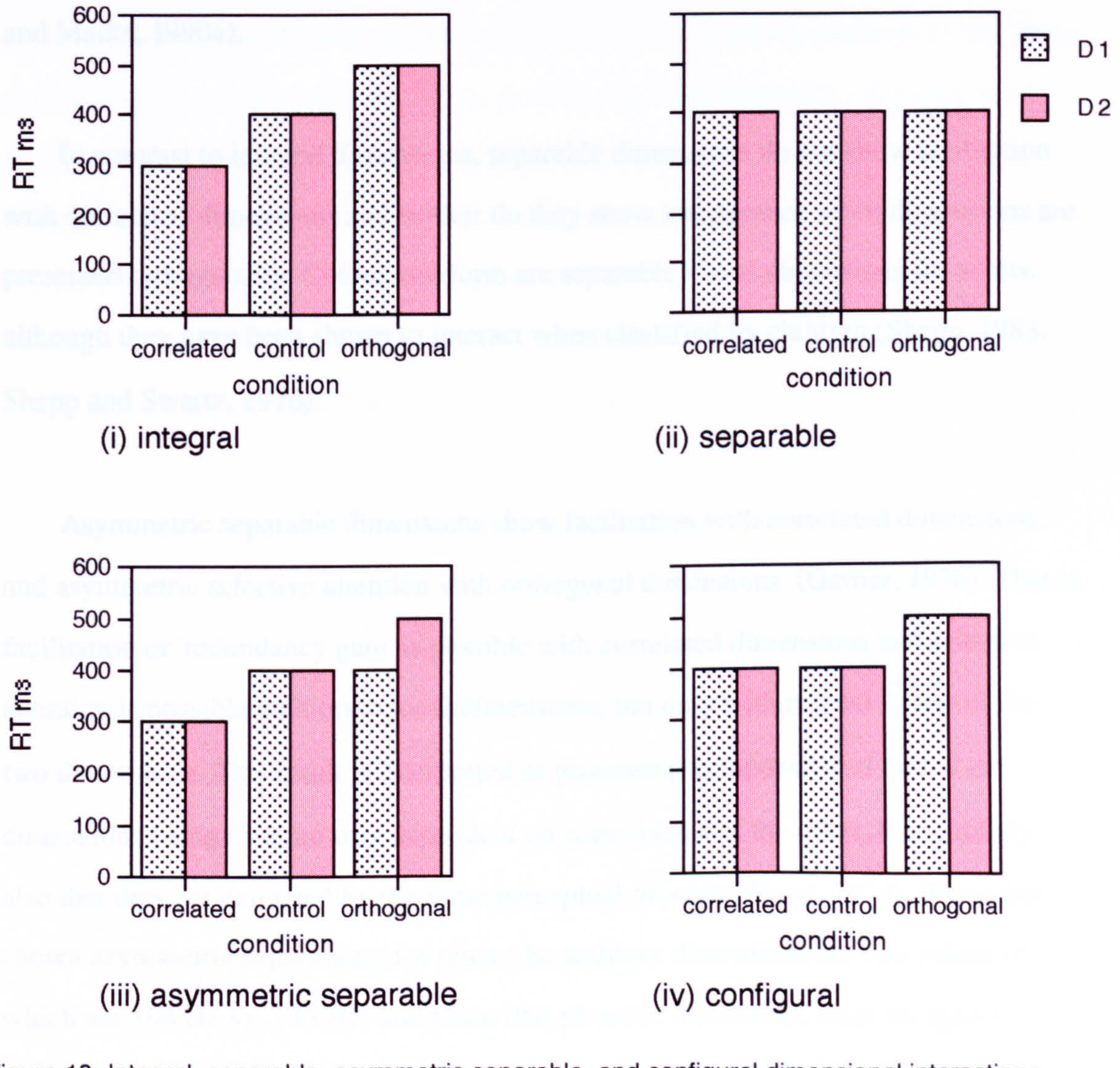

Figure 13. Integral, separable, asymmetric separable, and configural dimensional interactions as indicated by reaction time in speeded classification experiments. D 1 = Dimension 1, D 2 = Dimension 2

Integral dimensions show facilitation when dimensions are correlated and interference when they are orthogonal. The perceiver is able to form a 'unified percept'

and is therefore able to use correlated or contingency information while suffering interference when dimensions are combined orthogonally. Integral dimensions are seen as being extracted by a single perceptual process or by multiple processes that are strongly interdependent. Dimensional attributes can be attended to separately under pressure of the required task but at a time cost with orthogonal irrelevant variation. An example of visual integral dimensions are value (brightness) and chroma (saturation) (Garner, 1974). Auditory dimensions that interact are pitch and loudness (e.g., Melara and Marks, 1990a).

In contrast to integral dimensions, separable dimensions do not show facilitation with correlated dimensions and neither do they show interference when dimensions are presented orthogonally. Colour and form are separable visual dimensions for adults, although they have been shown to interact when classified by children (Shepp, 1983; Shepp and Swartz, 1976).

Asymmetric separable dimensions show facilitation with correlated dimensions and asymmetric selective attention with orthogonal dimensions (Garner, 1976). That is, facilitation or 'redundancy gain' is possible with correlated dimensions and selective attention is possible with orthogonal dimensions, but only with respect to one of the two dimensions. This result is interpreted as processing components of one of the dimensions being in some way dependent on components of the other. It is unlikely also that they are extracted by the same perceptual process (Wood, 1974). Wood has shown asymmetric separability for pitch (the auditory dimension, the two values of which are 104 Hz vs. 140 Hz) and place (the phonetic dimension, /bae/ vs. /gae/). Irrelevant variation in place does not interfere with the classification of pitch, but irrelevant variation in pitch interferes with the classification of place. Garner (1976) observes that asymmetrical separability of pitch and syllables could be due to the inherent physical properties of the stimuli. A syllable has to have a pitch, but pitch does not have to be a syllable.

Configural dimensions are claimed by Garner (1976) to be similar to integral dimensions in that selective attention to dimensions varied orthogonally is not possible. However, no 'redundancy gain' is demonstrated when dimensions are correlated. Pomerantz and Garner (1973) concluded this type of dimensional interaction best explained their results using stimulus sets generated by parentheses, ((, (),)(and)), with right and left position as the two dimensions. They argue that when elements are organised within the stimulus to form a larger unit, then selective attention to individual elements is not possible. Configural processing may be of particular relevance when faces are used as stimuli as it is known that faces are perceived and recognised as 'wholes' (e.g., Tanaka and Farah, 1993; Young, Hellawell, and Hay, 1987). Configural processing is also likely to be more important with some classification tasks than with others, with attention to selected features easy in some situations and incurring costs in others. For example, it is known that internal features are more important for responses to familiar faces than unfamiliar faces (H. D. Ellis, Shepherd, and Davies, 1979; Young, Hay, McWeeny, Flude, and Ellis, 1985). It is also of interest that reliance on internal features for familiar face recognition appears to be developmentally sensitive. Children around 10 years of age and older show the adult pattern while children up to age 7 years are better at recognising familiar classmates from external, not internal, features (Campbell, Walker, and Baron-Cohen, 1995; see also Carey, 1992).

The types of experimental outcomes that might be expected are therefore as follows. If selective attention is not possible, the increased uncertainty of any of 4 choices appearing next in the orthogonal condition compared with only 1 of 2 in the baseline (control) condition will slow response times. If selective attention is possible, response times are equivalent to baseline. Garner claims that one of the characteristics of integral dimensions is that the stimulus is seen as a kind of 'blob' and in the correlated condition it is possible for the participant to benefit from the additional or 'redundant' information available by some process of stimulus re-definition. However,

this is not the only reason faster response times in the correlated condition might be expected. Participants responding to separable dimensions can use the redundant information here too, possibly as a pictorial aid for remembering which example of the irrelevant dimension goes with which expression. Also, if dimensions are separable, participants may be free to choose which of the dimensions they process first, choosing either the easier dimension to discriminate or the one they prefer, which can lead to a gain. The conditions for such a 'selective serial processing' strategy are outlined by Biederman and Checkosky (1970) and Felfoldy and Garner (1971). The presence of a redundancy gain is therefore ambiguous and can indicate either integrated processing *or* parallel but independent processing. Its presence is therefore best considered additional evidence for integrality with the *critical* comparison to be made between *control and orthogonal conditions*.

To recapitulate, Bruce and Young's (1986) functional model of face recognition suggests that the analyses of expression and identity information proceed along independent routes. We don't need to recognise someone as someone we know to estimate their emotional state from their expression: We can recognise someone as familiar to us regardless of their emotional expression. Schweinberger and Soukup (1998, Exps. 1 and 2) suggest that the relationship between identity and expression processing may not be completely mutually independent. Using Garner's (1974, 1976) speeded-classification methodology they found that, while participants could attend selectively to identity information without being influenced by irrelevant variation in expression, expression classifications were influenced by variation in identity.

Schweinberger and Soukup's results are reproduced in Figure 14. A comparison of Figure 14 and Figure 13(iii) above shows that the results for expression classification conform to both criteria diagnostic of integrality (gain in the correlated condition and interference in the orthogonal condition). The results for the identity classification task are slightly divergent from Garner's prediction of the pattern followed for D1 (Figure

13(iii)) for asymmetric separability (the gain of 3-5 ms shown in the correlated condition is not significantly different from the RTs of either control or orthogonal conditions). Contingent variation in expression is not therefore available to participants making identity decisions: Identity information is analysed completely independently from expression in this experiment. Thus for the purposes of interpreting the results the correlated condition is essentially ignored (gain is ambiguous anyway) with the asymmetry of expression and identity processing resting on attenuated RTs in the orthogonal condition relative to control during expression, but not identity, classification.

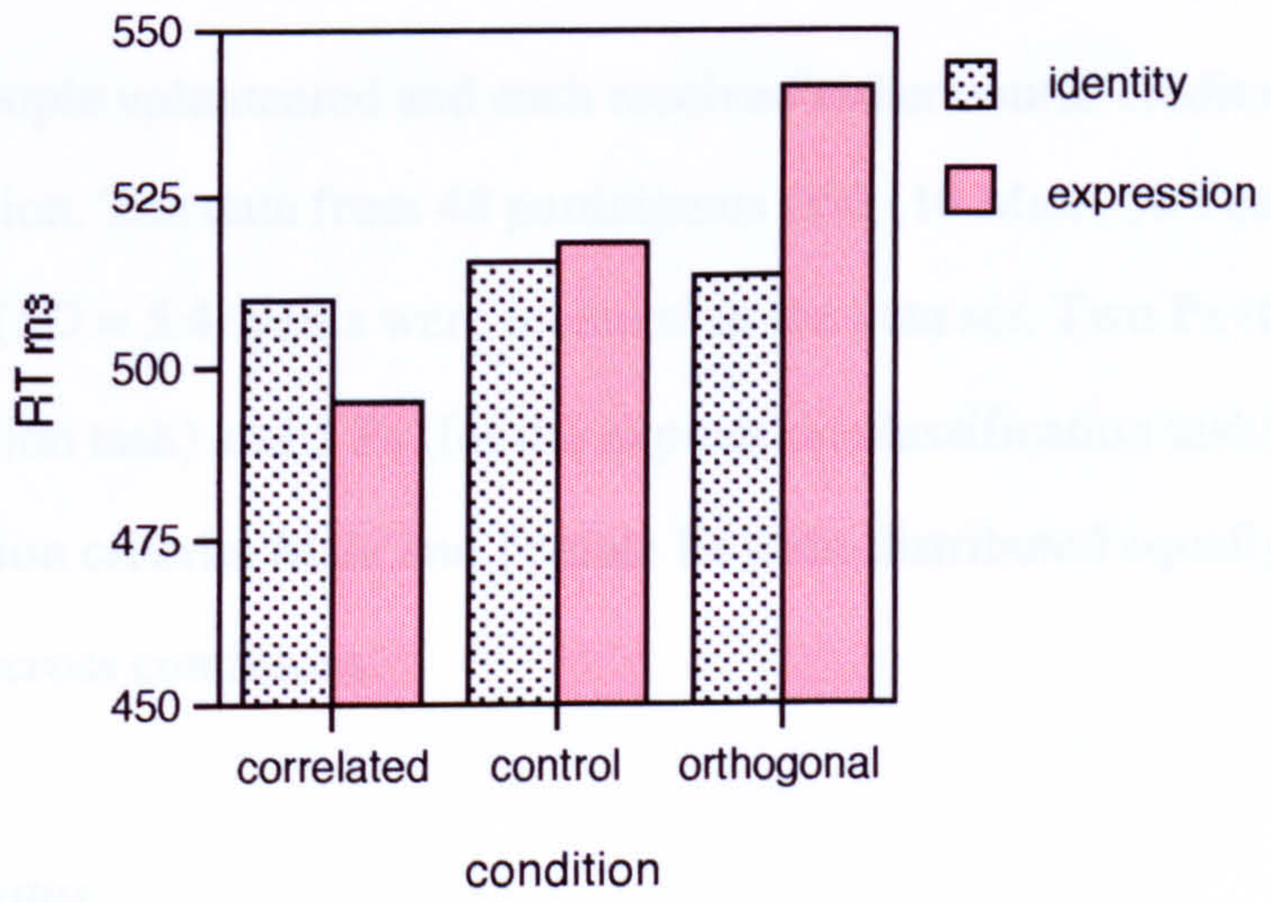

Figure 14. Schweinberger and Soukup's (1998, Exps. 1 and 2) results: Interpreted as showing the asymmetric separability of expression and identity information analysis.

Schweinberger and Soukup used two male faces and two variants of happy and sad expressions of each (a total stimulus set of eight items). In Experiment 2 a replication of Schweinberger and Soukup's experiment is carried out using different faces (again there is a total stimulus set of eight faces) to see if the asymmetric pattern of interference observed in their study generalises to different sad and happy identities. The number of participants used here is doubled to allow for the order of the blocks within each condition to be balanced (see procedural details below). The correlated condition is retained because of the contrast between Garner's integral and configural predictions (Figure 13, (i) cf. (iv)).

Experiment 2

In this experiment the expectation is that identity information will be processed independently of expression but that expression information will show interference from irrelevant variation in identity, if Schweinberger and Soukup's (1998) findings generalise to a different set of stimuli.

Method

Participants

Fifty-three people volunteered and each received either course credit or was paid for their participation. The data from 48 participants (Ps) (10 Male, 38 Female) with a mean age of 21.4 (SD = 5.4) years were included in the data set. Two Ps (for the identity classification task) and 3 Ps (for the expression classification task) did not achieve the inclusion criteria. Male and Female Ps were distributed equally between tasks and evenly across conditions.

Stimuli and apparatus

Happy and sad expressions from 2 male actors (Face Nos. 29 and 32) made up the stimulus set (Figure 15). Variations of each expression were captured as still frames from the same filming session from which the assessed frames had been taken. As only one of each variation had been rated for expression, agreement that each stimulus face expressed happiness or sadness, or that all variations of Person A belonged together as did all variations of Person B, was sought from Ps at the beginning of the experiment according to which task they were doing.

The stimuli were presented using "SuperLab" software on a light background on a Macintosh Quadra 800. Stimulus size measured 6 x 9.56 cm which subtended an angle of 5.7° horizontally and 9.15° vertically at a viewing distance of 0.6 m. A chin rest was

used to keep the participant's head level and in one place for the duration of the experiment.

Figure 15. Stimulus set for Experiment 2. Top: Two happy and 2 sad expressions from Face No. 29 (Person A). Bottom: Two happy and 2 sad expressions from Face No. 32 (Person B).

Design

The experiment had a 2 x 3 mixed design with the between-subjects variable of task at 2 levels (identity classification, expression classification) and condition at 3 levels (correlated, control, orthogonal). Dependent measures were reaction time (RT) and errors. It was also planned to analyse each dimension separately (including each value of the relevant and irrelevant dimensions across conditions) to determine the source of any intradimensional interference.

Procedure

The procedure for the identity classification task was as follows. The 24 Ps in this group were told that the task was to make a decision as quickly and as accurately as

possible as to whether the face presented on the computer screen belonged to Person A (referred to as 'A') or Person B (referred to as 'B'). Prior to the task, the stimuli, printed out and mounted on pieces of card, were shown to each participant for 3 to 5 seconds. Half saw A first and half saw B. Each subset was ordered randomly. Once seated in front of the computer Ps were asked to ignore the expressions while making their responses and to use their index fingers to press one key for A and another for B. The keys were 15 cm apart on the keyboard and hand of response was counterbalanced.

Each order of the 3 conditions was seen by 4 of the Ps. Each of the conditions was made up of 2 consecutive blocks of 100 trials each. Each block contained 20 practice trials ordered randomly followed by 80 test trials also ordered randomly. In the correlated condition half of the Ps saw happy faces of A with sad faces of B in Block 1 and sad faces of A with happy faces of B in Block 2. For the other half of the Ps, the correlated condition was made up of these same faces with the order of the blocks reversed. In the control condition (where the irrelevant variable is held constant) half of the Ps saw sad faces of both A and B in Block 1 and happy faces of both A and B in Block 2. For the other half of the Ps, the control condition block order was reversed. In the orthogonal condition Block 1 contained sad and happy faces of both A and B and Block 2 the same. In this way each stimulus picture was seen for a total of 20 test trials in each condition. (Counterbalancing for hand of response, the order in which each condition was seen, and the stimulus arrangement within each block for each P in the identity classification group are set out in Appendix C.)

The procedure for the expression classification task was as above for identity classification with task-relevant details changed as appropriate. For example, the faces mounted on card were organised into sad and happy sets and Ps were asked to ignore identity while making their expression decision. For expression classifications the make-up of the correlated and orthogonal conditions remained the same and the control condition contained sad and happy faces of A in Block 1 and sad and happy faces of B

in Block 2 for half the participants, with block order reversed for the other half of the participants.

For both tasks each trial started with the presentation of a fixation cross which was replaced after 1550 ms by a stimulus face. The face remained on the screen until a key was pressed when it was replaced immediately by the next fixation cross which began the next trial. RTs shorter than 150 ms and longer than 1500 ms and errors were recorded separately. Criteria for inclusion in the data set were 50% correct and within the time window (150 ms - 1500 ms) in each cell. Ps with errors and outlying responses of greater than 10% overall were excluded. The experiment took 30 to 35 minutes to complete.

Results

Errors and outliers

Errors for Ps who met the scoring criteria were few. Ps in the identity classification group made average incorrect responses of 1.7% (correlated, 1.6%; control, 1.4%; orthogonal, 2.1%). Ps in the expression classification group made average incorrect responses of 2.8% (correlated, 2.5%; control, 3.1%; orthogonal, 2.9%). Although errors were low, more were made on the expression task than on the identity task and this difference was significant as confirmed by a 2 x 3 ANOVA with task and condition as variables which revealed a main effect of task, $F(1, 46) = 5.52$, $p = .02$.

In order to find out whether error rates were different to different dimensional values, further separate 3 x 2 x 2 ANOVAs with condition, identity and expression as variables on each task-specific group were carried out. For the identity classification group there was a significant main effect of the irrelevant variable, $F(1, 23) = 6.41$, $p = .02$, with more errors made to happy expressions compared to sad ones. This was modified by an interaction with condition, $F(2, 46) = 5.89$, $p = .005$, with approximately twice as many errors made to happy faces in the orthogonal condition

compared with sad and happy faces elsewhere. For the expression classification group errors were distributed evenly across conditions for both relevant and both irrelevant variables. Outliers made up 0.7% of responses to identity and 0.6% of responses to expression.

RTs: comparisons between classification tasks across conditions

Mean correct RTs for both tasks in all experimental conditions can be seen in Figure 16. A 2 x 3 mixed ANOVA with task as the between-subjects variable and condition as the within-subjects variable showed no main effect of task indicating tasks were of comparable difficulty when RTs were considered (identity classification, $M =$ 573 ms; expression classification, $M = 584$ ms). There was a significant main effect of condition, $F(2, 92) = 11.27$, $p < .0001$. Inspection of Figure 16 suggests that this reflects an effect of condition when both identity and expression classifications were made. Asymmetric interference would have been indicated by a task x condition interaction, but this interaction here failed to achieve significance ($p = .8$).

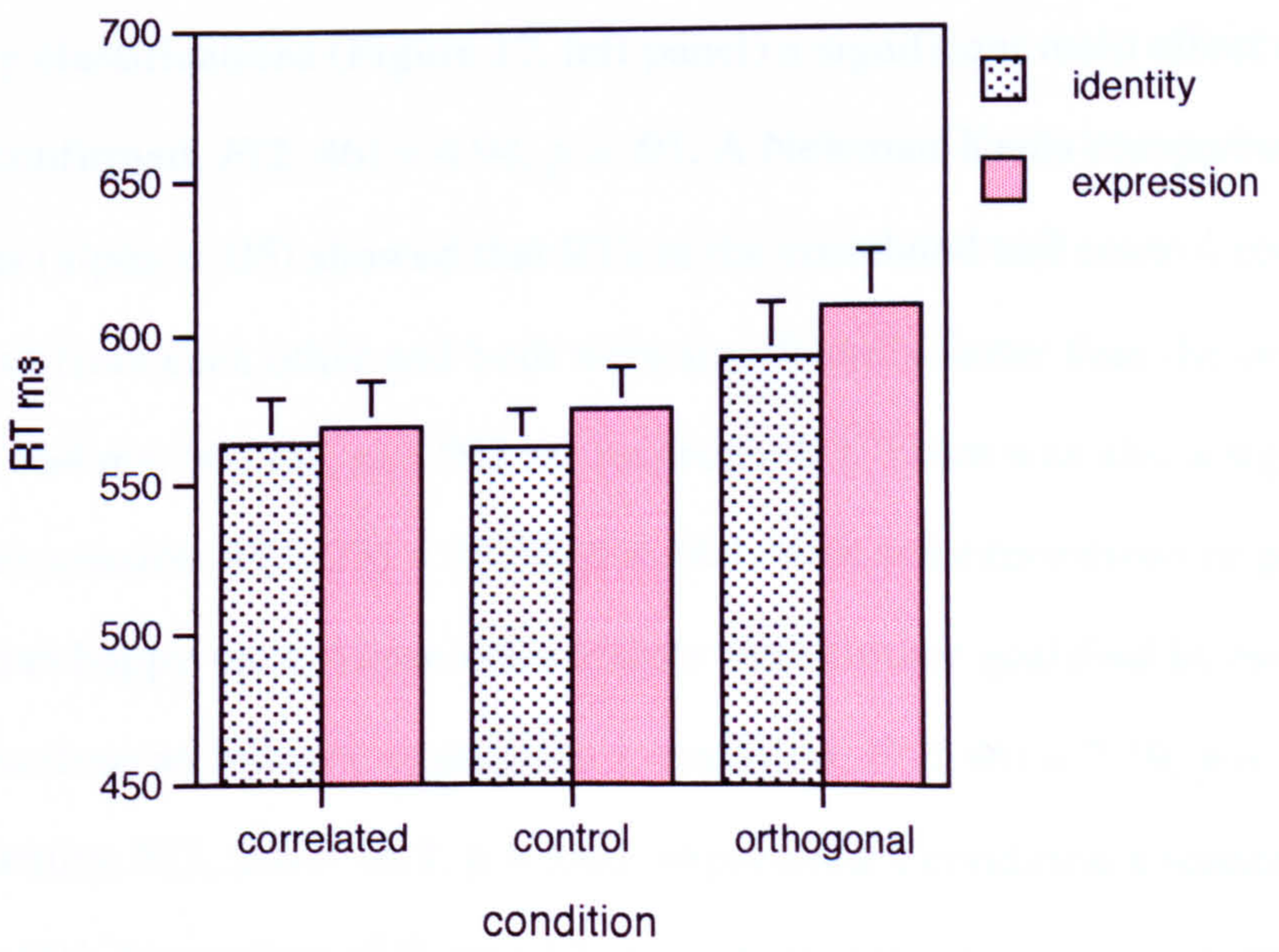

Figure 16. Mean reaction times in Experiment 2 for identity and expression classification groups in each condition. Vertical bars represent the positive standard errors of the means.

RTs: comparisons within each classification task

To find out which values of each relevant and irrelevant dimension were contributing to the condition effect observed above, separate 3 x 2 x 2 ANOVAs were carried out for each task with the within-subject variables of condition, identity and expression (Figure 17).

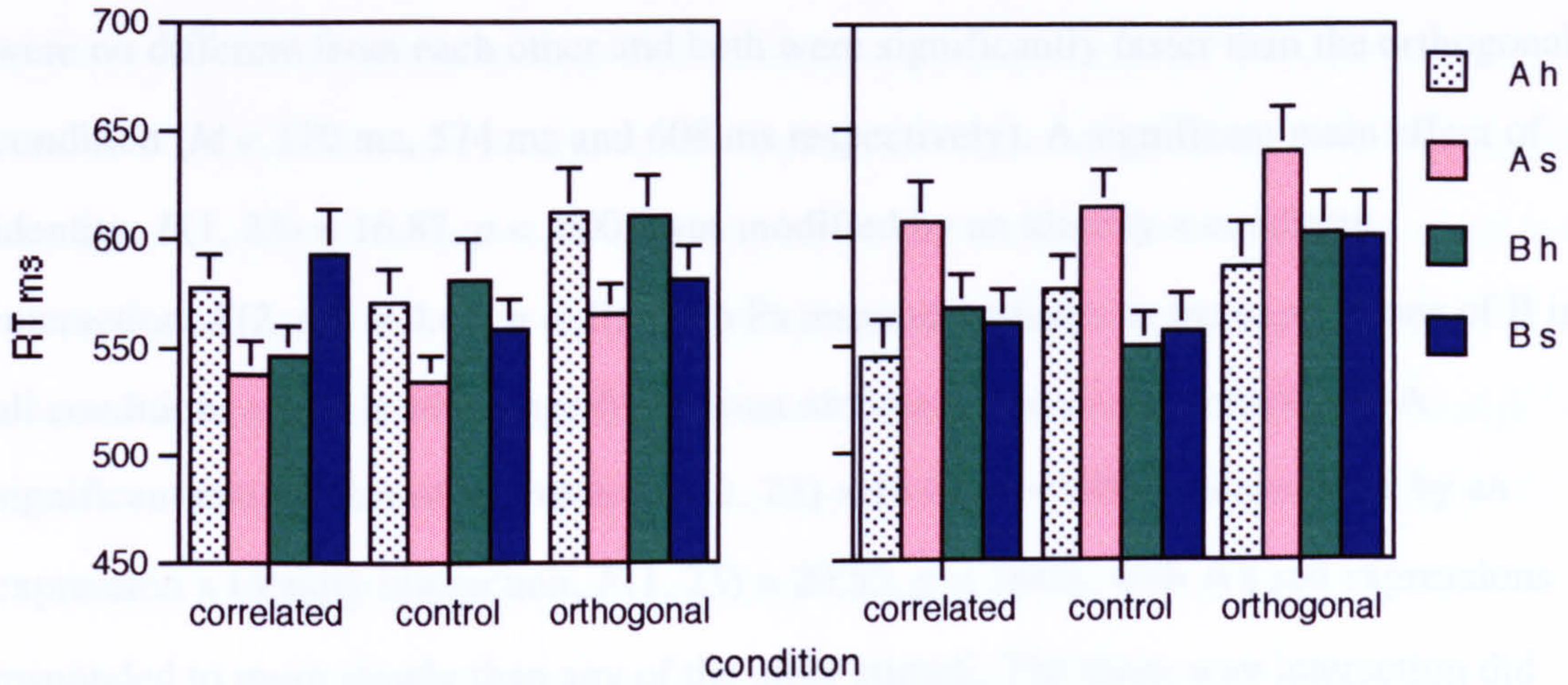

Figure 17. Mean reaction times for every combination of each relevant and irrelevant dimension for Experiment 2. In the left panel the relevant dimension is identity, and in the right panel expression. Vertical bars represent the positive standard errors of the means. A = Person A, B = Person B; h = happy, s = sad.

For identity classifications (Figure 17, left panel) a significant main effect of condition was confirmed, $F(2, 46) = 4.94$, $p = .01$. A Newman-Keuls comparison of condition means (alpha = .05) showed that RTs in the correlated and control conditions were no different from each other and both were significantly faster than the orthogonal condition ($M = 564$ ms, 562 ms, and 592 ms respectively). There was also a significant main effect of expression, $F(1, 23) = 16.36$, $p = .001$, with sad expressions responded to more quickly than happy ones. These main effects were further qualified by two- and three-way interactions as follows: expression x condition, $F(2, 46) = 7.19$, $p = .002$; expression x identity, $F(1, 23) = 16.1$, $p = .001$; expression x condition x identity, $F(2, 46) = 8.28$, $p = .001$. Inspection of Figure 17 suggests that the three-way interaction may be interpreted as the advantage to sad expressions being lost in the correlated condition for B as well as there being faster RTs to B happy when A and B happy were

no longer juxtaposed in this condition. Note that the hairlines of A happy, B happy and B sad are very similar, especially when compared with A sad (refer to Figure 15).

For expression classifications (Figure 17, right panel) there was a significant main effect of condition, $F(2, 46) = 6.5$, $p = .003$. A Newman-Keuls comparison of condition means (alpha = .05) again showed that RTs in the correlated and control conditions were no different from each other and both were significantly faster than the orthogonal condition ($M = 570$ ms, 574 ms and 608 ms respectively). A significant main effect of identity, $F(1, 23) = 16.87$, $p < .0001$ was modified by an identity x condition interaction, $F(2, 46) = 4.67$, $p = .01$, with Ps responding faster to the expressions of B in all conditions and this advantage for B most obvious in the control condition. A significant main effect of expression, $F(1, 23) = 16.01$, $p = .001$ was modified by an expression x identity interaction, $F(1, 23) = 20.55$, $p < .0001$, with A's sad expressions responded to more slowly than any of the other stimuli. The three-way interaction did not reach significance ($p = .2$).

Discussion

Inter-task relationship: mutual dependence?

Mutual interference is shown in this experiment. Participants took longer to make responses in the orthogonal condition compared with the control for both identity and expression classifications. In Garner's (1976) terminology this supports the integrality of these dimensions, and one interpretation of these results would be that variations in identity information interfere with expression processing and variations in expression interfere with identity processing. This interpretation is in marked contrast to the weight of experimental and neuropsychological evidence which suggests that identity (familiar faces) and expression processing are independent. The results are also in contrast to Schweinberger and Soukup's (1998) findings of asymmetrical interference where it was possible to attend to identity classification independently of variation in expression but expression classification was influenced by variation in identity. Possible alternative

explanations of these results are sought. The two cases of mutual interference and asymmetric interference are considered below.

Firstly, and with regard to both tasks, it could be questioned as to whether or not the experiment is an adequate test of dimensional interference. The values of the stimuli may not be representative of identity or of expression dimensions in the way that the 'mind of the experimenter' asserts. The stimulus items presented are members of a limited 8 item set. It could be argued that there are no dimensions here. There are just 8 stimulus - response combinations that the participant needs to learn in order to carry out the task efficiently. To do this they may try to remember each picture as a separate instance thereby establishing what Bruce and Young (1986) distinguish as a pictorial code for each picture regardless of which dimension is being discriminated. Also, Garner (1974) suggests that the informational structure of a single stimulus is determined in relation to the number of actual or inferred members of the total set. In the experiment here there are differences between individual stimuli such that a much larger set than the one intended may be inferred. For example, a hairline dimension is inferred that has values of long and short hair, and an additional expression dimension (e.g., non emotional) may be present if any of the sad expressions were misrecognised as neutral. According to Garner, participants may or may not be influenced by this redundant information when classifying single stimuli into categories. The result of additional inferred dimensions and the use of picture-based strategies may have been mutual interference.

Secondly, the case of asymmetric interference. The source of the interference from expression when making identity classifications may be different to that from identity when making expression classifications. Consider identity classification first. Selective attention may or may not be possible here depending upon how easy or difficult it is to tell one person apart from the other and thereby learn their identities. Schweinberger and Soukup's stimuli may have been easier than those here to discriminate on the basis

of identity. A different hairline for one of the identities associated with only one of the expressions means that there was a large perceptual cue to identity that varied coincidentally with the irrelevant dimension and participants may have needed longer to take this into account. Interference in this instance would appear (erroneously) to be from variation in expression. Schweinberger and Soukup's experiment may have avoided this confounding influence for identity classification. Hence in their experiment, but not in Experiment 2 here, it would have been possible to process identity independently of interference from irrelevant variation.

Interference in the expression classification task from variation in identity in both Schweinberger and Soukup's experiment and the one carried out here may be present as a pictorial 'artefact' similar to that mentioned above. There are, however, two additional competing explanations. The first concerns the relative speed of processing of each task where, if identity was always faster than expression (as it is, albeit non-significantly so, in both Schweinberger and Soukup's experiment and the one here: errors are also greater for expression classification than for identity in both studies and this difference achieves significance in the study here), information from this dimension would be more likely to interfere with expression than vice versa. The second explanation is that information about identity is indeed integral to expression processing in a way not predicted by the Bruce and Young (1986) model.

<u>Inter-task relationship: configural dimensions?</u>

If RTs in the correlated condition are taken into account as well as RTs in the control and orthogonal conditions, and a comparison made to Garner's (1976) configural dimensional interaction represented in Figure 13(iv) above, the patterns of responding are seen to be very similar. Alternatively, it may be that the P's cannot make use of the contingency information to improve RT due to a performance limitation. Further discussion of this feature of the experiment is continued below.

Intra-task relationships

For the identity classification task the results of the error analysis support the above 'pictorial' interpretation of the interference observed. Ps had difficulty distinguishing between A and B when both were happy and made approximately twice as many errors to happy expressions from both A and B in the orthogonal condition when either were expected. Analysis of RTs for the identity classification task also supports this interpretation. The main way of telling A apart from B is the difference in hairline which is more pronounced for A's sad expression than than it is for his happy expressions. If this difference is not available and the participant is expecting a choice between A and B both happy then reaction times are slowed. They are slowest in the orthogonal condition where the uncertainty is greatest. When the irrelevant variable is correlated, the possibility of a choice between A and B both happy does not arise, and B's happy face is responded to more quickly than B's sad face. Where the chance of the happy face coming up could be either A or B, sad expressions, more discriminable on the basis of hairline alone for the purposes of identity classification, regain their advantage. That is, expression affects identity processing when one of A's expressions makes him look like B.

Analysis of expression classification errors where errors were distributed evenly across conditions and relevant and irrelevant variables, and the lack of a significant three-way interaction when RTs were analysed, suggests that pictorial differences between items may not be responsible for the interference observed from identity here. However, relative ease of discriminability remains an issue, and the difficulty of classifying expression may be affected by the intensity of the expression. For example, responses to A's sad expressions may have been delayed by the variants of these expressions not looking 'sad enough' (see Figure 17, right panel).

Intra-task relationships: participants make use of configural pictorial cues when responding to identity

For identity classification, an examination of the RTs to stimulus types in the correlated condition (Figure 17, left panel) supports the delaying impact of hairline on the discrimination of A's happy expressions from B's sad ones. In the limited amount of time available to the viewer these faces look very similar, the point made above for A and Bs' happy expressions. However, because RTs to A's sad and B's happy faces are considerably faster than to A's happy and B's sad expressions in this condition, the lack of a redundancy gain is not due to a 'floor' effect. This promotes the idea (after Garner, 1976, p. 101) that configural dimensional interaction, rather than integral dimensional interaction, is involved here as P's attempt to learn the difference between these unfamiliar faces. This is compatible with the use of visually-derived codes that interfere mutually for expression and unfamiliar face analysis (Bruce and Young, 1986), and a role for this type of code prior to establishing an independent identity-specific semantic code once these faces have become familiar.

There is an apparent contradiction in the literature that may have some bearing on the difference between configural and integral dimensions. Children appear insensitive to configural aspects of faces until a certain level of maturation has been achieved (Carey and Diamond, 1977). Young children however, in research on visual perception (e.g., Shepp and Swartz, 1976) indicate that they do attend to the configuration of a stimulus and fail to perceive its components as separable dimensions. Sergent (1984) offers the suggestion that it may be the capacity to integrate configural and componential modes of processing that underlies the developmental improvement seen in face recognition in children around age 10 and the large capacity adults have for remembering faces. However, the situation may be more complicated than this. Carey (1992) suggests that there may be two distinct senses in which the 'configural encoding' of faces takes place and that only one of these may be implicated in adult expertise at encoding. She illustrates this by showing that the composite effect demonstrated by

Young et al. (1987) is consistent for 6 year olds, 10 year olds and adults, whereas 6 year olds identify inverted faces of familiar people more quickly than when these faces are upright, 10 year olds are about the same at both, and adults are worse at inverted than upright faces. Configural encoding, revealed in the Garner paradigm when discriminability of some of the stimuli is made difficult, may be a reflection of this latter process in adults. How far comparisons may be made with the very simple stimuli (parentheses) with which Pomerantz and Garner (1973) developed their ideas about configural processing and how it might be different from that of integral dimensions is questionable as faces are so much more complex. This matter is not pursued further here.

Modifying the stimulus set

One way of eliminating the uncertainty of identity classification due to the hairline is to eliminate the hairlines from stimuli. However, simply trimming faces is likely to increase the difficulty of the identity classification task relative to the expression task making any asymmetry in interference difficult to interpret. One way of making the identity classification task of more equivalent difficulty under these circumstances would be to use many instances of each identity. Uncertainty of expression classification could be remedied by replacing sadness with an expression that is recognised more easily (see Chapter 2), such as surprise.

While the findings on speech perception experiments (e.g., Mullenix and Pisoni, 1990) may or may not be applicable to how information from faces is processed, a useful methodological parallel may be considered concerning increased stimulus variability. Garner experiments investigating stimulus variability and asymmetrical processing dependencies have been carried out. It has been shown for adults that, if dimensional interference is present then, as the number of stimulus items increase, the amount of interference between control and orthogonal conditions also increases. Mullenix and Pisoni demonstrated this with dimensions of voice (male or female) and

word (words beginning with /b/ or /p/). Although the two stimulus dimensions are processed in a mutually dependent manner, Mullenix and Pisoni found a processing asymmetry where irrelevant variation in the voice dimension interfered more with processing the word dimension than variation in words interfered with processing the voices. They suggest that the talker's voice cannot be ignored selectively and that failures in selective attention resulting in decreased word recognition performance are caused by the mandatory processing of the talker's voice. As they increased the number of talkers' voices from 2 to 16, the amount of orthogonal interference from this dimension increased. The amount of interference from the word dimension when classifying voice when stimulus instances were more numerous increased also, though it was not so marked.

It is not possible to increase the number of identities in a two-choice classification experiment, nor is it possible to increase the number of expressions used. However, it is possible to increase the number of views of each person (as suggested above) and each expression seen by participants. If interference from irrelevant variation is present for either dimension it may be expected to increase under these conditions.

Implications of using the modified stimulus set

In the next experiment the stimulus set is expanded to provide several views of each identity and of each expression with the hairline removed. Although the participant is denied hairline difference as a clue to identity there are other ways in which the faces differ. Features thought not to be significant for expression classification, the chubbiness or leaness of the cheeks, the thickness of the eyebrows, the shape of the jaw and the outline of the face (these last become particularly visible as orientation to the camera changes) and so on, are present. Such featural characteristics and the opportunity to view them as the head turns to left and right may be important for building a representation of identity that is not susceptible to the idiosyncratic differences that can occur between different still pictures taken from the front of a

single identity. Denial of information from the hairline also 'forces' Ps to focus on the internal features of the face and perhaps to become familiar more quickly with the different identities. To carry out the expression classification task the participant is required, as always, to make a match to the internal representation they already have of each of the two selected expressions.

During the course of Experiment 2, a few participants became confused at the assignment of the letters A and B to each person, and this confusion affected their hand of responding. The requirement of a response to B with the left hand (so that this aspect of the task could be balanced) became very difficult to assert. It was decided that in Experiment 3, in spite of the knowledge that names are very difficult to access (e.g., Bruce and Young, 1986; Young, 1998), giving the actors fictitious names would at least overcome this confusion. Also, although naming the faces could be argued to give these faces the advantage of a lexical code in addition to an identity-specific code (Hanley, Pearson, and Howard, 1990; Young, 1998) as a structural representation of these unfamiliar faces is formed, this is uncertain that this happens to a greater extent than when calling the stimuli Person A and Person B.

Summary of Experiment 2 and predictions for Experiment 3

The results from Experiment 2 are interpreted as showing that a reliance on incidental differences and similarities between views of the different faces results in interference from irrelevant variation when processing identity and (possibly) expression information from still photographs of unfamiliar people. Encouraging the formation of structural codes for identity analysis and including more easily discriminated expressions is predicted to allow selective attention to identity regardless of expression variation, with selective attention to expression regardless of variation in identity still an open question. A second attempt at replicating Schweinberger and Soukup's (1998, Exps. 1 and 2) results is made in Experiment 3.

Experiment 3

In this experiment the expectation is that identity information will be processed independently of expression but that expression information will show interference from irrelevant variation in identity, if Schweinberger and Soukup's (1998) findings generalise under conditions of increased stimulus variability.

Method

Participants

Fifty-three people volunteered and each received either course credit or were paid for their participation. The data from 48 Ps (14 Male, 34 Female) with a mean age of 22.3 (SD = 5.3) years were included in the data set. Three Ps (for the identity classification task) and 2 Ps (for the expression classification task) did not achieve the inclusion criteria.

Stimuli and apparatus

Happy and surprised expressions from 2 male actors (Face Nos. 26 and 27 were given the names 'Ben' and 'Mike' for the purposes of the experiment) made up the stimulus set. Variations of each expression were captured as still frames from the same filming session from which the assessed frames were taken. Six stimulus examples of each expression from each actor were used at orientations of approximately 5, 20 and 45 degrees to the viewer's left and 5, 20 and 45 degrees to the right (Figure 18). Agreement that each stimulus face expressed happiness or surprise was sought from Ps doing expression classification at the beginning of the experiment. Similarly, agreement that all variations of Mike belonged together as did all variations of Ben, was sought from Ps doing identity classification.

The stimuli were presented as in Experiment 2 with the stimulus size altered slightly. Stimulus size measured 6 x 8.5 cm which subtended an angle of 5.7° horizontally and 8.1° vertically.

Figure 18. Stimulus set for Experiment 3. Top rows: Six happy and 6 surprised expressions from Face No. 26 (Ben). Bottom rows: Six happy and 6 surprised expressions from Face No. 27 (Mike).

Design

As for Experiment 2.

Procedure

As for Experiment 2 with modification as follows. For identity classification the 24 Ps in this group were told that the task involved making a decision as quickly and as accurately as possible as to whether the face presented on the computer screen was Mike or Ben. Prior to the task, the stimuli printed out singly on paper were shown to each participant for 3 to 5 seconds. Half saw Mike first, half saw Ben and each subset was ordered randomly. At this point in the experiment the Ps were tested as to which image belonged to which person. The stimuli were shuffled into a random order and the P asked to name each. They then sorted these into two separate piles, one for each identity. When they were able to do this without making errors they proceeded to the speeded classification task.

The increase in the number of instances of each identity and expression resulted in an increased number of trials in each block, and each of the conditions was made up of 2 consecutive blocks of 120 trials. Each block contained 24 practice trials ordered randomly followed by 96 test trials also ordered randomly. Conditions and blocks were further organised as for Experiment 2. Each stimulus picture was seen for a total of 8 test trials in each condition. As before, the procedure for the expression classification task was as for identity classification with task-relevant details changed as appropriate. Inclusion criteria were as for Experiment 2. The experiment took 35 to 40 minutes to complete.

Results

Errors and outliers

Errors for Ps who met the scoring criteria were few. Ps in the identity classification group made average incorrect responses of 2% (correlated, 1.9%; control, 2.1%; orthogonal, 2.1%). Ps in the expression classification group made average incorrect responses of 1.9% (correlated, 1.7%; control, 2%; orthogonal, 2.1%). Errors were not

analysed further. Outliers made up 0.8% of responses to identity and 0.6% of responses to expression.

RTs: comparisons between classification tasks across conditions

Mean correct RTs for both groups in all experimental conditions can be seen in Figure 19. A 2 x 3 mixed ANOVA with task as the between-subjects variable and condition as the within-subjects variable showed no main effect of task (identity classification, $M = 593$ ms, expression classification, $M = 573$). There was a significant main effect of condition, $F(2, 92) = 17.54$, $p < .0001$. Inspection of Figure 19 suggests that this reflected an effect of condition when making both identity and expression classifications. There was no significant task x condition interaction ($p = .5$). As for Experiment 2, mutual interference is suggested.

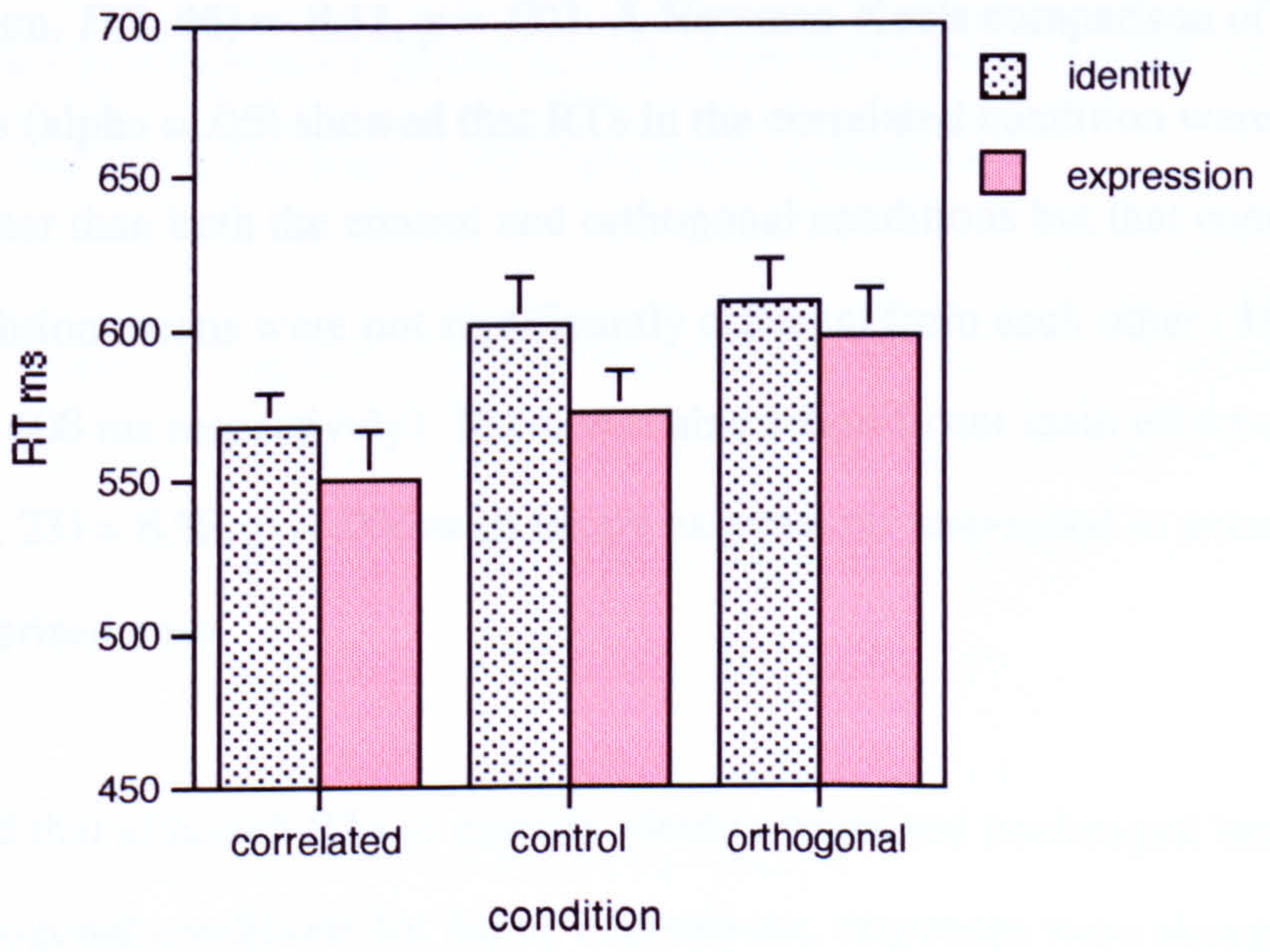

Figure 19. Mean reaction times in Experiment 3 for identity and expression classification groups in each condition. Vertical bars represent the positive standard errors of the means.

RTs: comparisons within each classification task

Separate 3 x 2 x 2 ANOVAs were carried out for each task with the within-subject variables of condition, identity, and expression (Figure 20).

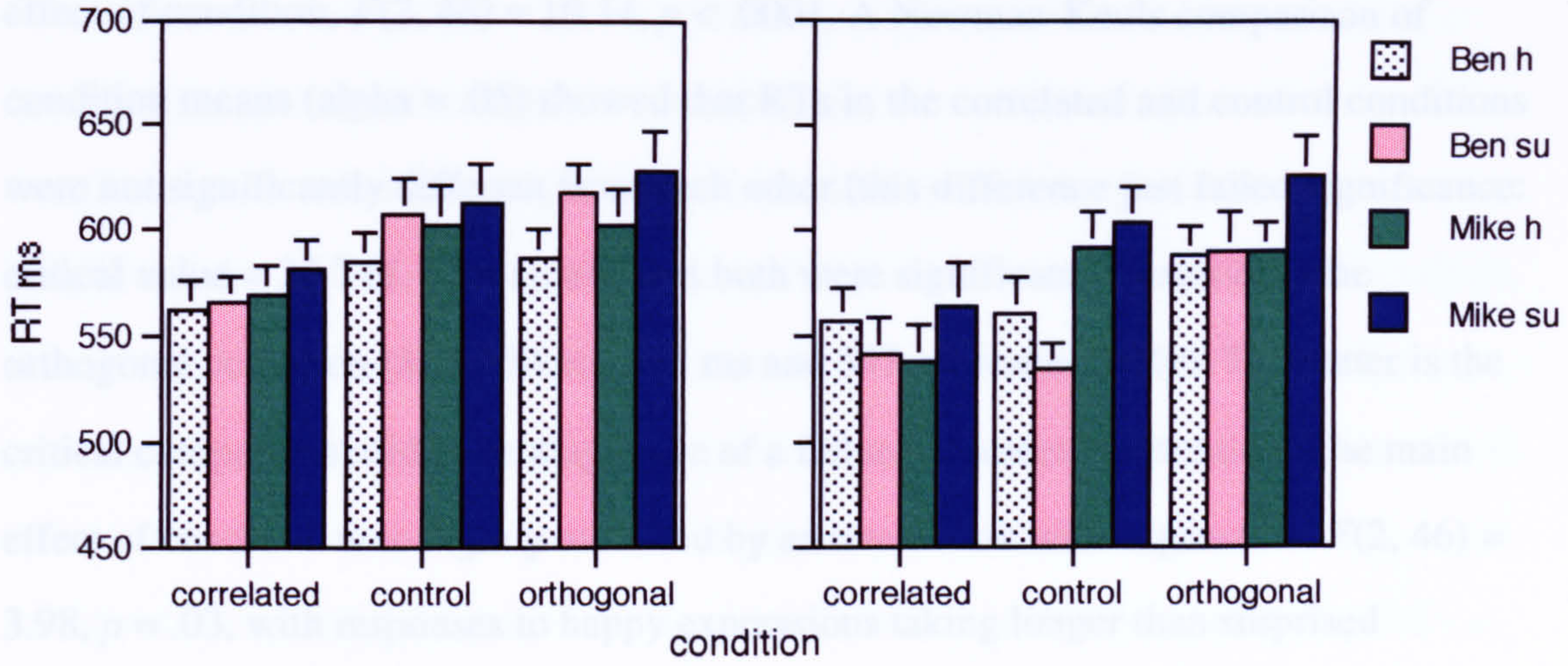

Figure 20. Mean reaction times for every combination of each relevant and irrelevant dimension for Experiment 3. In the left panel the relevant dimension is identity, and in the right panel, expression. Vertical bars represent the positive standard errors of the means. h = happy, su = surprised.

For identity classifications (Figure 20, left panel) there was a significant main effect of condition, $F(2, 46) = 8.11$, $p = .001$. A Newman-Keuls comparison of condition means (alpha = .05) showed that RTs in the correlated condition were significantly faster than both the control and orthogonal conditions but that control and orthogonal condition means were not significantly different from each other ($M = 569$ ms, 602 ms and 608 ms respectively). There was also a significant main effect of expression, $F(1, 23) = 8.98$, $p = .006$ with happy expressions responded to more quickly overall than surprised ones.

It was noted that although RTs to classify identity remained unchanged between control and orthogonal conditions for happy expressions, responses were slower in the orthogonal condition for surprised expressions. A 2 x 2 x 2 ANOVA excluding RTs in the correlated condition was therefore carried out. RTs to surprised expressions were significantly slower ($p = .01$) but the interaction with condition failed to reach significance ($p = .3$) and there were no other main effects or interactions.

For expression classifications (Figure 20, right panel) there was a significant main effect of condition, $F(2, 46) = 10.14$, $p < .0001$. A Newman-Keuls comparison of condition means (alpha = .05) showed that RTs in the correlated and control conditions were not significantly different from each other (this difference just failed significance: critical value = 25.7 cf. 23 ms), and that both were significantly faster than the orthogonal condition ($M = 550$ ms, 573 ms and 597 ms respectively). This latter is the critical comparison said to be diagnostic of a failure of selective attention. The main effect of condition was slightly modified by an interaction with expression, $F(2, 46) = 3.98$, $p = .03$, with responses to happy expressions taking longer than surprised expressions in the control condition only. A significant main effect of identity, $F(1, 23) = 27.06$, $p < .0001$, showed that Ben's expressions were classified faster than Mike's. This was modified by an interaction with condition, $F(2, 46) = 11.89$, $p < .0001$, which indicated that this advantage for Ben's expressions was most marked in the control condition. An interaction of identity with expression, $F(1, 23) = 26.12$, $p < .0001$, indicated that Mike's surprised expressions were more difficult to classify than either his happy expressions or Ben's happy and surprised expressions.

As RTs to expression may be influenced differently by the different identities across control and orthogonal conditions, a 2 x 2 x 2 ANOVA excluding RTs in the correlated condition was carried out. The main effect of condition, $F(1, 23) = 4.90$, $p = .04$, was indeed modified by an interaction with identity, $F(1, 23) = 7.86$, $p = .01$. A simple main effects analysis of this interaction confirmed that the difference between control and orthogonal means was significant for Ben only, ($F(1, 46) = 26.26$, $p < .0001$). The main effect of condition was also modified by an interaction with expression, $F(1, 23) = 6.43$, $p = .02$, and a simple main effects analysis of this interaction found the difference between control and orthogonal means significant for surprise only, ($F(1, 46) = 15.36$, $p < .0001$). Interference from variation in identity was therefore limited to Ben's surprised expressions for Ps making expression classifications.

Discussion

Inter-task relationship: asymmetric separability?

Slight asymmetric interference was found in this experiment although this was insufficient to result in an interaction between task and condition in the initial analysis. When expression classification RTs were analysed separately however, participants took significantly longer to make responses in the orthogonal condition compared with the control. This was in contrast to the identity classification group for, although participants took longer to make identity classifications across the conditions, the comparison considered diagnostic of integrality, that between control and orthogonal conditions, was not significant. In contrast to Experiment 2, redundancy gain in the correlated condition appeared for both groups, significantly so for identity classifications only. Under conditions in which the variability of the stimulus set was increased, slight evidence has been found in support of Schweinberger and Soukup's findings of asymmetric separability between these two facial dimensions.

It is noteworthy that, although the condition effect for identity classification is not modified by either the relevant or the irrelevant variables, this is not so for expression classification where the condition effect is modified by both. This indicates that, during expression classification selective attention may be possible for some expressions and not others, and interference from irrelevant variation may be specific to some identities. Schweinberger and Soukup (1998) found their lack of a condition effect for identity classification modified marginally by the relevant variable and not at all by the irrelevant variable. For expression classification their significant condition effect was similar for both expressions tested (happy and sad) and independent of whose face was shown.

Summary of Experiments 2 and 3 and predictions for Experiment 4

The results of Experiment 2 suggest that speeded classifications of identity and expression are both influenced by variation in the irrelevant dimension. An incautious interpretation of these results is that these dimensions are integral (or some version of integral such as 'configural') with the difference between stimuli being determined by their overall (dis)similarity instead of the values they sustain along dimensions assigned nominally by the experimenter. This is not to say that the participants are unaware of the dimensions given in each set of instructions as they did perform each task to a high level of accuracy. It may, however, be made more or less difficult to attend selectively to the required dimension given idiosyncratic intra- and inter-dimensional differences between the stimuli (e.g., a different hairline for only one expression for one of the identities). If these differences prevent selective attention, then the opportunity to form a structural or abstract code for either identity or expression predicts independence for either or both dimensions.

This prediction was born out in Experiment 3 for identity analysis only. Asymmetric interference similar to that reported by Schweinberger and Soukup (1998) was found. Identity, with modifications made to the stimulus set and the instructions, could be attended to selectively, and expression classification was influenced by variations in identity. Identity interference with expression analysis, however, was qualified by the finding that it may be dependent on the particular expressions and identities used.

It was decided in the next experiment to see whether or not any trace of asymmetric interference would be sustained under conditions in which the variability of the stimulus set was *reduced* to a minimum. One way of doing this is by using the expressions of one actor to make up two identical sets of expressions and creating the impression that two different identities are present by changing the hairline on one of these sets. Given that sad (Exp. 2) and surprise (Exp. 3) expressions from 'Ben' (Exp. 3)

have been shown susceptible to interference, these expressions from this one actor were selected as stimuli for Experiment 4. Two different 'identities' were then created by removing the actor's hair and pasting the hairstyle from two other male actors of approximately the same age on to his face. The light-haired and dark-haired versions were then assigned names (Paul and Jim). As the identity classification task requires only that the P detect the difference in hair and expression variation is identical for both, then it should be easy for Ps to attend selectively to this feature. In addition, as the expressions do not themselves vary, then it should be possible for Ps to attend selectively to expression regardless of variation in hairstyle, given that the hairline is not thought to be implicated in the assessment of emotional state from facial expression. If interference from irrelevant variation is present at all for either dimension it may be expected to decrease under these conditions.

Experiment 4

In this experiment the expectation is that identity and expression information will be processed independently of each other. However, if Schweinberger and Soukup's (1998) findings of asymmetric interference apply to conditions in which stimulus variability is reduced, then identity information will be independent of expression with expression processing influenced by variation in identity.

Method

Participants

Fifty-four people volunteered and each received either course credit or were paid for their participation. The data from 48 Ps (16 Male, 32 Female) with a mean age of 22.0 (SD = 7.2) years were included in the data set. Five Ps (for the identity classification task) and 1 P (for the expression classification task) did not achieve the inclusion criteria. Only one of the 6 Ps excluded committed too many errors. Four Ps

from the identity classification task and the P from the expression classification task realised that the faces were all of the same person and so were excluded on this basis.

Stimuli and apparatus

Two variations each of sad and surprised expressions from 1 male actor (Face No. 26) were captured as still frames, duplicated, and the hair removed. Two different 'identities' were then constructed by pasting the hair from two other male actors on to each face (Figure 21). The new identities were named Paul (light-haired version) and Jim (dark-haired version). Agreement that an example sad expression was sad and an example surprise expression was surprise and that the two were different was sought from Ps doing expression classification at the beginning of the experiment. Similarly, agreement that Paul could be distinguished from Jim, was sought from Ps doing identity classification. The stimuli were presented as in Experiments 2 and 3 with the stimulus size altered slightly. Stimulus size measured 4.8 x 6.9 cm which subtended an angle of 4.6° horizontally and 6.6° vertically.

Figure 21. Stimulus set for Experiment 4. Top row: Two sad and 2 surprised expressions from Face No. 26 (Paul). Bottom row: Two sad and 2 surprised expressions from Face No. 26 (Jim).

Design

As for Experiments 2 and 3.

Procedure

As for Experiments 2 and 3 with modification as follows: For the identity classification task the 24 participants in this group were told that the task involved making a decision as quickly and as accurately as possible as to whether the face presented on the computer screen was Paul or Jim. Prior to the task, each P saw one example of each face. Half saw Paul first and half saw Jim. They then proceeded to the speeded classification task.

Each of the conditions was made up of 2 consecutive blocks of 56 trials. Each block contained 16 practice trials ordered randomly followed by 40 test trials also ordered randomly. Conditions and blocks were further organised as for Experiments 2 and 3. Each stimulus example was seen for a total of 10 test trials in each condition. As before, the procedure for the expression classification task was as for identity classification with task-relevant details changed as appropriate. Inclusion criteria were as for Experiments 2 and 3 with the additional criterion that the Ps did not realise that the faces were all of the same person. The experiment took 20 to 25 minutes to complete.

Results

Errors and outliers

Errors for Ps who met the scoring criteria were few. Ps in the identity classification group made average incorrect responses of 1.4% (correlated, 1.1%; control, 1.1%; orthogonal, 1.8%). Ps in the expression classification group made average incorrect responses of 1.6% (correlated, 1.4%; control, 1.8%; orthogonal, 1.8%). Errors were not

analysed further. Outliers made up 0.9% of responses to identity and 0.9% of responses to expression.

RTs: comparisons between classification tasks across conditions

Mean correct RTs for both groups in all experimental conditions can be seen in Figure 22. A 2 x 3 mixed ANOVA with task as the between-subjects variable and condition as the within-subjects variable showed no main effect of task (identity classification, $M = 533$; expression classification, $M = 567$). There was a significant main effect of condition, $F(2, 92) = 5.47$, $p = .006$. Inspection of Figure 22 suggests that this reflects an effect of condition when expression classifications were made and, possibly, when identity classifications were made. There was no significant task x condition interaction ($p = .7$).

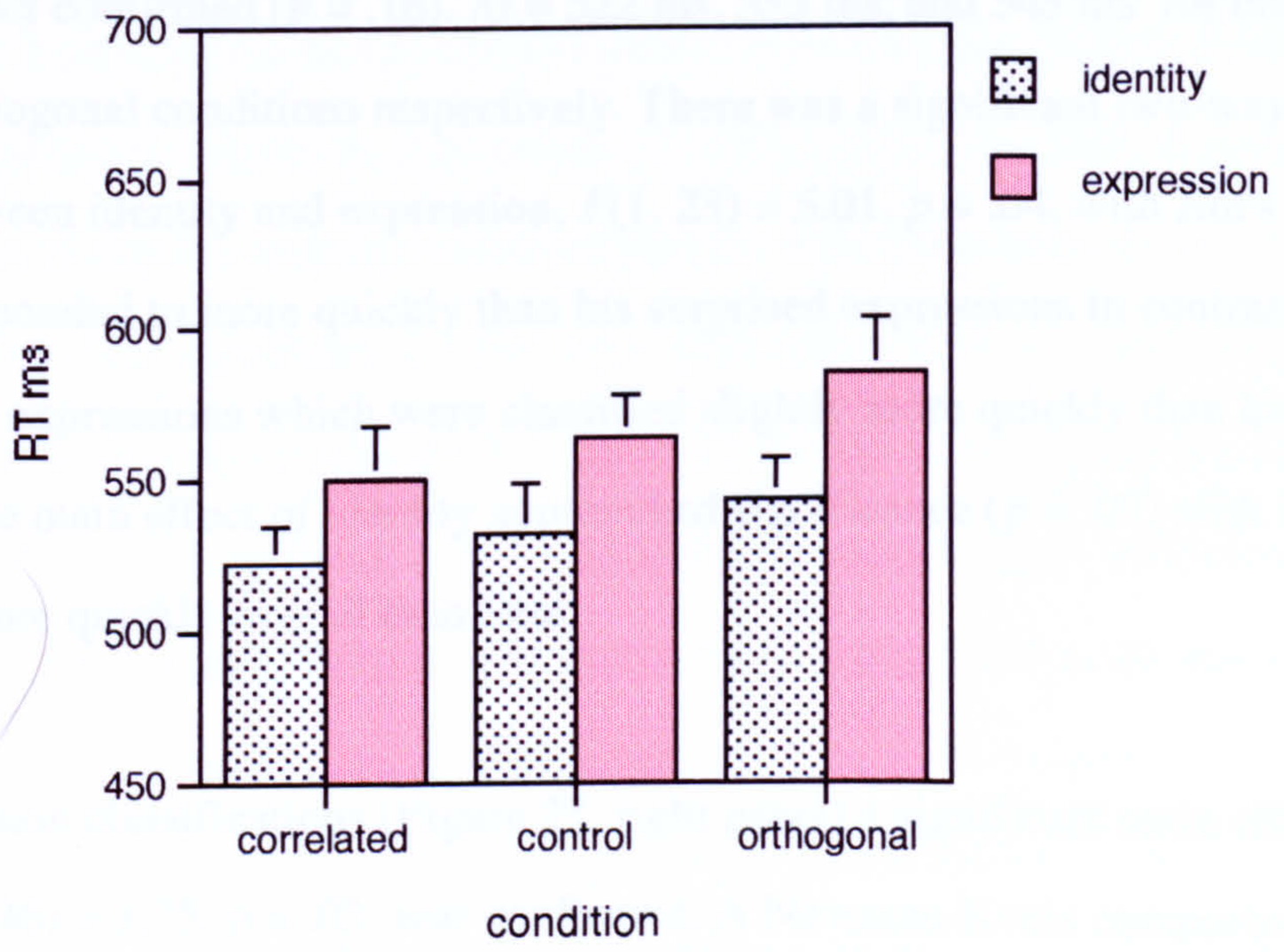

Figure 22. Mean reaction times in Experiment 4 for identity and expression classification groups in each condition. Vertical bars represent the positive standard errors of the means.

RTs: comparisons within each classification task

Separate 3 x 2 x 2 ANOVAs were carried out for each task with the within-subject variables of condition, identity and expression (Figure 23).

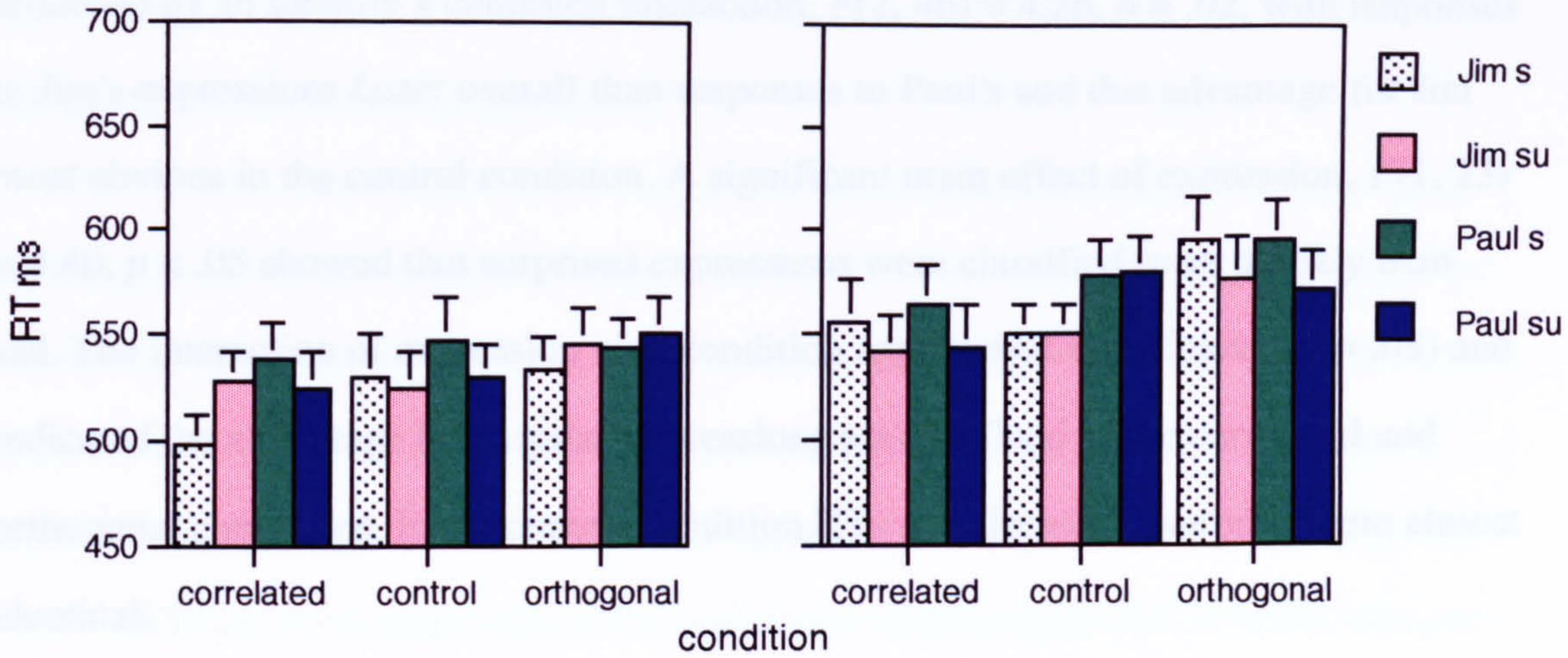

Figure 23. Mean reaction times for every combination of each relevant and irrelevant dimension for Experiment 4. In the left panel the relevant dimension is identity, and in the right panel, expression. Vertical bars represent the positive standard errors of the means. s = sad, su = surprised.

For identity classifications (Figure 23, left panel) a significant main effect of condition was *not* confirmed ($p = .18$). $M = 522$ ms, 533 ms, and 543 ms for correlated, control and orthogonal conditions respectively. There was a significant two-way interaction between identity and expression, $F(1, 23) = 5.01$, $p = .04$, with Jim's sad expressions responded to more quickly than his surprised expressions in contrast to Paul's surprised expressions which were classified slightly more quickly than his sad expressions. The main effect of identity approached significance ($p = .07$) with Jim responded to more quickly overall than Paul.

For expression classifications (Figure 23, right panel) a significant main effect of condition, $F(2, 46) = 3.75$, $p = .03$, *was* confirmed. A Newman-Keuls comparison of condition means (alpha = .05) showed that RTs in the correlated and control conditions were no different from each other and that the correlated condition mean was significantly faster than the orthogonal condition mean ($M = 551$ ms, 564 ms and 585 ms for correlated, control and orthogonal conditions respectively). However, the comparison said to be critically diagnostic of a failure of selective attention, that between control and orthogonal condition means, failed to achieve significance (critical value = 25 cf. 21 ms). A significant main effect of identity, $F(1, 23) = 5.90$, $p = .02$ was

modified by an identity x condition interaction, $F(2, 46) = 4.26$, $p = .02$, with responses to Jim's expressions faster overall than responses to Paul's and this advantage for Jim most obvious in the control condition. A significant main effect of expression, $F(1, 23) = 4.40$, $p < .05$ showed that surprised expressions were classified more quickly than sad. The interaction of expression with condition approached significance ($p = .08$) and indicated the advantage for surprise expressions was confined to the correlated and orthogonal conditions. In the control condition RTs to sadness and surprise were almost identical.

Although the difference between control and orthogonal means was not significant, inspection of Figure 23, right panel, shows that RTs to expression might be influenced differently by the different identities. A 2 x 2 x 2 ANOVA excluding RTs in the correlated condition was therefore carried out. The main effect of condition disappeared confirming the Newman-Keuls comparison above. However, the identity x condition interaction once again showed as significant, $F(1, 23) = 9.77$, $p = .005$. A simple main effects analysis of this interaction confirmed that the difference between control and orthogonal means was significant for Jim only, ($F(1, 46) = 6.84$, $p = .01$), with RTs faster to Jim in the control condition ($F(1, 46) = 12.66$, $p = .001$). The main effect of expression approached significance ($p = .05$) as did the expression x condition interaction ($p = .06$). Again from inspection of the figure it looked as though sad and surprised expressions might be affected differently by variation in identity so a simple main effects analysis was carried out on these means. This found that the difference between control and orthogonal means was significant for sad expressions, ($F(1, 46) = 5.30$, $p = .03$), with RTs slower to sadness in the orthogonal condition, ($F(1, 46) = 8.24$, $p = .006$). The slight amount of interference from variation in identity found in this experiment was therefore limited to Jim's sad expressions for Ps making expression classifications.

Discussion

Inter-task relationship: independence?

The results of this experiment suggest that identity classifications can be carried out independently of variation in expression and that expression classifications can be carried out independently of variation in identity. This suggests that under conditions in which the variability of the stimulus set is decreased, these two dimensions may be separable. These results are, however, not completely straightforward for at least two reasons. Firstly, further analysis of the expression classification task revealed stimulus item effects that lend support to the idea that a failure of selective attention to expression with unfamiliar faces can be based on a single difference between the pictures used. Secondly, each participant whose results were included in the data set (48 out of 54) was astonished at de-briefing that Jim and Paul had the same face. Indeed, not only did they have the same face, the pictures used were identical apart from the hair. This latter showed that changing the hairline on an unfamiliar face is sufficient to convince most viewers that they are looking at a different person. This is regardless of whether they are asked to attend to identity or to expression information.

In spite of the faces being identical insofar as expression was concerned, the addition of different hair (whether or not a different identity was also added) was sufficient to produce results tending in the direction of Schweinberger and Soukup's (1998). The difference between control and orthogonal conditions for expression classification approached significance while the difference between control and orthogonal conditions for identity classification more clearly did not. Although expression classification may be susceptible to interference from identity as the Ps believed they were responding to two different people, the possibility that minimal stimulus variation that happens to convey a difference in identity rather than the "special status of identity information" (p. 1763, Schweinberger and Soukup, 1998) may be responsible for this susceptibility, so long as the faces remain unfamiliar, has not been excluded.

Intra-task relationships

As predicted, results for identity classification support independence from irrelevant expression variation. Relevant variation did however make a difference. One explanation for faster RTs to Jim's face might be because higher contrast in the image, introduced with the dark hairline, allowed a more rapid response (Watt, personal communication). If so, RTs to Jim in the expression classification task would also be expected to be faster, which they were. In addition, in the expression classification task, significant interference was shown for Jim's sad expressions. Surprise expressions, in contrast to the findings in Experiment 3, did not show significant interference from variation in 'identity' here.

General discussion

The primary aim of these experiments was to explore the generality of Schweinberberger and Soukup's (1998) findings of asymmetric separability for identity and expression dimensions. How far do their findings extend to different facial identities and different expressions?

The first experiment in this chapter (Exp. 2) found that if the identity of one face resembled the identity of the other, if only for one of the expressions, then mutual interference was experienced. The second experiment (Exp. 3), in which participants were encouraged to form full and separate identity-specific codes for each of the identities, did produce a situation resembling that of asymmetric separability under conditions of increased stimulus set variability. However, although the independence of identity emerged, the failure of selective attention to expression information was present for one expression and one identity only. Also, for the classification of expression, irrelevant identity variation was not found to be independent of condition (interference was found for Ben and not Mike between control and orthogonal

conditions). This is in contrast to Schweinberger and Soukup's (1998) findings where interference from both identities was present for both expressions in the orthogonal condition. When stimulus set variability was reduced and identity made easy to discriminate through modification of the hairline (Exp. 4), identity was classified independently whereas expression again showed signs of susceptibility to interference. This was again present for one 'identity' and one expression only. In the experiments here, compared with Schweinberger and Soukup's, different expressions have been found to be differently susceptible to variation in identity. Schweinberger and Soukup found happiness and sadness similarly open to interference, as did Experiment 2 here. Experiment 3 however, found surprise significantly more affected by variation in identity than happiness, and in Experiment 4, where sad and surprised expressions were compared, only sad expressions were significantly affected. While there is increasing evidence that emotional expression as an umbrella category is of limited use when investigating processing mechanisms, to find one expression open to interference in one experiment and not in the next, hints either of disconcerting complexity, or of perceptual responses sensitive to differences between individual items that are sensitive to the context (inferred dimensions, increased or decreased variability) of the total stimulus set.

It is suggested that still photographs of unfamiliar faces are treated as single events until task-relevant information is abstracted for functional purposes. Up to this point, they are classified on the basis of how similar or different they are from each other both within and across dimensional lines. If the visual similarity between items is high and discrimination is difficult then interference is mutual. If the identity discrimination between initially unfamiliar faces is easy, then this analysis may proceed independently of variation in expression. Expression analysis however, may continue to show interference from variation in identity dependent on which identities and which expressions are presented. Schweinberger and Soukup argue that this may be because identity processing is 'informationally encapsulated' (Fodor, 1983) and as such is not

open to interruption from other processes prior to the production of its own output. Expression analysis on the other hand, is more mutable and sensitive to the automatic generation of identity-specific codes upon exposure to the stimulus.

However, simply changing the hairline is sufficient to produce results that maintain the independence of identity processing and show traces of interference for expression. This might suggest that interference is present, not because we are extracting a structural identity-specific semantic code that filters, unreciprocated, through to expression analysis, but that the task of assessing an emotional expression (perceiving a configuration cf. checking a hairline or an eyebrow for the identity of an unfamiliar face) is such that any stimulus differences slow the participant in conditions of greater unexpectedness more than they do for the identity task. This suggests that if the 'right' combination of expressions and identities were found, it may be possible to show any combination of interrelationship from mutual interference through to independence. Schweinberger and Soukup argue against this 'relative speed of perception' explanation of their findings by pointing out that their RTs for expression and identity judgements were almost identical (518 ms cf. 513 ms). So too, in none of Experiments 2, 3, and 4 here, was either classification task significantly faster or slower than the other. In those experiments where asymmetric interference was present, identity was slower than expression classification (593 ms cf. 573 ms, Exp. 3) for one, and identity was faster than expression classification (533 ms cf. 567 ms, Exp. 4) for the other, but not significantly so in either case. It seems unlikely that the relative speed of processing argument applies in the experiments here either. This is in support of Schweinberger and Soukup's findings. In further support of Schweinberger and Soukup's (1998) findings a very recent study by Schweinberger, Burton and Kelly (in press) found that by using morphed faces, asymmetric interference between identity and expression was present for both easy and difficult to discriminate faces.

The replications and extensions of Schweinberger and Soukup's (1998) experiments carried out here (using double the number of participants) have been a partial success. Although slight asymmetric interference has been found, it does not generalise consistently to the different stimulus faces and expressions used here. Further work is required to determine whether the asymmetry found relates to the 'special status' of identity analysis or whether it relates to variation across the image that 'just happens' to carry the information specifying identity. Would we find an asymmetric relationship, for example, if personally familiar or famous expressive faces were used in this paradigm, or would we find, as the Bruce and Young (1986) model predicts, clear separability? In the absence of these future experiments for expression (though see Schweinberger and Soukup, 1998, Experiment 5 for facial speech and 'personally familiar' identity dimensions), it is too soon to modify the Bruce and Young (1986) model. If, as Bruce and Young suggest, expression processing in the context of familiar identities is shown as independent of variation in identity, the model will need no modification.

Overview

Speeded classification to identity may occur independently of variation in expression if the identities used are easy to tell apart. A small amount of interference has been shown to occur when participants make speeded classifications to facial expressions and identity information varies. These latter results, however, are inconclusive as to whether the Ps are reaching a decision on the basis of pictorial differences between the stimuli used rather than on the basis of a code for expression sensitive to identity-specific information. It is possible that the results represent a half-way situation, with the faces in the process of becoming familiar, prior to the development of separable codes for both identity and expression. The use of expressive faces that are already personally familiar may take this issue further. Garner's reaction

time methodology seems suited to a bidirectional exploration of the relationship between two types of information from the face. It shows a sensitivity to differences between dimensions when different groups are compared and to differences between stimulus items when single dimensions are considered. In addition to a (unidirectional) rating study, this methodology is therefore further employed to explore Bruce and Young's (1986) predicted independence between expression and sex information from the face in the next chapter.

4

Expression and sex

The sex someone is, and the emotion they are expressing, must both be taken into account in an assessment of how biddable they might be as a potential mate, but it is clearly not necessary to recognise what sex someone is to know what emotion they are expressing, and vice versa. Bruce and Young (1986), while not explicit about the detail of sex and expression perception and recognition, do reserve separate processing codes for these functionally very different types of information. Different types of analyses are therefore carried out independently on the same stimulus. Some of the evidence suggesting the independent analysis of expression and sex information has already been presented in Chapter 1: It is also outlined below in more detail. What we know of the differences important for discrimination between male and female faces, and the differences between anger and surprise (the expressions chosen for these experiments) are covered next. After this, the three experiments in this chapter that explore the relationship between the analysis of emotional expression and sex are described.

Evidence for independence

Laboratory evidence addressing the specific independence of sex and expression is sparse. There is evidence to suggest that both are independent from identity analysis,

and some to suggest that sex information from the voice is independent from visible facial speech, but none to offer a direct comparison of each with the other. A priming study by Ellis et al. (1990) investigated the effect of familiarity, sex, and expression decisions during the Phase 1 task (first exposure to stimulus faces) on later decisions to familiarity, sex, and expression in the Phase 2 task (second exposure). They found that any of the three Phase 1 decisions speeded later familiarity decisions, that neither familiarity nor sex Phase 1 decisions speeded later sex decisions, and that neither familiarity nor expression Phase 1 decisions speeded later expression decisions. The results of this study are interpreted as supporting the idea that priming is confined to the system that mediates identity. Expression decisions were not made in this study to faces that had been classified previously for sex, nor were sex decisions required for those classified previously for expression. Further information on the independence of identity and sex decisions comes from a study by Bruce et al. (1987; see also Bruce, 1986). Whether a face was either easy or difficult to classify as male had no effect on saying whether a face was familiar or not. For sex decisions, only if the sex of a face was hard to classify, did familiarity have an effect. Presumably, in this latter case, the identity of the person was accessed first, the semantic information about sex retrieved, and a decision reached on this basis. Yet further experimental evidence for the independence of identity and expression comes from a study by Young et al. (1986). Familiarity facilitated decisions to pairs of faces when the participant was asked to decide whether the faces were of the same person or not, but had no effect on the time taken to match pairs of faces for expression. In an audio-visual study to investigate the independence of sex information and the analysis of facial speech, Green et al. (1991) found that mismatched male and female voices to female and male videotaped faces did not interfere with speech comprehension. From this experimental evidence then, it is likely that sex and expression are independent from identity analysis, and that sex information is independent of facial speech analysis, but it is less certain that sex and expression are independent from each other.

Evidence for the neuropsychological dissociation of sex and expression processing is non-existent. Neither are there unequivocal reports of the dissociation of sex and identity. A possible reason for this lack of knowledge may be because prosopagnosic patients have not always been tested for the recognition of face gender, as the recognition of familiar people (and what sex they are, through knowledge about that person) from voice and gait may remain unimpaired. This does not always apply, and there have been reports of severely prosopagnosic patients who cannot tell the gender of a face either (e.g., Cole and Perez-Cruet, 1964). The tests have not always been rigorous and Cole and Perez-Cruet mention that their patient was impaired at sex discrimination on the basis of his inability to recognise that characters in a soap opera on television with the sound turned off were women: Their concern was more with his inability to recognise familiar people. Tranel, Damasio, and Damasio (1988) found intact facial expression, age and gender recognition in patients with impaired recognition of identity, and Humphreys, Donnelly, and Riddoch (1993) report a patient (GK) who was relatively unimpaired at identifying famous faces but poor at the expression and gender of unfamiliar faces. There have been numerous studies supporting the double dissociation of expression and identity (e.g., Calder, Young, Rowland, et al., 1996; Parry et al., 1991), and the double dissociation of expression and facial speech analysis has also been reported (Campbell et al., 1986). From this neuropsychological evidence then, it is likely that sex and expression are independent from identity analysis, and that expression analysis is independent of facial speech analysis but, again, it is less certain that sex and expression are independent from each other.

Evidence for interaction

Many of the independences demonstrated are consistent with logical separations in the structural information needed to perform different tasks. For example, expression requires that the shape of the mouth is analysed irrespective of whose mouth it is or what it says, and identification requires that the same person is identified regardless of

their expression. Nonetheless, a recent study which was the focus of the previous chapter (Schweinberger and Soukup, 1998, Exps. 1 and 2) suggests asymmetric independence between identity and expression. Further evidence of complexity comes from studies on other functional facial information. For example, Schweinberger and Soukup's (1998, Exps. 3 - 7) selective attention experiments found an asymmetric relationship between identity and facial speech similar to the one they found for identity and expression. That is, it was possible to ignore the different speech actions depicted when saying who the person was, but not possible to ignore who the person was when classifying the speech action. Walker et al. (1995), also investigating facial speech and identity processing, looked at the susceptibility of their participants to the McGurk effect. This 'illusion', where it is not possible to report the seen or the heard information uncombined unless the ears, or the eyes, are covered, is very persistent. Walker et al. did however find that when participants were familiar with the seen faces and the voices presenting the speech tokens were unfamiliar, then they were less likely to report hearing blends, compared with when seen faces and incongruent voices were both unfamiliar. Gender information and gaze direction have also been studied. Campbell et al. (1996) found that speeded sex decisions to faces with gaze averted were slowed compared with when the faces were looking straight ahead. In a rating study, Campbell et al. also found that male faces were judged to be less masculine with eyes averted. In contrast, judgements to female faces were not affected by gaze direction. As the major perceptual feature involved is the lid-to-brow distance, they suggest this is particularly salient for males and that this increased distance in faces looking down slows responses.

This last finding is of particular relevance to the experiments reported here. If lid-to-brow distance also varies as the result of a change in expression (which it does when the face changes from being angry to being surprised) then sex decisions might also be facilitated or delayed depending on what expression is shown. I am however, getting a little ahead of myself here: first some information about how we tell male from female

faces, and angry expressions from surprised ones, and then, the experiments.

Visual information used for male and female face discrimination

The sex of a face is not determined exclusively by cues from the eyes and brows, though these are important. Bruce, Burton, Hanna, et al. (1993) found a role for superficial textural detail (e.g., stubble), relational information (e.g., nose size relative to the chin) and 3-dimensional information (e.g., brow and chin protuberance). Some features may be more or less important than others. Brown and Perrett (1993) masked the hair and hairline of 16 male and 16 female faces and averaged each set to produce male and female prototypes. Male features were then exchanged for female and vice versa. The jaw and the eyes and brows were found to be more important than the chin or the brows alone. All features in isolation except the nose carried 'gender' information in this study. Similarly, Roberts and Bruce (1988) found that while masking the nose adversely affected sex decisions, viewers were not able to use the nose in isolation to contribute information to sex-of-face decisions whereas they were still able to use the eyes and mouth. They suggested that masking the nose may have affected the extraction of overall topographic information about the face. Chronicle, Chan, Hawkings, et al. (1995) found that the nose is a useful feature in isolation when the head is at an angle to the viewer. Yamaguchi, Hirukawa, and Kanazawa (1995), used a prototype face within which they exchanged male and female features, and found that substitutions of the brows and face outline had the strongest effects of changing gender judgements.

Burton, Bruce, and Dench (1993) took photographs of 91 male and 88 female faces (profile and full-face views), again with the hairline concealed, and measured them in several ways. They were looking for a single function that could be used to classify faces either as male or female as reliably as human participants. The highest accuracy they achieved was 94% with 16 variables that took into account both 2- and 3-D information. Though not a simple combination of features, this compared favourably

with an accuracy of 96% on full-face views with adult participants. When Euclidean distances only were considered, 85% accuracy with 12 variables was obtained. The six most important of these were, in ascending order, the eye-to-eyebrow distance, forehead height, the distance between the eyebrows, the mouth width, nose width at the base of the nose, and eyebrow thickness.

O'Toole, Abdi, Deffenbacher, and Valentin (1993) used male and female face pixel-based images and principal components analysis to extract descriptors of major importance (see also Abdi, Valentin, Edelman, and O''Toole, 1995; O'Toole, Deffenbacher, Valentin, et al., 1998). With a sample made up of equal numbers of male and female faces adding the first eigenvector that was extracted to the second eigenvector created a masculine looking face and subtracting the second from the first created a feminine looking face. This is interpreted as meaning that the second eigenvector tends to separate male from female faces. The pixels with the largest values contributing to the make up of the second eigenvector are concentrated in the hair, forehead, eyebrows, nose and chin area, with male faces tending to have shorter hair, thicker eyebrows, a bigger nose, and a longer chin than female faces.

It is likely then that we use a multiplicity of cues from the face to determine the sex of a person with information from the eyes and brows and chin and jaw areas making a substantial contribution. It is probable that the lid-to-brow distance plays a major role as the measurements made on faces looking straight ahead by Campbell, Wallace, and Benson (1996) revealed very little overlap between the scores for male and female faces, with this distance in women being larger. Differences in the eye area also play a role in discriminating between different expressions, although again it is not the sole cue available to the observer. Angry and surprised expressions are considered in more detail below as the lid-to-brow distance is contrasted maximally between these two particular expressions.

Visual information used for anger and surprise discrimination

For expression decisions posed and spontaneous expressions, photographs of actors or line drawings and even schematic faces have been used in attempts to identify the underlying structural information mediating recognition. The most comprehensive measurement system to describe the way in which facial muscles and features change during the expression of emotions is called the Facial Action Coding System (FACS) and was developed by Ekman and Friesen (1976, 1978; cited in Rosenberg, 1997). FACS allows the description of visible changes in the face using 44 action units (AUs) together with the underlying muscle groups involved. FACS-coded events can be classified into emotion categories that match facial events with emotional events.

In a study of AUs that were generated when actors portrayed felt emotions Gosselin, Kirouac, and Doré (1997) found the following were generated for anger and surprise. For anger the Brow Lowerer (lowers eyebrows and pulls them together), the Upper Lid Raiser (raises the upper lid exposing more of the upper portion of the eyeball), the Lip Tightener (tightens the lips making them appear more narrow), the Jaw Drop (parts lips so that the space between the teeth can be seen), the Lower Lip Depressor (pulls the lower lip down and flattens the chin boss), and the Lip Stretcher (stretches lips horizontally) were frequently generated. For surprise the Upper Lid Raiser, the Jaw Drop, the Inner Brow Raiser (raises only the inner part of the eyebrow), the Outer Brow Raiser (raises only the outer part of the eyebrow), the Mouth Stretch (stretches mouth open), and the Lips Part (parts lips to a limited extent) were common.

Yamada's (1993) work with schematic faces has already been mentioned in Chapter 2 (see also Figure 2, this thesis). He asked participants to create emotional expressions by moving eight feature points around the eyes and mouth and found that displacements over the six categories of expression (happiness, fear, anger, sadness, disgust and surprise) could be described by the two factors he called 'curvedness/ openness' and 'slantedness'. Faces created in his Experiment 1 were then used in

Experiment 2 where a different group of participants classified items as belonging to one of the categories used for the first experiment. The structure of correlational displacements of feature points indicated these same descriptors, plus a third variable (the raising of the inner eyebrows and pursing up of the mouth are correlated with each other), could account for 98% of the variance. Open and slanted eyes and in particular, the movements of the middle of the eyebrow and the middle of the upper eyelid, and open and slanted mouths, are therefore implicated in how we make decisions to place schematic faces into categories of emotional expressions.

Katsikitis (1997) asked observers to match photographs and line drawings of posed facial expressions with emotion categories and applied a multidimensional-scaling procedure to the judgement data. Two orthogonal dimensions were revealed. An horizontal axis, which Katsikitis called pleasantness - unpleasantness with happiness and surprise at one end and disgust, anger and sadness at the other, and a vertical axis that she labelled upper-face - lower-face dominance with surprise, fear and sadness, which have the similar feature of eyebrow involvement in their expression at one end, and happiness, disgust and anger, all characterised by movements of the mouth, at the other. Anger and surprise therefore contrast on both dimensions described by Katsikitis.

So, both expression and sex rely in part on variations in lid-to-brow distance. When eyebrows are raised this indicates the face is surprised, but this should also indicate that the face is female. In Experiment 5 participants are asked to rate still photographs of angry and surprised male and female faces according to how masculine or feminine they think they are.

Experiment 5

If sex and expression information are independent from each other then the rated masculinity of angry faces will be no different from the ratings of surprised faces with a main effect of sex only expected. If variations in expression affect the perceived masculinity of faces then a difference in ratings due to expression is expected. Male faces especially may be considered less masculine when surprised if the lid-to-brow distance is more salient for men than for women.

Method

Participants

Participants (Ps) were recruited while viewing a gallery exhibition. Twenty-four members of the public (8 Male, 16 Female) agreed to take part.

Stimuli and Apparatus

Selection and assessment of stimuli

Angry and surprised expressions from 5 male and 5 female actors made up the stimulus set (Figure 24). The mean expression recognition scores and standard deviations for each subset of faces are as follows: female angry, 93% (SD = 7.5); male angry, 94% (SD = 8.0); female surprised 87% (SD = 9.8); male surprised 83% (SD = 8.7). Stimuli were printed out, a single image per page, and made into booklets for presentation to raters.

Brow-to-lid measurements were made on expressively neutral faces (Figure 25) in the following manner using the method proposed by Campbell, Wallace, and Benson (1996). The vertical distance between the eyelid and the underside of the brow above the pupil divided by the diameter of the iris is called ratio minA. The vertical distance between the corner of the eye at either the inner or outer canthi (whichever is greater) and the underside of the brow divided by the diameter of the iris is called ratio maxA.

Neutral male and female faces of this set are distinguished clearly from each other with regard to this feature: minA, $t(4) = 4.02$, $p < .02$; maxA, $t(4) = 4.95$, $p < .01$, two-tailed.

Figure 24. Stimulus set for Experiment 5. Far left column (from top): female angry Face Nos. 2, 7, 9, 16, 17; Centre left: female surprised; Centre right: male angry Face Nos. 21, 22, 24, 32, 41; Far right: male surprised.

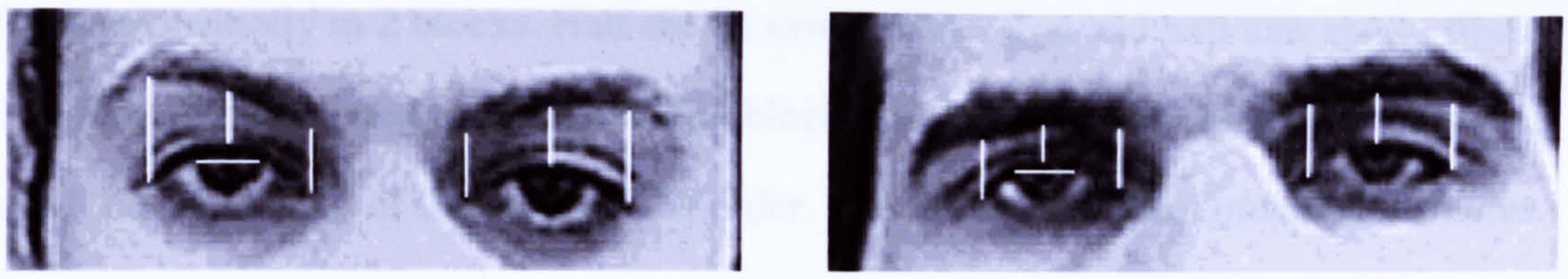

Figure 25. Measurements of the eyelid that distinguish female (left) from male (right) expressively neutral faces (after Campbell et al., 1996).

To see if sex differences for this feature were sustained for expressive faces a 2 x 2 x 2 mixed ANOVA was carried out with sex (male, female), expression (angry, surprised) and ratio (maxA, minA) as factors. Although there were main effects of ratio ($F(1, 8) = 179.51$, $p < .0001$) and expression ($F(1, 8) = 173.80$, $p < .0001$) with a two-way interaction between ratio and expression ($F(1, 8) = 6.01$, $p = .04$), no main effect of sex was revealed. There was however a three-way interaction between sex, expression and ratio, $F(1, 8) = 6.64$, $p = .03$. This last is interpreted as showing that the increment in the maxA ratio (which reflects the outer canthi-to-brow distance) between angry and surprised expressions is disproportionately greater for male faces than for female. The effect though is small. These measurements show that the differences between male and female faces are clearly visible if the viewer looks at the eyelid to brow distance while these faces are expressively neutral. This distinction between male and female faces is not so sharp if this feature is considered when the faces are distorted by angry and surprised expressions.

Design

A 2 x 2 within-subjects design was used with sex (male, female) and expression (angry, surprised) at 2 levels. Ratings were the dependent measure.

Procedure

Ps were invited to rate faces (20 in total), according to how feminine or masculine they appeared. Ratings ranged from 1 *(very feminine)* to 15 *(very masculine)*. They were asked to try and ignore the expressions shown on the faces. Each P viewed the

faces sequentially in 2 blocks. Half the Ps saw females first and half saw males first. The faces were ordered randomly within blocks and two different random orders were used. Equal number of Ps viewed each order. The task took approximately 5 minutes.

Results

Rating scores are shown in Figure 26. A 2 x 2 ANOVA revealed main effects of sex, $F(1, 23) = 46.8$, $p < .0001$, and expression, $F(1, 23) = 92.5$, $p < .0001$. Male faces were thought an average of 2.4 scale intervals less masculine and female faces an average of 1.9 intervals more feminine when surprised compared with when they were angry.

Figure 26. The effect of surprised and angry expressions on ratings of face masculinity, Experiment 5. 1 = very feminine; 15 = very masculine.

Discussion

This experiment provides some evidence to suggest that angry and surprised expressions may modify judgements of masculinity and that this response is consistent with the way in which eyelid to brow distances vary. The finding that both male and female surprised faces were considered more feminine than angry faces is not completely analogous to the rating study carried out by Campbell et al. (1996) where there was an interaction between 'maleness' and 'femaleness' for faces looking down

compared with faces looking at the viewer such that only male faces looking down were thought more 'female'. Having found that physical variation of lid-to-brow distance does impact on gender ratings, the next study examines whether there is interaction between these two types of coding using an interference task.

Experiment 6

A test of the modification of sex judgements by expression is carried out by placing the stimuli in a reaction time experiment using the selective attention paradigm described by Garner (1974, 1976). It is predicted on the basis of the results of Experiment 5 that sex decisions will be influenced by variation in expression. It is an open question as to whether expression decisions will be influenced by variation in sex. Although there is no necessary equivalence between how sex and identity information are processed, expression classification has been found susceptible to interference from identity information in this speeded-classification format (Schweinberger and Soukup, 1998, Exps. 1 and 2; Experiments 2, 3, and 4, this thesis).

Method

Participants

Twenty-seven Females volunteered and each received either course credit or was paid for her participation. The data from 24 Ps with a mean age of 21.5 (SD = 5.8) years were included in the data set. Three Ps (for the expression classification task) did not achieve the inclusion criteria.

Stimuli and apparatus

The face stimuli used were as for Experiment 5. They were presented using "SuperLab" software on a light background on a Macintosh Quadra 800. Stimulus size measured 6 x 9.9 cm which subtended an angle of 5.7° horizontally and 9.4° vertically

at a viewing distance of 0.6 m. The participant's head was kept level and in one place with the use of a chin rest.

Design

The experiment had a 2 x 3 mixed design with the between-subjects variable of task at 2 levels (sex classification, expression classification) and the within-subjects variable of condition at 3 levels (correlated, control, orthogonal). Dependent measures were reaction time (RT) and errors. As for experiments in the previous chapter, it was planned to further analyse single dimensions at each level of the relevant and irrelevant variables across conditions.

Procedure

The procedure for the sex classification task was as follows: The 12 Ps in this group were told that the task involved making a decision as quickly and as accurately as possible as to whether the face presented on the computer screen was male or female. Prior to the main task, Ps saw each stimulus face (printed out and mounted on pieces of card) for 3 to 5 seconds, so that they would be familiar with the range of stimuli included. Half saw the male faces first and half saw the female faces first. Each subset was ordered randomly. Once seated in front of the computer Ps were asked to ignore the expressions on the faces while making their speeded responses and to use their index fingers to press one key for male and another for female. The keys were 15 cm apart on the keyboard and hand of response was counterbalanced.

Each order of the 3 conditions was seen by 2 of the participants. Each of the conditions was made up of 2 consecutive blocks of 100 trials. Blocks contained 20 practice trials ordered randomly followed by 80 test trials ordered randomly. In the correlated condition, Block 1 contained male angry and female surprised faces (the sex decision would be easy in this block) and Block 2 male surprised and female angry faces (the sex decision would be hard in this block). In the control condition Block 1

contained male and female angry faces and Block 2 male and female surprised faces. In the orthogonal condition Block 1 contained male angry and surprised and female angry and surprised faces and Block 2 the same. In this way each stimulus face was seen for a total of 8 test trials in each condition.[5]

The procedure for the expression classification task was as above for sex classification with task-relevant details changed as appropriate. For example, Ps were asked to ignore sex while making their expression decision. For expression classifications the make-up of the correlated and orthogonal conditions remained the same and the control condition contained angry and surprised male faces in Block 1 and angry and surprised female faces in Block 2.

For both tasks each trial started with the presentation of a fixation cross which was replaced after 1550 ms by a stimulus face. The face remained on the screen until a key was pressed when it was immediately replaced by the next fixation cross. Criteria for inclusion in the data set were 50% correct and within the time window (150 ms - 2500 ms) in each cell. Ps with errors and outlying responses of greater than 10% overall were excluded. The experiment took 30 to 35 minutes to complete.

Results

Errors and outliers

Errors for Ps who met the scoring criteria were few. Ps in the sex classification group made average incorrect responses of 1.6% (correlated, 1.7%; control, 1.7%; orthogonal, 1.1%). Ps in the expression classification group made average incorrect responses of 2% (correlated, 1.3%; control, 2.7%; orthogonal, 2.2%). Error rates were

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[5] Appendix C regarding participant allocation does not apply to the Garner experiments reported in this chapter. As only 24 (cf. 48) Ps were used in each experiment, block order in each condition was not balanced, and a choice was made about which combination to place first and which to place second.

not analysed further. Outliers made up 0.03% of responses to sex and 0.2% of responses to expression.

RTs: comparisons between classification tasks across conditions

Mean correct RTs for both groups in all experimental conditions can be seen in Figure 27. A 2 x 3 mixed ANOVA with task as the between-subjects variable and condition as the within-subjects variable showed a significant main effect of group, $F(1, 22) = 12.55$, $p = .002$, a significant main effect of condition, $F(2, 44) = 8.45$, $p = .001$, and a significant interaction between task and condition, $F(2, 44) = 3.80$, $p = .03$. Mean RTs for sex and expression classification were 522 ms (SD = 87 ms) and 679 ms (SD = 142 ms) respectively. Inspection of Figure 27 suggests that the interaction reflected an effect of condition when making classification decisions for the expression task but not for the sex classification task. This was confirmed by a simple main effects analysis, $F(2, 88) = 11.8$, $p < .0001$. In summary, Ps made sex classifications more quickly than expression classifications with Ps showing faster reactions to stimuli in the correlated condition in the latter task.

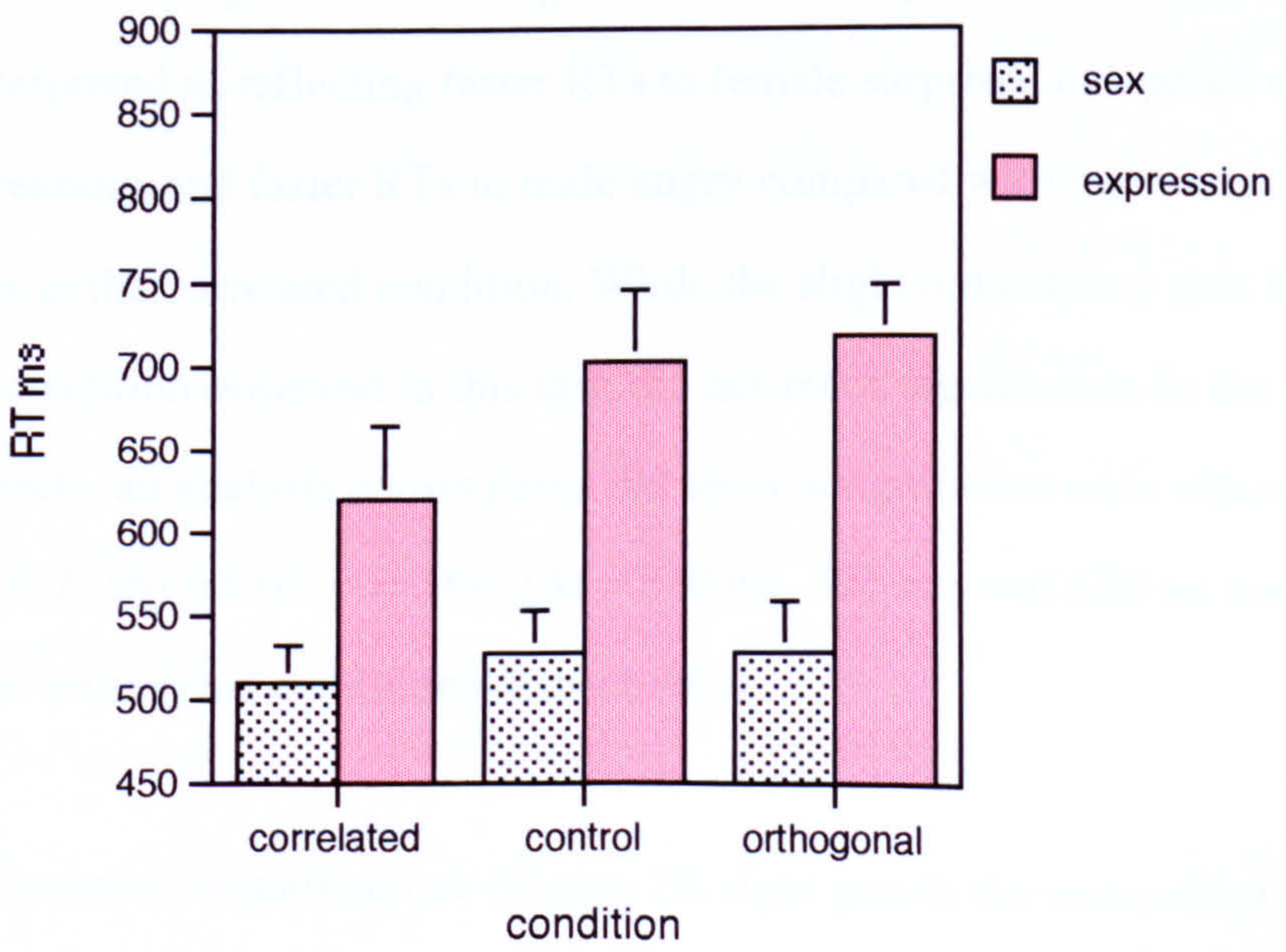

Figure 27. Mean reaction times in Experiment 6 for sex and expression classification groups in each condition. Vertical bars represent positive standard errors of the mean.

RTs: comparisons within each classification task

Separate 3 x 2 x 2 ANOVAs were carried out for each task with the within-subject variables of condition, sex, and expression (Figure 28).

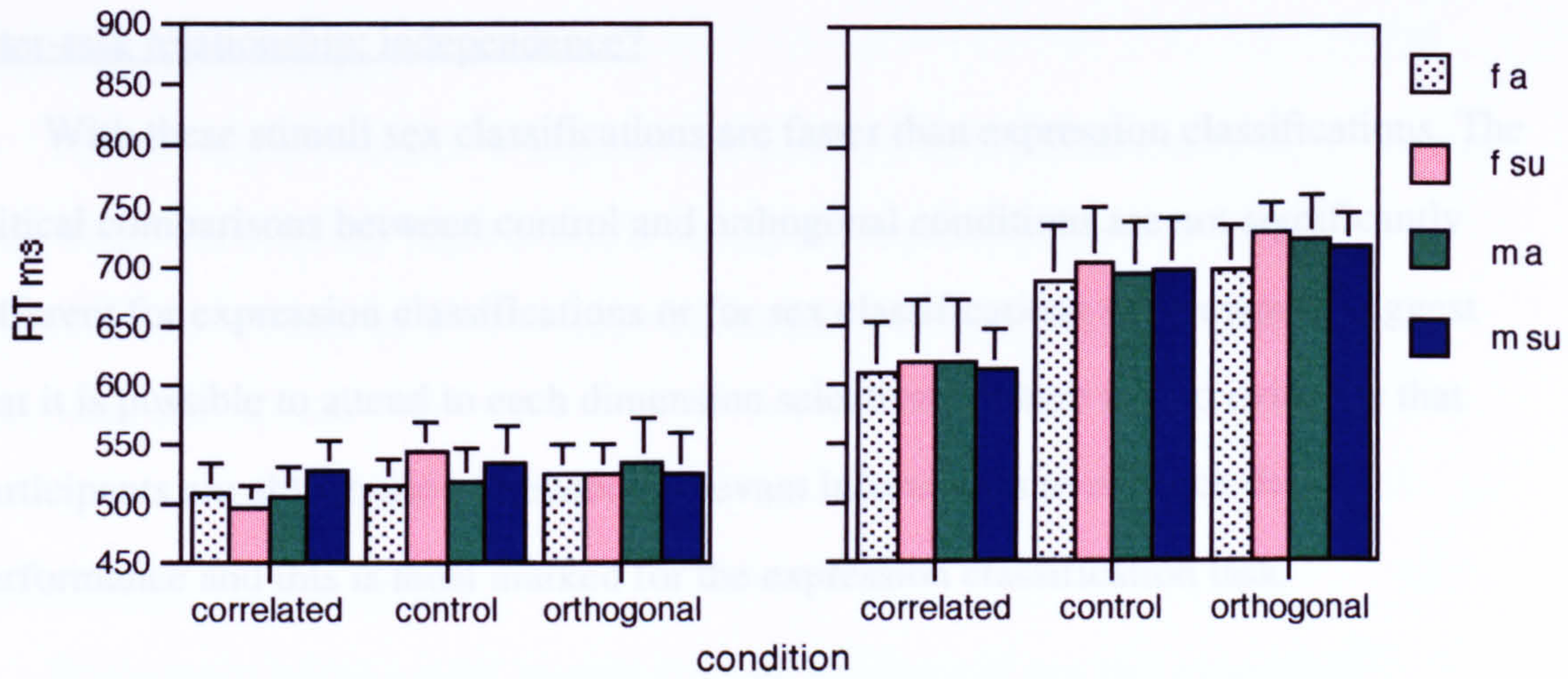

Figure 28. Mean reaction times for every combination of each relevant and irrelevant dimension for Experiment 6. In the left panel the relevant dimension is sex, and in the right panel, expression. Vertical bars represent the positive standard errors of the means. f = female face, m = male face, a = angry, su = surprised.

For sex classifications (Figure 28, left panel) no main effects of condition, sex, or expression reached significance. A significant three-way interaction , $F(2, 22) = 4.5$, $p = .02$ is interpreted as reflecting faster RTs to female surprised compared with female angry expressions and faster RTs to male angry compared with male surprised expressions in the correlated condition. While the slight redundancy gain in the correlated condition observed in this task did not reach significance in the analysis across subjects, an analysis across items did show a significant main effect of condition, $F(2, 16) = 8.05$, $p = .004$, ($M = 510$ ms, 528 ms, and 528 ms for correlated, control, and orthogonal conditions respectively).

For expression classifications (Figure 28, right panel) the main effect of condition, $F(2, 22) = 7.3$, $p = .004$, was further confirmed by an analysis across items, $F(2, 16) = 95.82$, $p < .0001$. However, Newman-Keuls comparison (alpha = .05) of condition means showed that, although RT in the correlated condition was significantly different

from control and orthogonal conditions, these latter were no different from each other (M = 619 ms, 701 ms, and 716 ms respectively).

Discussion

Inter-task relationship: independence?

With these stimuli sex classifications are faster than expression classifications. The critical comparisons between control and orthogonal conditions are not significantly different for expression classifications or for sex classifications which would suggest that it is possible to attend to each dimension selectively. There is also evidence that participants are able to use correlated irrelevant information to enhance their performance and this is most marked for the expression classification task.

The obvious difference in task difficulty indicated by longer reaction times to expression compared with sex in the baseline (control) condition makes meaningful comparison of these two dimensions difficult. Melara and Mounts (1993), in a series of experiments to investigate the roles of practice, response mode and baseline discriminability in modifying the asymmetric interference between colour-word and colour dimensions, found that discriminability dominated interactions. Matching baseline discriminabilities between words and colours removed almost all interference, and certainly asymmetric interference between these dimensions in a Garner experiment (Exps. 1c and 1w). Where discriminability is mismatched, Melara and Mounts propose that information from the more discriminable dimension will intrude on the less discriminable one causing asymmetric interference and resulting in a "mandatory failure of selective attention" (p. 627). Mismatching task difficulty may therefore in some cases lead to the presence of interference with dimensions shown eventually to be separable.[6] In order to eliminate the possibility of the more

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[6] This may not be true for all dimensions (e.g., identity and expression, see Schweinberger et al., in press)

discriminable dimension (sex) intruding on the processing of the less discriminable dimension (expression), RTs in the control condition should not be significantly different from each other.

Intra-task relationships

There is slight evidence to suggest that variation in expression may affect the ease with which contingency information is accessible to participants making sex classifications (enhanced RTs to surprised female and àngry male faces in the correlated condition).

Summary of Experiment 6

While these initial results support the independence of sex and expression processing, the redundancy gain in the expression classification task together with the (non-significant) increase in orthogonal RT over the control condition, is suggestive of asymmetric interference. An attempt is made in the next experiment to match baseline RT in order to make a more appropriate comparison.

Experiment 7

As the discrimination of sex from facial features is affected strongly by hair (O'Toole et al., 1993) and jaw lines (Brown and Perrett, 1993), cropping the stimuli used in Experiments 5 and 6 was predicted to slow sex decisions without affecting too greatly the time taken to respond to expression. Once again, on the basis of the results of Experiment 5, it is predicted that sex classification will be influenced by variation in expression. It remains an open question as to whether expression classification will be influenced by variation in sex, although the redundancy gain and slight attenuation of RTs in the orthogonal condition of Experiment 6 suggest that it may be.

Method

Participants

Forty-eight Ps (32 Female, 16 Male) volunteered and each received either course credit or was paid for their participation. The data from 24 Ps with a mean age of 23.1 years (SD = 5.8) were included as 22 Ps (for the sex classification task) and 2 Ps (for the expression classification task) did not achieve the inclusion criteria. The sex classification task was much harder than in Experiment 6.

Stimuli and apparatus

The face stimuli used are as in Experiments 5 and 6 except that they are cropped to remove hair and jawline information (see Figure 29). Stimulus size was slightly smaller at 6 x 8.5 cm. The images subtended an angle of 5.7° horizontally and 8° vertically at a viewing distance of 0.6 m. Other viewing conditions remained as for Experiment 6.

Figure 29. Examples of the cropped faces used in Experiment 7. From left to right: female angry, female surprised, male angry, male surprised.

Design

As for Experiment 6.

Procedure

As for Experiment 6.

Results

Errors and outliers

Errors for Ps who met the scoring criteria were few. Ps in the sex classification

group made average incorrect responses of 2.9% (correlated, 2.7%; control, 3.1%; orthogonal, 2.9%). Ps in the expression classification group made average incorrect responses of 1.9% (correlated, 1.3%; control, 2.4%; orthogonal, 2.1%). Error rates for these Ps were not analysed further. Outliers made up 0.5% of responses to sex decisions and 0.3% of responses to expression.

Errors made by Ps excluded from the data set for sex classifications made up 11.6% of responses which were approximately evenly distributed across conditions (correlated, 11.8%; control, 11.9%; orthogonal 11.2%). Of these errors, 26% were made to fa, 15% to fsu, 27% to ma, and 32% to msu faces. The majority of the disqualifying responses by the 2 Ps who did not achieve inclusion criteria for the expression classification were outliers.

RTs: comparisons between classification tasks across conditions

Mean correct RTs for both groups in all experimental conditions can be seen in Figure 30. A 2 x 3 mixed ANOVA with task as the between-subjects variable and condition as the within-subjects variable showed no significant main effects of task or condition and no significant interaction between task and condition. Mean RTs for sex and expression classifications were 759 ms (SD = 117) and 708 ms (SD = 120) respectively. The lack of a main effect of task is taken to indicate that difficulty is approximately equivalent in each task if RTs alone are considered.

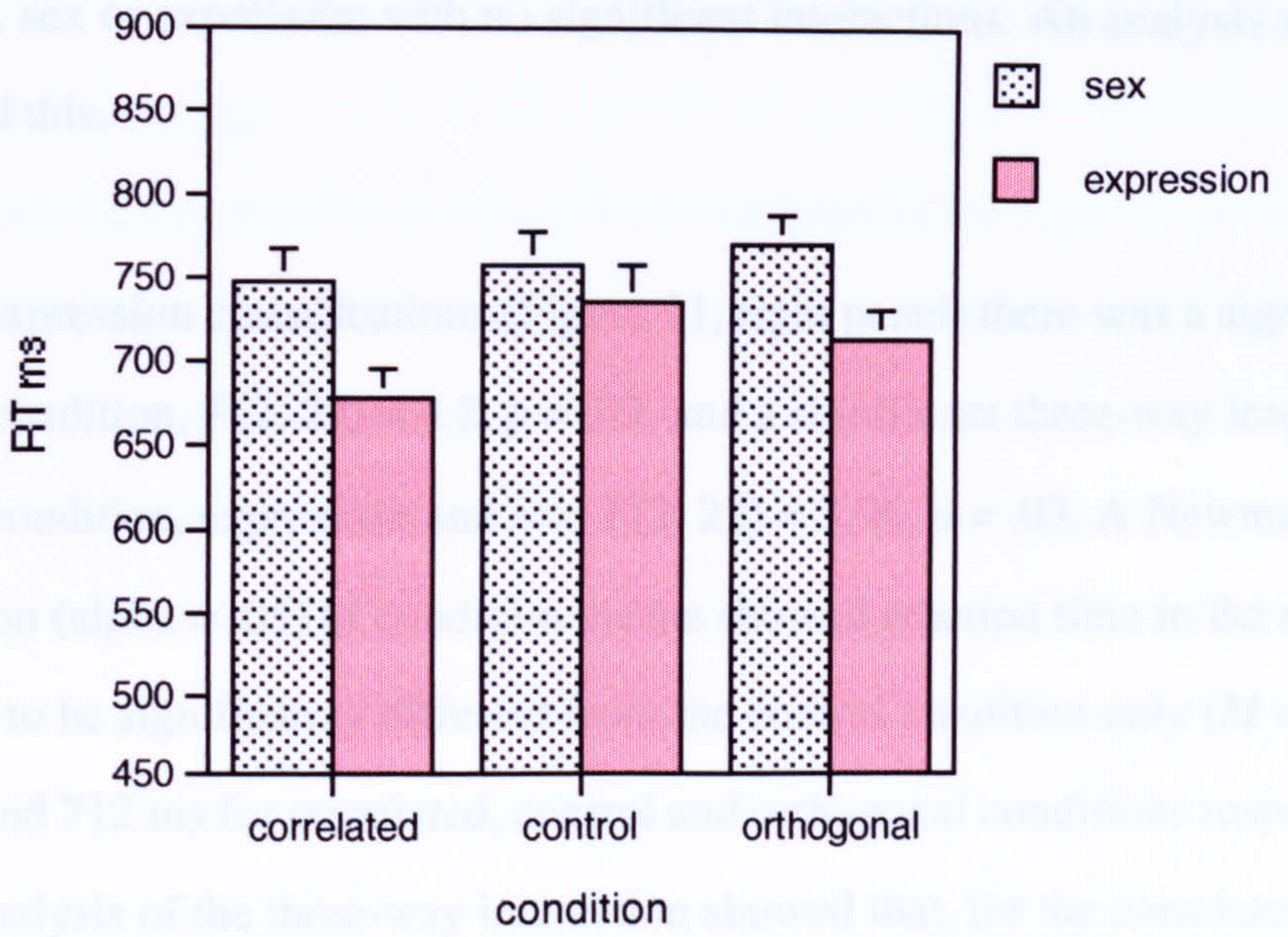


Figure 30. Mean reaction times in Experiment 7 for sex and expression classification groups in each condition. Vertical bars represent positive standard errors of the mean.

<u>RTs: comparisons within each classification task</u>

Separate 3 x 2 x 2 ANOVAs were carried out for each task with the within-subject variables of condition, sex and expression (Figure 31).

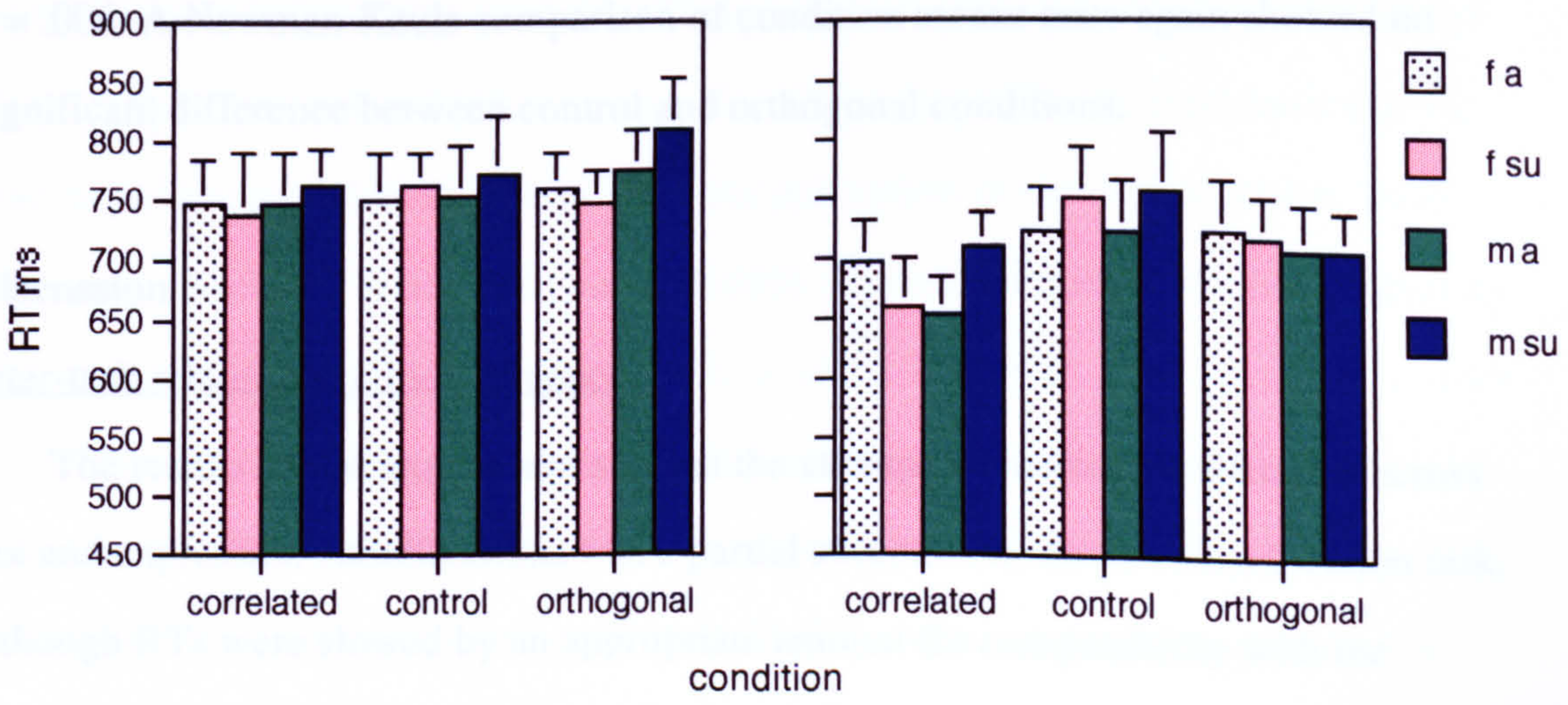


Figure 31. Mean reaction times for every combination of each relevant and irrelevant dimension for Experiment 7. In the left panel the relevant dimension is sex, and in the right panel, expression. Vertical bars represent the positive standard errors of the means. f = female face, m = male face, a = angry, su = surprised.

For sex classifications (Figure 31, left panel) there were no significant effects of

condition, sex or expression with no significant interactions. An analysis across items confirmed this.

For expression classifications (Figure 31, right panel) there was a significant main effect of condition, $F(2, 22) = 4.2$, $p = .03$, and a significant three-way interaction between condition, expression and sex, $F(2, 22) = 3.96$, $p = .03$. A Newman-Keuls comparison (alpha = .05) of condition means showed reaction time in the correlated condition to be significantly different from the control condition only ($M =$ 678 ms, 736 ms, and 712 ms for correlated, control and orthogonal conditions respectively). Further analysis of the three-way interaction showed that, for the correlated condition, female surprised faces were responded to more quickly than female angry faces and for male faces this was reversed, with male angry faces responded to more quickly than male surprised faces, $F(2, 33) = 5.4$, $p = .009$. An items analysis confirmed this pattern with a significant main effect of condition, $F(2, 16) = 21.3$, $p < .0001$, a significant two-way interaction between condition and expression, $F(2, 16) = 3.6$, $p = .05$, and a significant three-way interaction between condition, expression and sex, $F(2, 16) = 7.2$, $p = .006$. A Newman-Keuls comparison of condition means once again showed no significant difference between control and orthogonal conditions.

Discussion

Inter-task relationship: independence?

The results of this experiment suggest the attempt to match task difficulty across sex and expression classifications was a partial success. For the sex classification task, although RTs were slowed by an appropriate amount for comparability with the expression task, accuracy was compromised. An analysis of RTs alone lends support to the tentative conclusion from Experiment 6 that Ps are able to attend selectively to each dimension independently of the other. This indicates that, provided the structural information is sufficient to make the correct sex judgement then variations in expression are processed independently.

Intra-task relationships

For expression classifications (cf. sex classifications in Exp. 6), the accessibility of contingent information is influenced by the irrelevant dimension with male faces responded to more quickly as angry and female faces responded to more quickly as surprised. This indicates that when stimulus information contained within the value on the irrelevant dimension corresponds to stimulus information within the value on the relevant dimension used to make a classificatory decision, responses may be speeded, and when it conflicts, responses may be slowed.

For sex classifications, errors made by the large number of participants excluded from the RT data analysis (22 out of 34 tested for this task) also reflect an influence of irrelevant variation, this time of expression. Nearly twice as many errors were made to female angry compared with female surprised faces, and more made to male surprised compared with male angry faces. In spite of being shown which faces belonged in each set, faces were classified by participants as either male or female early in the task on the basis of the information available. This pattern of errors is in line with the ratings made in Experiment 5 and indicates that, for still photographs, an expressive face (at least angry and surprised faces) can alter our perception of someone's gender. These results are consistent with Burton et al's (1993) observation that faces misclassified by discriminant function analysis were also those raters saw as atypical for their sex. The errors were distributed evenly across conditions indicating that this aspect of stimulus assessment was not affected by increasing difficulty across the Garner conditions. This is suggestive of automatic processing specific to the values within each dimension, rather than a failure of selective attention between dimensions.

Summary of Experiment 7

When RTs for participants who achieved a high level of accuracy at sex classification were compared with those who maintained a similar level of accuracy at

expression classification no failure of selective attention for either dimension was observed. However, 'congruency' effects, which emerged in the correlated condition when Ps classified expression, and in the types of errors made by Ps who did not achieve criterion accuracy at classifying the faces for sex, suggest that Ps are indeed influenced by changes in irrelevant variation when comparisons are made within dimensions.

General discussion

Variation in expression was able to modify the rated masculinity of male and female faces when participants were allowed unlimited viewing time. However, during speeded classification of the same faces in the laboratory, selective attention to both sex and expression dimensions was possible under conditions in which sex classifications were both easy (Exp. 6) and difficult (Exp. 7). While the assessment of masculinity/ femininity and male/ female decisions could be considered different tasks, separate analyses of each of the classificatory tasks of Experiments 6 and 7 yielded results that suggest how these findings might be reconciled. These showed that variations in expression consistent with those features that play a role in the discrimination of sex from faces, may be used to enhance responding to both sex (Exp. 6) and expression (Exp. 7), when these dimensions are correlated. The role of this variation is particularly evident in Experiment 7 when making sex classifications to faces in which much of the structural information used to decide the sex of a face is removed. Errors are made because surprised faces in these circumstances look more female and angry faces look more male, probably because the remaining major cue to sex, the lid-to-brow distance is congruent with these decisions.

Laboratory experiments suggesting that functionally different types of information interact do not always include equivalent tasks for both dimensions under consideration. For example, the inclusion of gaze direction classifications for baseline

and filtering tasks as well as a baseline measure for sex classifications would extend Campbell, Wallace, and Benson's (1996) findings with regard to sex-of-face and gaze direction dimensions. Differences within a filtering task for one dimension may reveal the extent to which facial configurations relevant to a decision for one type of facial information are congruent with the configural information used for another. This may be particularly relevant in an experimental situation where information is impoverished (e.g., brief presentation, still b/w photographs).

In conclusion, while the perceived masculinity of a face may be modified by variations in expression in a rating task, in a speeded-classification task, in circumstances where task difficulty and accuracy of responding are matched, both sex and expression may be attended to selectively. The evidence presented here provides qualified support for functional models of face processing (e.g., Bruce and Young, 1986) suggesting independent processing routes for sex and expression information.

Overview

Although a (unidirectional) rating study indicated that variation in expression was able to modify decisions about the sex of a face, a comparison of these dimensions within a selective attention paradigm indicated that analyses could proceed independently. Separate analysis of the Garner tasks indicated that the effect of irrelevant variation is revealed when errors are made to impoverished stimuli and when dimensions are correlated. How far these findings would generalise to other expressions, particularly those that incorporate no obvious sexually dimorphic physical characteristic, is not known. The next chapter proceeds with an exploration of how expression might interact with gaze direction. Intuitively, these two facial dimensions should be closely integrated as both are key to the communication of intention. Interest in gaze is a relatively recent 'discovery' by cognitive psychologists and is not included in Bruce and Young's (1986) framework.

5

Expression and gaze direction

Looking at someone and observing that they are looking back at you has great importance for the regulation of human interaction. Imagine this. You are sitting in class (you are not really paying attention) and you hear the teacher's voice tone change. A question has been asked. You look up and (Oh no!) the teacher is looking at you. The teacher turns, looks at the board, and turns back to you. Clearly this is the kind of situation that requires a response. You wish you had kept your head down but you know that the teacher knows, and the teacher knows that you know (see Nagel, 1976, for a description of the role eye contact may play in escalating arousal) that the signal sent has been received. A voice from behind is heard supplying an answer. You subside in relief. The moment has passed.

This mini-script, which we have almost all experienced in one role or the other, serves to illustrate a number of points about gazing behaviour. Eye direction reveals whether or not you are the object of another person's attention. We are not perfectly accurate at determining the direction of someone else's gaze direction and may assume that we are the target if their gaze direction is near enough (e.g., Martin and Jones, 1982; Jenkins, 1997). And, if someone looks at you, it is an arousing event. Consider

further, if the teacher had been smiling or stern how this might have modified your response. If she or he had been looking at someone on the other side of the room would your own attention have been quite so engaged?

This chapter is concerned with the relationship between emotional expression and gaze direction processing. Although there is evidence that each is an important social signal and there are suggestions that each influences the other, there is to date no model that makes testable predictions about how interactions might proceed between these two dimensions. Some of the evidence from studies suggesting independence, those suggesting interaction, and information about what visual information is used when we process gaze direction is outlined below. Happiness and anger are the expressions chosen for exploration in this chapter, so information about the visual facial muscle movements that occur when the face is happy (anger was described in the previous chapter), as well as studies that have found differences in our responses to positive and negative expressions are mentioned. This evidence is taken into account when suggesting likely outcomes for the four experiments that follow.

Evidence for independence

As is the situation with the independence of sex and expression, there is very little explicit evidence from neuropsychological studies for the double dissociation of gaze direction and expression analysis. Again there is some evidence to suggest that gaze direction detection dissociates from identity analysis, as there is evidence for the independence of expression and identity (described in the previous chapters). Neurophysiological studies have also played an important role in our understanding of gaze processing. Some of the relevant findings are discussed below.

Campbell, Heywood, Cowey, Regard, and Landis (1990) showed that macaque monkeys trained to recognise averted gaze preoperatively failed to do this task after the removal of those regions of the superior temporal sulcus (STS) containing cells

sensitive to gaze direction. The monkeys had no difficulty in telling different faces apart from one another and in responding on the basis of familiarity (see also Heywood and Cowey, 1992). In an experimental comparison with unimpaired adult humans and prosopagnosic patients KD and AB, Campbell et al. and Heywood and Cowey found that, although KD and AB were equally densely prosopagnosic, KD performed much better than AB at the gaze detection task who responded on the basis of head direction alone. Campbell et al. speculate that, if it is possible to show that the ability to detect gaze direction doubly dissociates from identity analysis, then further dissociations such as that between gaze direction and expression might be found in the future.

Prior to studies that suggested that it was possible to be selectively impaired for different expressions (Adolphs et al., 1994, 1995), tests on expression recognition were made as if to a single category and averaged across all expressions. For example, in a report from Young et al. (1995), an association between gaze and expression processing is maintained by virtue of their mutual dissociation from familiar face recognition and unfamiliar face matching. Their patient DR had problems in understanding gaze direction and facial expression, learning new faces, and name retrieval. For the gaze direction task she was asked to say which face out of a presentation pair was looking at her. (It is assumed this face was expressively neutral.) The distracter (non-target) face was looking either 5°, 10°, or 20° to the left or right. As the direction of gaze became more similar to that of the distracter, DR made more mistakes. Control Ps made errors with the most similar deviations (5°) only. For one of two expression tasks the patient was asked to match a target expression to one that was the same from one of four different people: only one was expressing the target emotion. She was no better than chance at this. For the other task she was shown a single photograph of a face showing anger, sadness, happiness, disgust, surprise, or fear, which she was asked to match to one label of six printed out below the target photograph. DR was also unsuccessful relative to controls at this task. It was suggested that a functional processing relationship and/ or physical proximity where the lesion affected the processing sites of

both, may be responsible for the mutual dissociation of gaze and expression from familiar face recognition in this patient. Further testing has found that DR is particularly poor at recognising fear, and to a lesser extent anger and disgust, compared with her recognition of happiness and sadness which are within normal levels (Calder, Young, Rowland, et al., 1996). The precise processing relationship between gaze and expression(s) is unknown in this patient.

Neurophysiological evidence suggests that fine distinctions can be made at the neuronal population level between where the head is oriented and where the eyes are looking. Populations of cells in the STS of the macaque monkey have been found that are responsive to views of the face towards and away (profile) from the viewer (Perrett, Smith, Potter, et al., 1985). Some of these cells recorded responses to head orientation independent of where the eyes were looking and some responses to the eye area alone. In addition, some cells sensitive to the eyes looking away were suppressed by full face orientation and vice versa indicating a preference for the agreement of gaze and head direction. In a later study, Perrett, Oram, Harries, et al. (1991) found cells in the temporal cortex that were active at certain narrow angles of view of the presented head. They suggest these cells were responsible for viewer-centred representations that allowed the monkey to know where the head was attending. They found other cells that were responsive to all views and suggest these were responsible for object-centred representations that told the monkey who the person was. A proportion of the cells they found were view selective for different identities and yet other cells were both view and identity selective. The majority of the cells found were 'tuned' to one view and Perrett et al. (1991) argue strongly for this as evidence for the detection of direction of attention. Further to this, Perrett, Hietanen, Oram, and Benson (1992) proposed a specific mechanism linking view sensitivity with the comprehension of intent. Connections from 3-5 mm patches in the STS sensitive to full face and profile views of faces to similar patches in the parietal cortex thought to be involved in spatial awareness and the control of attention are known to exist. However, the possibility that

the cells found in the previous study (Perrett et al., 1991) were involved in building up an identity representation of the stimulus was not excluded by the data. In summary then, most support for the independent analysis of gaze direction and expression is by analogy with the independence of each from identity processing and any conclusion at this stage remains speculative.

Evidence for interaction

Unfortunately, for the purpose of exploring the relationship between gaze direction and expression at the physiological level, Perrett et al's (1985, 1991) studies were done with expressively neutral stimuli. Similarly, Hasselmo, Rolls, and Baylis (1989), who found cells in the inferior temporal lobe (IT) to be responsive primarily to identity while cells in the STS were responsive to expression, tested full face stimuli. Interestingly, there is some evidence from the latter study that exceptions to functional specialisation for identity may be made for socially significant expressions such as the open-mouth threat expressions. The close relationship between the perception of threat and submission signalled by gaze aversion (e.g., Mendelson, Haith, and Goldman-Rakic, 1982) would indicate that a similar close association may also be found for gaze direction and expression perception. There seems to be a convergence of movement, expression, and gaze sensitivity in the STS (for a review see Desimone, 1991; Hasselmo et al., 1989) that suggests a high-level specialisation in this location for these types of information. So, although there may be functional and physical separation within the STS for different types of information from the face, there may also be sub-areas specialised for the coordination of social signals (e.g., Heywood and Cowey, 1992; Walsh and Perrett, 1994).

Gaze and emotion processing deficits are also implicated in the development of children with autism who have difficulty understanding the intentions of others (e.g., Baron-Cohen, 1994). Baron-Cohen proposes that there are neurocognitive subcomponents that help the adult with this task. These are involved in the detection of

intention and eye direction detection (of which eye contact is a special case) which are prerequisite to the awareness of joint attention (of which mutual attention is a special case) and finally, to the knowledge of another person as having a mind similar to one's own. Leekam, Baron-Cohen, Perrett, Milders, and Brown (1997) suggest that, for children with autism, a specific mechanism called joint visual attention, does not develop in line with mental age and propose a gaze monitoring deficit that arises from one or more sources: Perseveration of attention (failure to generate spontaneous responses or the 'capture' of the child's attention and trouble disengaging and moving on); failure to understand the social significance of gaze; unwillingness to look at what the experimenter is looking at; an affective impairment that arises from failure of 'normal' affective development possibly through imitation. Neurophysiological correspondence is found for some of the components of Baron-Cohen's model in the cells of the STS sensitive to head and eye direction (Perrett and Emery, 1994). However, while some studies focus on the significance of gaze processing for autistic children (e.g., Baron-Cohen, Campbell, Karmiloff-Smith, Grant, and Walker, 1995), others focus on the idea of an affective processing deficit. Comparative studies with normal and learning disabled control groups have shown autistic children perform poorly on tasks requiring affective judgements to faces (see Hobson, 1993).

The nonhuman primate eye is different from humans' in that it does not contain large white areas (Kobayashi and Kohshima, 1997), and macaque monkeys from up to two weeks of age are possibly unable to discriminate direct eye contact from pictures of conspecifics. Mendelson, Haith, and Goldman-Rakic (1982) studied the pattern of eye fixations of these monkeys at Weeks 1, 3 and 7 to pictures of monkeys that looked either directly at them or away to the left or right. They found that the older monkeys looked less at the faces that looked back at them directly. In addition to this, at Week 3 significantly more emotionality (squirming, squealing and lip smacking) was shown to faces looking back than at either Weeks 1 or 7. Mendelson et al. suggest that by Week

3 the significance of direct gaze as a potential social threat is available to the infant monkeys and they cope with this by averting their own gaze.

Face gaze from strangers is also likely to be interpreted as threatening by humans under certain conditions (e.g., Ellsworth, Carlsmith, and Henson, 1972), and is likely to be moderated by expression. Hughes and Goldman (1978) were interested in the way we were more likely to move closer to someone unknown if they are looking directly at us and smiling compared with if they are not smiling. Complex interactions between expression, eye contact and sex were revealed in this study with men more likely still to move closer to someone who was not looking at them. Women showed however, that they preferred to move closer to a female confederate if she was looking at them (unsmiling) compared with when she had her back turned. Thayer and Schiff (1975) also found sex effects when participants looked at either male or female scowling or smiling confederates. Estimates of time were more greatly overestimated during encounters with scowling confederates who maintained eye contact and this effect was most marked for female - female encounters.

Dimberg and Ohman (1983) demonstrated that we may make very fine distinctions on the basis of expression and gaze direction. They measured the skin conductance responses of participants who had been electric shock conditioned (the shock was indicated by participants to be at the level of 'discomfort' rather than 'pain' in each case) to large photographs of angry faces either looking towards the P or with both head and eyes turned away. Whether or not the face was directed towards the participant during conditioning did not seem to matter with regard to what happened during extinction. It was only if the face was directed towards the participant *during* extinction that responding was maintained. Dimberg and Ohman suggest that you can learn whether someone is potentially dangerous regardless of where they direct their anger. The learning becomes manifest when the participant explicitly becomes the target. In an experiment to determine whether the effective cues were the orientation of the head or

the eyes it was found that first-interval anticipatory responses (1-4 s after CS onset) were maintained by both head (eyes towards and eyes averted) and eyes (head turned with eyes towards), but that for second-interval anticipatory responses (4-9 s after CS onset) angry faces with eyes directed towards the participants were required.

Additionally, it is noted that in a review article, Kleinke (1986) lists the functions of gaze and eye contact as including (i) organising interpersonal interaction by providing information, (ii) regulating interaction, (iii) expressing intimacy, (iv) exercising social control, and (v) facilitating service and task goals (see also Patterson, 1982). Although there are important differences, overlapping and similar claims are made by those considering the communicative functions of emotions (e.g., Scherer, 1994) and, by extension, emotional expressions. It would be surprising if associations between gaze direction and expression analysis are not rapid and interactive on this shared functional basis alone. Kendon (1967), attempting to make sense of complex interactive effects revealed by experiments investigating the functional relationship between gaze and expression suggests that at the very least we must entertain two hypotheses: "...on the one hand to engage in eye-contact with some-one is to seek to affiliate with him, and on the other, it is to challenge him." (p. 59).

Visual information used for gaze direction discrimination

Gaze direction is determined primarily in humans by the amount of visible sclera that appears either side of the iris as the eyeball turns in its socket (Watt, 1995). The visibility of the sclera may be modified by whether the eyebrows are lowered or raised, and the way the eyes and eyebrows can function together as a signalling system is demonstrated by applying vertical and horizontal spatial filters to static images of expressive faces. The signal from a smiling eye where the lids are close together is relatively weak and may be strengthened by raising the eyebrow.

Neurophysiological (e.g., Perrett et al., 1985) and experimental psychological studies (e.g., Langton, 1999, manuscript in preparation) suggest that our perception of where the eyes are looking is also modified by where the head is facing. An illustration from an early investigator, Wollaston (1824; cited in Bruce and Young, 1998, p. 211) demonstrates this effectively. Simply by changing the direction in which the lower half of the face is turned, pairs of eyes looking in the same direction can be made to appear to look in different directions.

Watt (1995) points out that both gaze direction and expression are dynamic facial gestures in a way that the age, identity, and sex of a face are not over the short time course needed to reach a decision. Information about them is therefore potentially conveyed by the mobile features of the face, that is, the eyes, eyebrows and mouth. Applying the same filtrations to the mouth as applied to the eyes above, shows how the pattern of light and dark changes as the mouth is open or closed or if teeth are visible. It is likely that gaze direction is determined primarily by what happens in the eye region and what direction the head is facing, and that expression involves both eye and mouth regions.

Gaze direction: eyes looking at you are privileged

Von Grünau and Anston (1995) using a visual-search paradigm found that Ps responded faster to pairs of eyes (without eyebrows) looking towards them (eyes looking away to the left or right were present as distracters), than when the target was a pair of eyes looking away to the left (eyes looking towards and to the right were distracters), or to the right (eyes looking towards and to the left were distracters). Error data also showed that decisions to straight gaze pairs were easier than to averted gaze pairs. However, there is an assumption in this study that categorical equivalence exists between eyes looking at the viewer, eyes looking left, and eyes looking right. If a division is made between eyes looking at the viewer and eyes looking away then the equivalence of the search tasks is brought into question. Replication of this study and

generalisation of the findings to eyes within the context of a face would be useful. Von Grünau and Anston discuss their results in terms of an evolutionary advantage to the rapid detection of eyes looking at the viewer, which does seem feasible. They also make a comparison with the possibility that we have also evolved to detect threat faces rapidly (see also Sackett, 1966), but the literature on the efficiency with which we detect threat faces is not straightforward (see below).

Visual information used for anger and happiness discrimination

In a study of action units (AUs: visible changes in the face due to the underlying movement of selected groups of muscles) that were generated when actors portrayed felt emotions Gosselin, Kirouac, and Doré (1997) found that for happiness the Cheek Raiser and Lip Corner Puller were far more frequent than any other AUs. The Lips Part and Jaw Drop, actions that were not predicted to depict happiness, were also found, though infrequently. (For anger, changes around the eyes, brows, lips, jaws, and chin are detailed in Chapter 4.)

Although expressions can be thought of as a complex configural arrangements, it is possible to determine the difference between anger and happiness by the simple contrasts between lowered and slightly raised lines for eyebrows and downturned and upturned lines for a mouth, as seen often in cartoons (see also a study on actors in Hollywood films, Carroll and Russell, 1997). Aronoff, Wioke, and Hyman (1992) took a particularly minimalist approach to finding out what might be the key features eliciting affective responses to angry and happy faces. In one experiment they varied the degree of roundness and diagonality of an elliptical form and, in another, the arrangement of two diagonal lines relative to each other (Figure 32). Participants made ratings of affective evaluation (e.g., kind - cruel), potency (e.g., tough - fragile), and activity (e.g., energetic - inert) to these stimuli and the results showed that roundness conveyed the meaning of warmth, and that acute angles with downward pointing vertices conveyed the meaning of threat. Aronoff et al. relate their findings to other

studies finding that stable underlying shapes contribute to social evaluations (e.g., the cuteness of babies) and suggest that their results offer strong support for the ecological theory of social perception (e.g., McArthur and Baron, 1983). We are prepared neurobiologically to make certain types of associations with certain types of physical forms which convey both information and meaning. Happiness and anger are two emotions where it is quite easy to see that clear perceptual signals, and a preparedness to recognise them, would allow us to take advantage of opportunities and steer clear of dangers.

Figure 32. Stimuli used by Aronoff et al. (1992) to test affective responses. The leftmost stimulus, i.e. the inverted V, was thought significantly more bad than the others.

Valenced expression: angry faces are privileged

Hansen and Hansen (1988) reported that angry faces appeared to 'pop out' of a happy crowd whereas this was not so for a happy face in an angry crowd. This result was used as support for the preattentive processing of threat faces. However, the expressions used in their experiment were found to be confounded with relative amounts of light and dark areas (Hampton, Purcell, Bersine, Hansen, and Hansen, 1989; Purcell, Stewart, and Skov, 1996). Nothdurft (1993) using schematic faces and nonfaces failed to replicate pop out for faces or facial expressions and Hansen and Hansen (1994) themselves state that "it is clear now that angry faces do not pop out of happy crowds as the result of the preattentive, parallel detection of angry faces" (p. 227). Although preattentive effects have not been found, Hansen and Hansen (1994) observed that it took participants longer to search a field of nine angry faces than it did to search a similar field of happy faces.

Also using a visual search paradigm, White (1995) tested the idea that a single feature associated with affect (down-turned vs. up-turned mouth) may be responsible

for pop out. He found evidence to support this idea with schematic happy and sad faces tested in both upright and inverted formats. He did however claim that a comparison of intercept values showed there was an effect of valence for the upright faces giving an advantage to happy faces. The difference from the inverted condition is important because inversion is thought to interfere with the configural encoding of faces (Leder and Bruce, 1998; Valentine, 1988; though see Rakover and Teucher, 1997), and with the representation of expression in the face (Bartlett and Searcy, 1993; Searcy and Bartlett, 1996). There may also be different effects of inversion for different expressions (Kirita and Endo, 1995; McKelvie, 1995). There is a general difficulty with the visual search paradigm in that, if photographs of faces are used, the likelihood of a simple pattern or contrast confound is increased: The use of schematic faces introduces concerns about ecological validity.

Subsequently, Hansen and Hansen (1994) used a different paradigm to look for evidence of the attention grabbing power of negative stimuli. They measured the latency of saccadic eye movements towards and away from angry and happy faces that appeared unpredictably either side of a fixation point and used this as an index of attention. The task was either to detect an angry face or to detect a happy one in consecutive blocks in a within-subjects design. They found that, although Ps were as likely to fixate happy or angry faces from the fixation point initially and there was no difference in the speed with which they did this on the initial saccade, they were faster to move *to* an angry face from a happy one and slower to move *from* an angry face to a happy one. In addition, saccadic latencies were longest if both faces were angry and shortest when both faces were happy. Hansen and Hansen identify these findings as support for angry faces attracting attention automatically, and capturing it once they have it. Automatic processes are defined as simple, efficient, nonflexible, and stimulus-controlled processes unaffected by capacity limitations. Controlled attentional processing is defined as flexible, serial, under conscious control, and capacity limited.

In a further experiment to see if the allocation of controlled processing resources was affected in addition to the automatic attentional effect they had obtained, Hansen and Hansen (1994) measured the amount of time spent on the first target in a task in which both expressions that appeared either side of a fixation point had to be named. They also looked at this time interval when the task was to say if the expressions were the same or different. Although the naming task took longer than the discrimination task, more time in each was spent focused on the angry faces. Automatic processes are seen as capable of directing the resources available for controlled processing. Hansen and Hansen call the faster automatic processing of threat faces a "superiority" effect and the slower controlled processing of threat faces an "inferiority" effect. Pratto and John (1991), in experiments with undergraduates similar to those carried out with people with emotional disorders (e.g., Mathews, 1994), found what they call an automatic vigilance effect for negative words in a Stroop task, with longer latencies in colour naming and better memory for the disagreeable words. Pratto and John therefore assessed the 'advantage' shown to negative stimuli by longer latencies. Early superiority and later inferiority effects to angry expressions seem to occur in spite of their more difficult discrimination relative to happy ones (Jenkins, 1997; McAndrew, 1986) and the recognition advantage shown for happy faces in many cross cultural studies (e.g., Russell, 1994; Chapter 2 of this thesis). This recognition advantage for happy over negative expressions shows whether studies have been done with schematic representations (Kirita and Endo, 1995) or with both line-drawn and 'real' representations (Katsikitis, 1997).

Unfortunately studies on differences between positive and negative expressions have been carried out mostly with faces either looking directly towards the viewer, or gaze direction has not been reported because it was not the variable of interest. Although the findings described above predict that we react quite differently to faces looking at us compared with faces looking away, and angry faces compared with happy ones, the directions of these predictions are not always consistent. It was decided

therefore to show a set of angry and happy faces with eyes looking towards and away from the viewer to a group of participants and ask them to rate how interesting they found them and how much they liked them. Perhaps gaze direction and expression dimensions will interact with each other sufficiently to modify rated responses.

Experiment 8

Using 'interest' and 'likability' scales makes use of the notion of emotional stimuli provoking 'action tendencies' in the perceiver (Lang, 1995). The link between the production of actions and expressions was made by Darwin (1872/1948) and is pervasive in the emotion literature for both encoders and decoders. A recent application of this idea is in a study by Angrilli, Cherubini, Pavese, and Manfredini (1997) who looked at responses to images rated high and low on valence and arousal (after Lang, Bradley, and Cuthbert, 1990; Lang, Greenwald, Bradley, and Hamm, 1993; Russell, 1980). On the basis of their findings (Angrilli et al's work is described further in Chapter 7) they propose two principal axes along which people respond emotionally to stimuli. The first is an 'approach-interesting' direction vs. a 'withdrawal-boring' direction and is described as being driven by the informational content of the stimulus. The direction of movement here depends upon the attentional demand the stimulus places on the viewer. The second is an 'approach-appetitive' direction vs. a 'withdrawal-aversive' direction and is described as being driven by the affective valence of the stimulus. In this formulation of emotional responses, action tendencies are described as motivated by separate attentional and affective systems.

The first predicted outcome concerns the interest ratings. Happy faces looking towards the viewer are predicted to be very interesting to the participants, with happy faces looking away of little interest. Participants are also expected to find angry faces very interesting if they are looking towards them, a result that would be compatible

with the attention-grabbing hypothesis for threat related stimuli (e.g., Hansen and Hansen, 1994). Angry faces looking away may still be of interest if they sustain value for the viewer as potentially threatening (cf. Dimberg and Ohman, 1983). The second predicted outcome concerns the likability ratings. Participants are predicted to like happy faces and dislike angry ones. This would place these faces on opposite ends of the approach-appetitive and withdrawal-aversive continuum. How much expression and gaze direction will modify each other on each of these scales is unknown.

Method

Participants

Open University students were recruited during their break from class. Twenty-four students agreed to take part (12 Male, 12 Female).

Stimuli and apparatus

The stimulus set was made up of happy and angry faces looking towards and away from the viewer from 2 female actors (Face Nos. 32 and 17) and 2 male actors (Face Nos. 22 and 7) (Figure 33). The subset of angry expressions (only those looking towards the viewer were rated for expression) achieved recognition agreement of 90% (SD = 7.1), and the subset of happy expressions, 88% (SD = 10.9). Gaze was deflected to the left or right of the viewer by 20°. Each face measured 6 x 8.5 cm, was printed out on to paper, and made up in to small booklets for presentation to Ps.

Design

Two 2 x 2 within-subjects designs were used, as the interest and liking measures were analysed separately. For each measure expression was at 2 levels (angry, happy) and gaze direction was at 2 levels (towards, away). The dependent measure was rating score.

Figure 33. Stimulus set for Experiment 8. Far left column: angry faces looking towards the viewer; Centre left: angry away; Centre right: happy towards; Far right: happy away. Rows, from top to bottom: Face Nos. 32, 17, 22, and 7.

Procedure

Ps were asked to look at a booklet and give two 'first impressions' of the faces they saw. The first of these was to do with how interesting they found each face and the second with how much they liked each face. They were asked to rate each impression on a separate scale. Ratings ranged from 1 (*very **un**interesting face*) to 15 (*very interesting face*) and 1 (*do not like this face at all*) to 15 (*like this face a lot*). They were

asked to try and ignore the expression and eye direction as much as possible, to rate each face in the sequence given and not to look forward or back over the faces as they completed them. Four booklets were used, each of which was in a different pseudo-random order. The restriction on order was that no two faces from the same actor were placed adjacent within the sequence. Six participants, 3 Male and 3 Female looked at each book. The experiment took approximately 5 minutes.

Results

Mean ratings scores are shown at Figure 34.

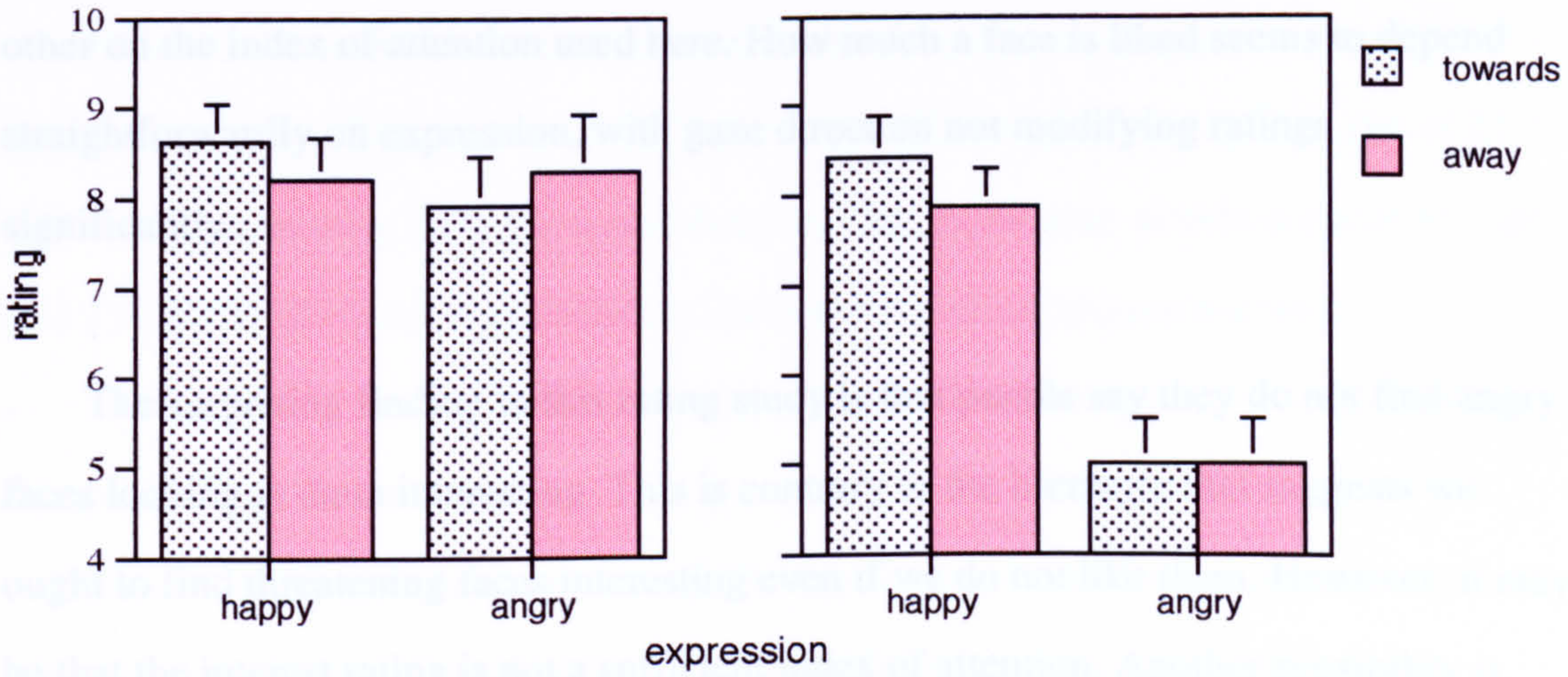


Figure 34. The effect of happy and angry faces looking towards or away from the viewer on ratings of viewers' 'first impressions' in Experiment 8. The left panel shows mean interest ratings and the right panel mean liking ratings. Vertical bars represent the positive standard errors of the means. See text for an explanation of rating scales.

A 2 x 2 ANOVA of interest rating scores (Figure 34, left panel) revealed no main effects for either expression or gaze direction with a significant interaction between these two variables, $F(1, 23) = 5.7$, $p = .03$. Happy faces looking towards the viewer were found most interesting, angry faces looking towards the viewer were found least interesting, and happy and angry faces looking away of were of intermediate and almost equivalent interest.

A 2 x 2 ANOVA of liking rating scores (Figure 34, right panel) revealed a main effect of expression, $F(1, 23) = 33.3, p < .0001$, with angry faces liked much less than happy ones whether they looked towards the viewer or not. The effects of gaze direction and the interaction between gaze direction and expression did not reach significance, although there is a tendency for happy faces looking at the viewer to be liked more than happy faces looking away.

Discussion

The results suggest that happy faces looking at the viewer are of greatest interest to the viewer. Contrary to expectation however, viewers rate angry faces looking at them as of least interest. Gaze direction and expression are therefore seen to influence each other on the index of attention used here. How much a face is liked seems to depend straightforwardly on expression, with gaze direction not modifying ratings significantly.

The surprising finding in this rating study is that people say they do not find angry faces looking at them interesting. This is contrary to the literature that suggests we ought to find threatening faces interesting even if we do not like them. However, it may be that the interest rating is not a sufficient index of attention. Another possibility is that the time courses of attentional and affective decisions are likely to be different with early interest perhaps overwhelmed by an aversive response prior to making the rating.

It is not possible to say from this rating study whether gaze direction modifies expression, or whether expression modifies gaze direction, with the attentional measure of rated interest used. Using these stimuli in a Garner experiment will make the direction of this modification explicit. A speeded-classification design may also determine if there is an initial rapid response to angry faces looking towards the viewer in addition to finding out whether or not it is possible to attend to these two facial dimensions selectively.

Experiment 9

A test of the interaction between expression and gaze direction was carried out by placing the angry and happy faces looking towards and away from the viewer used in Experiment 8 in a speeded-classification experiment using the selective attention paradigm described by Garner (1974, 1976).

Method

Participants

Fifty-one Ps volunteered and each received either course credit or were paid for their participation. The data from 48 Ps (16 Male, 32 Female) with a mean age of 21.9 (SD = 4.9) years were included in the data set. One P (for gaze direction classification) and 2 Ps (for expression classification) did not achieve the inclusion criteria.

Stimuli and apparatus

The set of 16 stimulus faces was as for Experiment 8 (see Figure 33). The stimuli were presented using "SuperLab" software on a light background on a Macintosh Quadra 800. Stimulus size measured 6 x 8.5 cm which subtended an angle of 5.7° horizontally and 8.2° vertically at a viewing distance of 0.6 m. The participant's head was kept level and in one place with the use of a chin rest.

Design

The experiment had a 2 x 3 mixed design with the between-subjects variable of task at 2 levels (gaze direction classification, expression classification) and the within-subjects variable of condition at 3 levels (correlated, control, orthogonal). Dependent measures were reaction time (RT) and errors. It was also planned to analyse single dimensions as in previous Garner experiments.

Procedure

The procedure for the gaze direction task was as follows: the 24 participants in this group were told that the task involved making a decision as quickly and as accurately as possible as to whether the face presented on the computer screen was looking at them or away from them. Prior to the task, the stimuli, printed out and mounted on pieces of card, were shown to each participant for 3 to 5 seconds. Half saw the faces looking towards them first, half saw the faces looking away from them and each subset was ordered randomly. Once seated in front of the computer Ps were asked to ignore the expressions on the faces while making their speeded responses and to use their index fingers to press one key for faces looking at them and another for faces looking away. The keys were 15 cm apart on the keyboard and hand of response was counterbalanced.

Each possible order of the 3 conditions was seen by 4 of the participants. Each of the conditions was made up of 2 consecutive blocks of 100 trials each. Each block contained 20 practice trials ordered randomly followed by 80 test trials also ordered randomly . In the correlated condition half of the Ps saw angry faces looking at them with happy faces looking away in Block 1 and happy faces looking at them with angry faces looking away in Block 2. For the other half of the Ps, the correlated condition was made up of these same faces with the order of the blocks reversed. In the control condition (where the irrelevant variable is held constant), half of the Ps saw angry faces looking towards and away from them in Block 1 and happy faces looking towards and away from them in Block 2. For the other half of the Ps, the control condition block order was reversed. In the orthogonal condition, Block 1 contained angry and happy faces looking towards and away and Block 2 the same. In this way each stimulus face was seen for a total of 8 test trials in each condition. (Appendix C is relevant to this procedure.)

The procedure for the expression classification task was as above for gaze direction classification with task-relevant details changed as appropriate. For example, the faces mounted on card were organised into angry and happy sets and the Ps were asked to ignore gaze direction while making their expression decision. For expression classifications the make-up of the correlated and orthogonal conditions remained the same and the control condition contained angry and happy faces looking away in Block 1 and angry and happy faces looking towards in Block 2 for half the participants, with block order reversed for the other half of the participants.

Each trial started with the presentation of a fixation cross which was replaced after 1550 ms by a stimulus face. The face remained on the screen until a key was pressed when it was immediately replaced by the next fixation cross which began the next trial. Responses were scored as correct if the appropriate key was pressed in a time window of 150-2000 ms after stimulus onset. RTs longer than 2000 ms and errors were recorded separately. Criteria for inclusion in the data set were 50% correct and within the time window in each cell. Ps with errors and outlying responses of greater than 10% overall were excluded. The experiment took 30 to 35 minutes to complete.

Results

Errors and outliers

Errors for Ps who met the scoring criteria were as follows: Ps in the gaze direction classification group made average incorrect responses of 2.7% (correlated, 2.1%; control, 2.8%; orthogonal, 3.2%); Ps in the expression classification group made average incorrect responses of 2.3% (correlated, 2.6%; control, 2%; orthogonal, 2.3%). Although error rates are low there is an indication of increasing errors for the gaze direction classification task across conditions. A 2 x 3 ANOVA with task and condition as variables confirmed a task x condition interaction, $F(2, 92) = 3.64$, $p = .03$, however post hoc comparisons of the means for gaze direction errors showed that, although the mean of the correlated condition was different from the orthogonal mean, control and

orthogonal means were not significantly different from each other. Outliers made up 0.5% of responses to gaze direction and 0.5% of responses to expression.

RTs: comparisons between classification tasks across conditions

Mean correct RTs for both groups in all experimental conditions can be seen in Figure 35. A 2 x 3 mixed ANOVA with task as the between-subjects variable and condition within-subjects revealed no significant main effects and no significant interactions. The mean RT for the gaze task was 664 ms (SD = 133) and for the expression task was 689 ms (SD = 99). The tasks therefore appeared to be of approximately equal difficulty when RTs were considered.

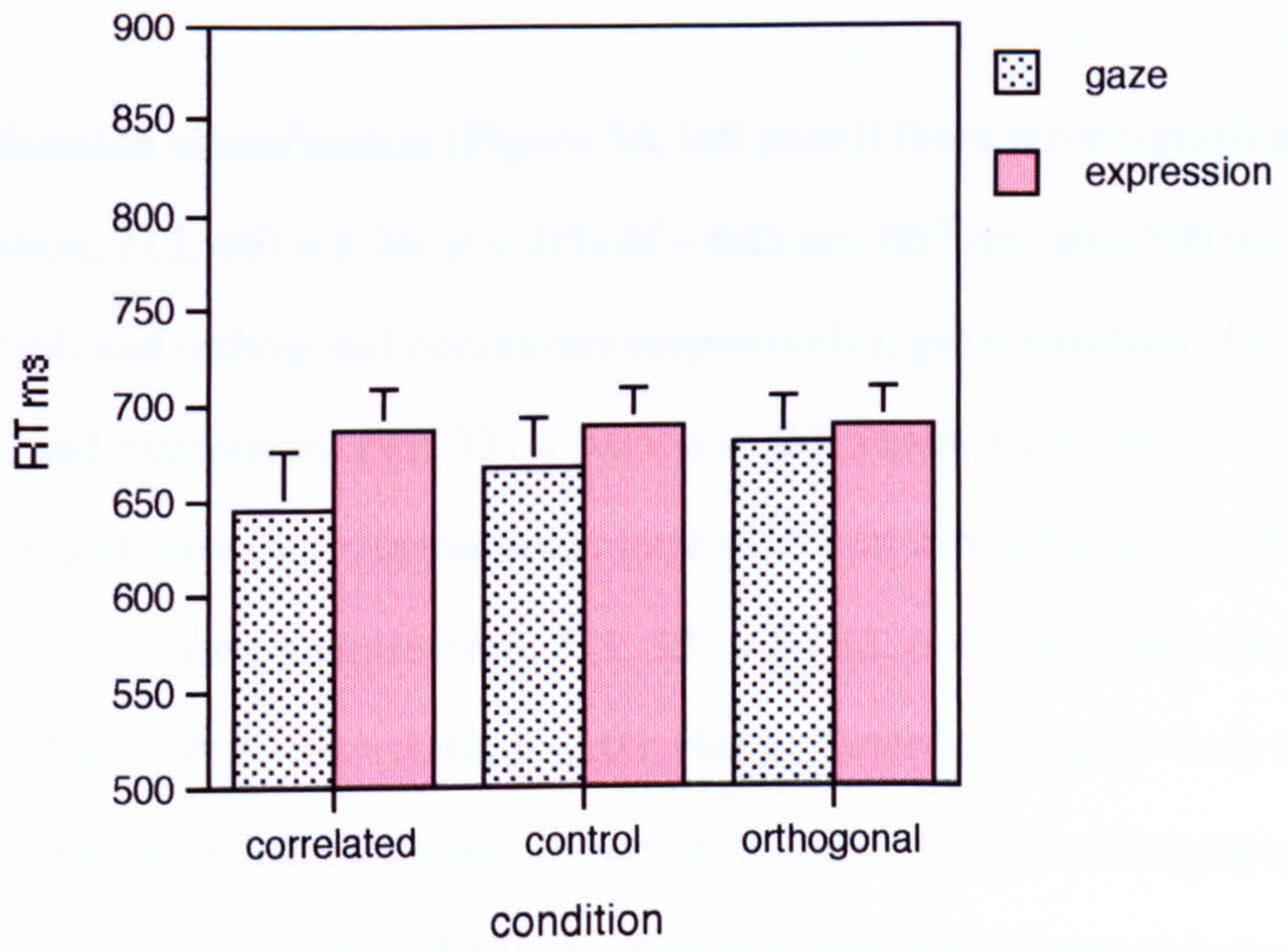


Figure 35. Mean reaction times in Experiment 9 for gaze direction and expression classification groups in each condition. Vertical bars represent positive standard errors of the mean.

RTs: comparisons within tasks

Separate 3 x 2 x 2 ANOVAs were carried out for each task on correct RTs with the within-subject variables of condition, gaze direction and expression (Figure 36).

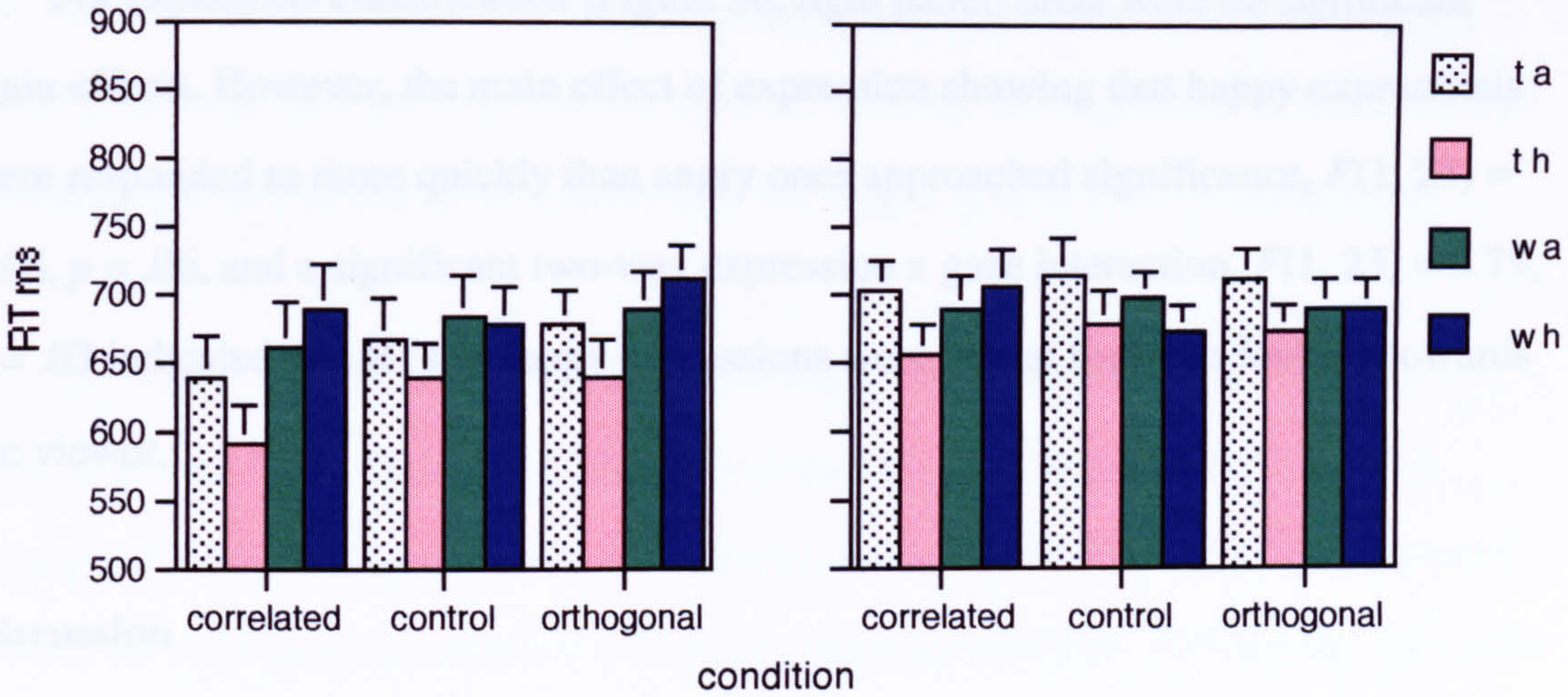


Figure 36. Mean reaction times for every combination of each relevant and irrelevant dimension for Experiment 9. In the left panel the relevant dimension is gaze direction, and in the right panel, expression. Vertical bars represent the positive standard errors of the means. t = towards, w = away; a = angry, h = happy.

For gaze direction classification (Figure 36, left panel) there were significant main effects of condition, $F(2, 46) = 3.26$, $p = .05$ ($M = 645$ ms, 667 ms, and 680 ms for correlated, control, and orthogonal conditions respectively), gaze direction, $F(1, 23) = 16.37$, $p = .001$, and expression, $F(1, 23) = 5.04$, $p = .04$. These main effects were modified by two- and three-way interactions: gaze direction x condition $F(2, 46) = 4.85$, $p = .01$; gaze direction x expression, $F(1, 23) = 54.82$, $p < .0001$; gaze direction x expression x condition, $F(2, 46) = 3.41$, $p = .04$. Happy faces looking towards the viewer were responded to faster than any others, with happy faces looking away responded to slowest: Inspection of the figure suggests that the difference between RTs to angry and happy expressions looking away is not sustained for the control condition. An analysis across items confirmed the main effect of condition, $F(2, 6) = 37.44$, $p < .0001$, but post hoc tests for both subjects and items analyses for the critical comparisons of control and orthogonal means, failed to achieve significance. The items analysis also confirmed the main effect of gaze direction, $F(1, 3) = 22.40$, $p = .02$, and the three-way gaze direction x expression x condition interaction, $F(2, 6) = 22.98$, $p = .002$.

For expression classification (Figure 36, right panel) there were no significant main effects. However, the main effect of expression showing that happy expressions were responded to more quickly than angry ones approached significance, $F(1, 23) = 4.05$, $p = .06$, and a significant two-way expression x gaze interaction, $F(1, 23) = 5.79$, $p = .03$ indicated that RTs to happy expressions were fastest for faces looking towards the viewer.

Discussion

Inter-task relationship: independence?

This experiment detected no significant interdimensional interference. There is a suggestion of interference in the gaze classification task, but twice the numbers of participants were used here compared with Schweinberger and Soukup's (1998, Exps. 1 and 2) expression-identity contrast so the effect, if it exists, is very small. These results therefore are taken to mean that it is possible within the context of this task to attend selectively to gaze direction without interference from variation in expression and to attend to expression without interference from variation in where the gaze is directed.

Intra-task relationships

There are significant intradimensional differences between types of stimulus item. For gaze direction classification RTs are faster to faces looking towards us compared with faces looking away. In addition, RTs are faster to faces looking at us if those faces are happy. For expression classifications there is a slight advantage for happy faces looking towards us over other items.

Faster RTs to faces looking at the viewer when classifying gaze direction may be explained as follows. We are known to be sensitive to both head and eye direction and the effect of these cues is additive (Perrett et al., 1985; Langton, 1999, manuscript in preparation). When head and eye direction are congruent (head and eyes looking at the viewer) the task will be easier than when they are incongruent (head looking at the

viewer with eyes looking away). Added to this, the direction the head is facing is a much larger cue than the direction the eyes are looking. Incongruence of head and eye direction and size of cue alone can account for longer RTs to faces looking away.

For faster RTs to happy compared with angry faces looking at the viewer in the gaze direction classification task there are at least two explanations. The first is a perceptual explanation to do with the visibility of the signal: The signal may be more visible for smiling eyes compared with angry ones, for example. Perhaps the sclera and eyebrows raised slightly work together to facilitate gaze direction detection (Watt, 1995). The second is an affective explanation to do with an activational response to angry faces that slows down responding, thus giving the happy faces an advantage. The effect obtained resembles the anger inferiority (and/ or superiority) effects described by Hansen and Hansen (1994). Aversion to angry faces may apply in both classification tasks.

Summary of Experiments 8 and 9

The interaction found for gaze direction and expression in a task when Ps rated faces for interest (Exp. 8) was not present when Ps were asked to attend selectively to either gaze direction or expression (Exp. 9). Although there is no significant interdimensional interference revealed in this experiment, it is evident from an examination of RTs to types of stimulus item within tasks (more so for the gaze direction task) and across conditions, that happy faces looking towards the viewer are responded to consistently more quickly than angry faces looking towards the viewer.

It should be possible to tell whether the results arise from the physical visibility of the signal by inverting the faces. If this is so, then the effect should persist. It is therefore planned to repeat Experiment 9 with the faces presented upside down.

Experiment 10

In this experiment with inverted faces, if happy eye direction is more visible, then the pattern of responding is expected to remain the same as in Experiment 9 for gaze direction classification. If, however, angry eye direction is more visible in angry faces looking at the viewer, then these will be responded to more quickly than happy ones. If there is something attractive about an upright happy expression (or aversive about an angry one) that modifies RT, then happy inverted faces looking at the viewer are expected to lose their advantage when compared with angry inverted faces for *both* gaze direction and expression classification. Inverting the face is known to be detrimental to the processing of some expressions (Kirita and Endo, 1995; McKelvie, 1995) and gaze direction processing (Campbell et al., 1990; Maruyama and Endo, 1984; Vecera and Johnson, 1995), and it is expected that both tasks will be more difficult. No interdimensional interference is predicted.

Method

Participants

Sixty-nine Ps volunteered and each received either course credit or were paid for their participation. The data from 48 Ps (14 Male, 34 Female) with a mean age of 21.3 (SD = 6.7) years were included in the data set as 13 Ps (gaze direction) and 8 Ps (expression) did not achieve the inclusion criteria. Both tasks were more difficult with inverted faces.

Stimuli and apparatus

The stimuli used in Experiments 8 and 9 were used here also and presented inverted.

Design

As for Experiment 9.

Procedure

As for Experiment 9 except that all faces were shown inverted. (Appendix C is relevant to this experimental procedure.)

Results

Errors and outliers

Errors for Ps who met the scoring criteria were as follows: Ps in the gaze direction classification group made average incorrect responses of 3.1% (correlated, 2.4%; control, 3.4%; orthogonal, 3.4%); Ps in the expression classification group made average incorrect responses of 2.3% (correlated, 2.2%; control, 2.6%; orthogonal, 2.4%). Errors were not analysed further. Outliers made up 2.6% of responses to gaze direction and 1.7% of responses to expression.

RTs: comparisons between classification tasks across conditions

Mean correct RTs for both groups in all experimental conditions can be seen in Figure 37. To check for interdimensional interaction a 2 x 3 mixed ANOVA, with task as the between-subjects variable and condition within-subjects was carried out. This revealed no significant main effects and no significant interactions. The mean RT for the gaze direction classification task was 769 ms (SD = 124 ms) and for the expression classification task was 723 ms (SD = 106 ms).

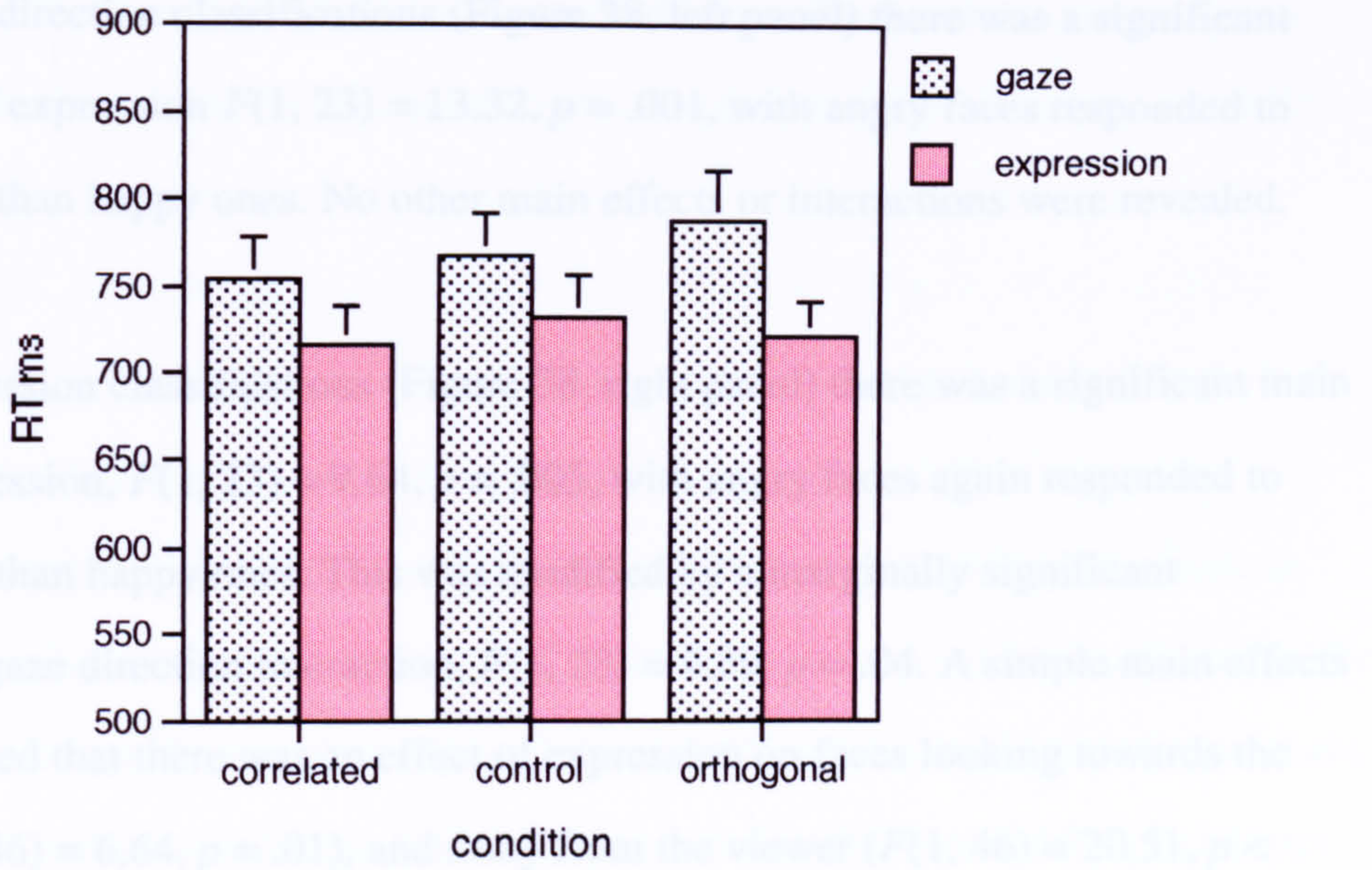


Figure 37. Mean reaction times in Experiment 10 (inverted faces) for gaze direction and expression classification groups in each condition. Vertical bars represent positive standard errors of the mean.

RTs: comparisons within each classification task

Separate 3 x 2 x 2 ANOVAs with condition, gaze direction and expression as within-subjects variables were carried out on the groups doing each task (Figure 38).

The analysis of single dimensions is of particular interest here to check the predictions.

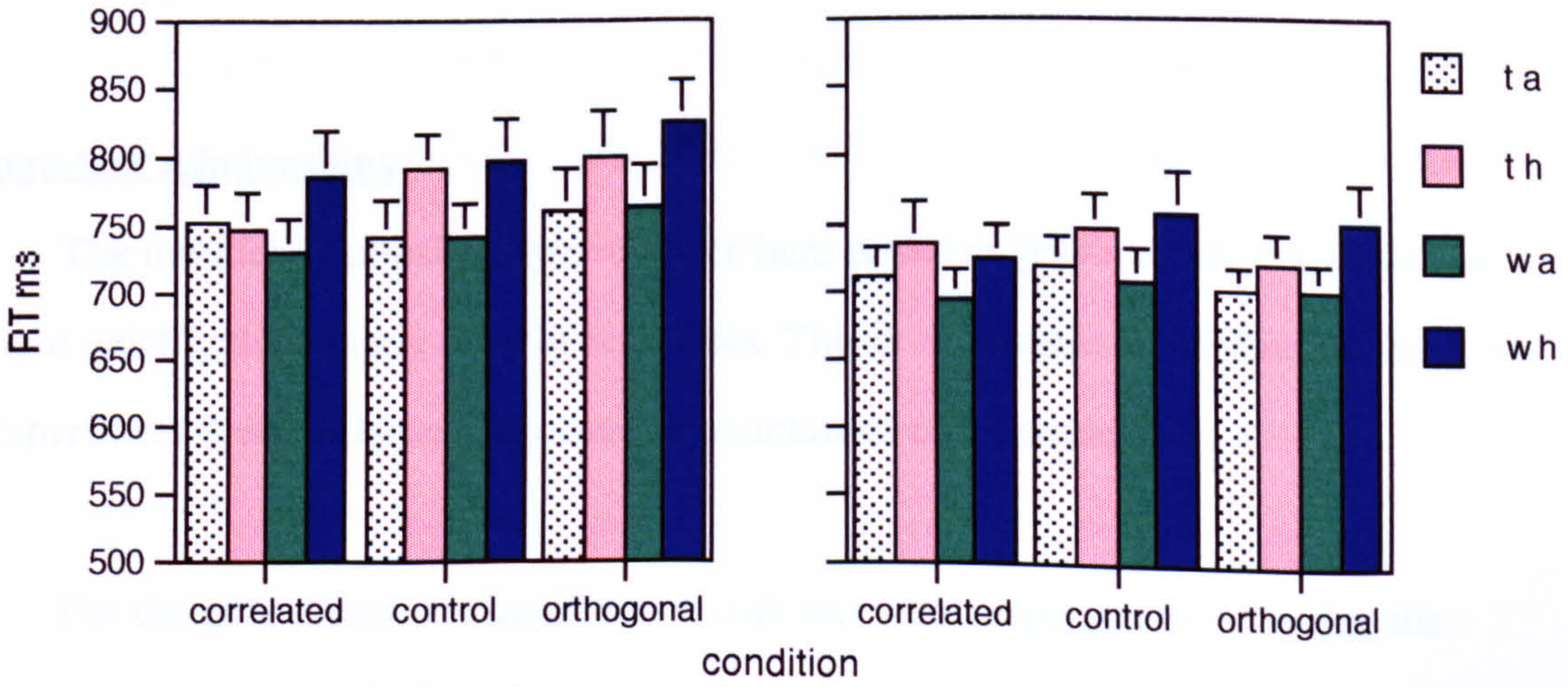


Figure 38. Mean reaction times for every combination of each relevant and irrelevant dimension for inverted faces in Experiment 10. In the left panel the relevant dimension is gaze direction, and in the right panel expression. Vertical bars represent the positive standard errors of the means. t = towards, w = away; a = angry, h = happy.

For gaze direction classifications (Figure 38, left panel) there was a significant main effect of expression $F(1, 23) = 13.32, p = .001$, with angry faces responded to more quickly than happy ones. No other main effects or interactions were revealed.

For expression classifications (Figure 38, right panel) there was a significant main effect of expression, $F(1, 23) = 9.64, p = .005$, with angry faces again responded to more quickly than happy ones. This was modified by a marginally significant expression x gaze direction interaction, $F(1, 23) = 4.89, p = .04$. A simple main effects analysis showed that there was an effect of expression on faces looking towards the viewer ($F(1, 46) = 6.64, p = .01$), and away from the viewer ($F(1, 46) = 20.51, p < .0001$), but no significant effect of gaze direction on expression. That is, there is a slight advantage for angry faces looking away from the viewer compared with angry faces looking towards the viewer, and this is contrasted with a disadvantage for happy faces looking away from the viewer compared with happy faces looking towards the viewer.

Discussion

Inter-task relationship: independence.

As expected, no interdimensional interference is revealed in this experiment.

Intra-task relationships

The intradimensional pattern revealed here is that angry faces are responded to more quickly than happy ones in both tasks. This is in contrast to the findings in Experiment 9 where happy expressions maintained an advantage.

For the gaze direction classification task this result supports the idea that the whites of angry eyes looking both toward and away from the viewer are more visible than the whites of smiling eyes in an inverted face. Thus the delay to angry faces found in Experiment 9 did not persist in this experiment. This suggests that the context of an upright happy face helps us to know quickly whether someone is looking at us. That is,

the signal from the eyes is different for angry and happy faces and this is to do with factors additional to, or in spite of, the amounts of sclera visible either side of the iris (cf. Watt, 1995).

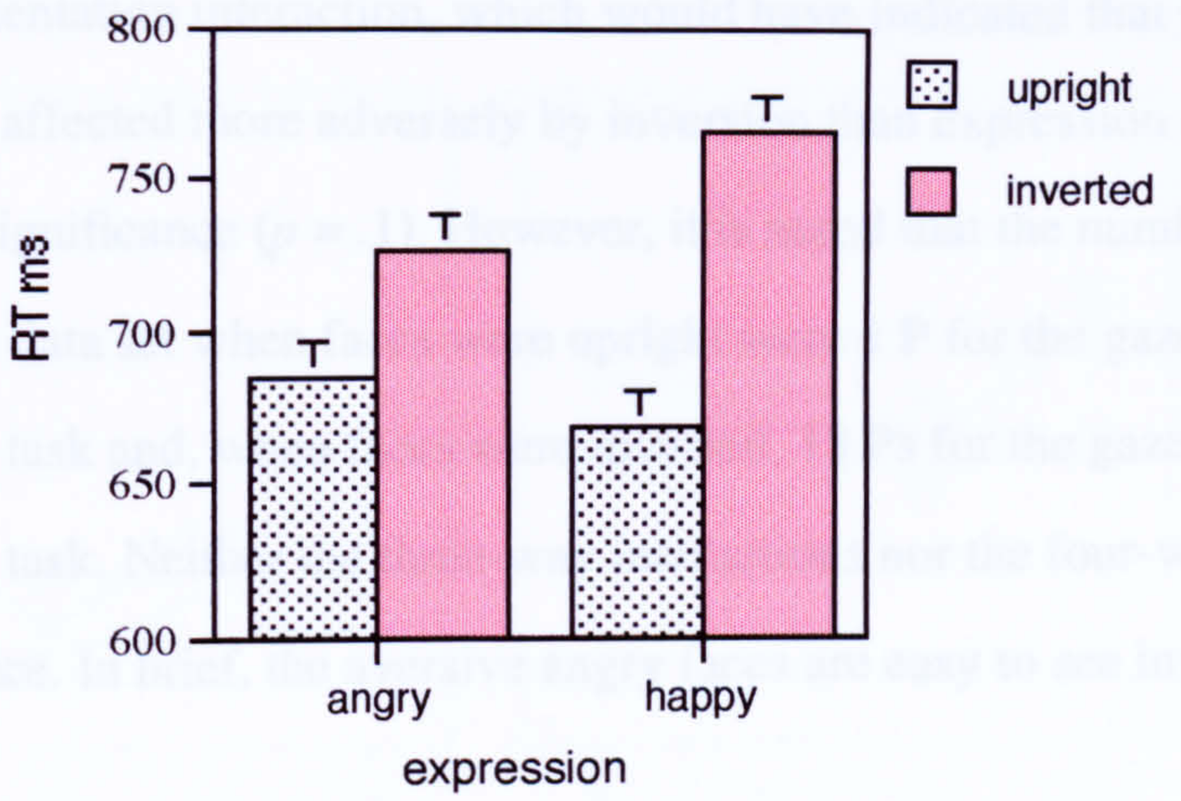
For the expression classification task there was an advantage for angry faces with this most marked for angry faces looking away from the viewer. This angry face advantage for inverted faces does not agree with McKelvie's (1995) finding from an identification task that happy, surprised and neutral expressions were not affected badly by inversion, whereas the negative expressions of sadness, fear, anger and disgust were. In contrast to this, Kirita and Endo (1995) in a two-choice RT task did find that happy faces compared with sad schematic and real faces had an advantage when upright that disappeared when the stimuli were inverted. The sad faces gained a slight advantage at inversion in their study. Both Kirita and Endo and McKelvie use componential vs. configural (or 'holistic') processing modes to explain their findings but reach different conclusions for the same expressions (e.g., "While happy faces were likely to be judged by holistic processing, sad faces were likely to be recognised by analytic processing." Kirita and Endo, 1995, p. 160 cf. "... sad and angry are most strongly based on configural information, and that, with no effect of inversion, happy is the most strongly based on a component." McKelvie, 1995, p. 332). Further experimentation with expressive faces is required to clarify an argument that has become a touch tautological.

According to the 'dual-mode' account outlined by Searcy and Bartlett (1996), the spatial-relational mode of processing information depends on the face being upright. If, however, by inversion or other task demand, the viewer is forced to focus on components of the face, this may or may not involve a detrimental effect (see also Young, Hellawell, and Hay, 1987). In order to find out if there is anything immediately obvious about the items used to do with separate facial features (the eyes or the mouth) the results from Experiments 9 and 10 are compared in the next section.

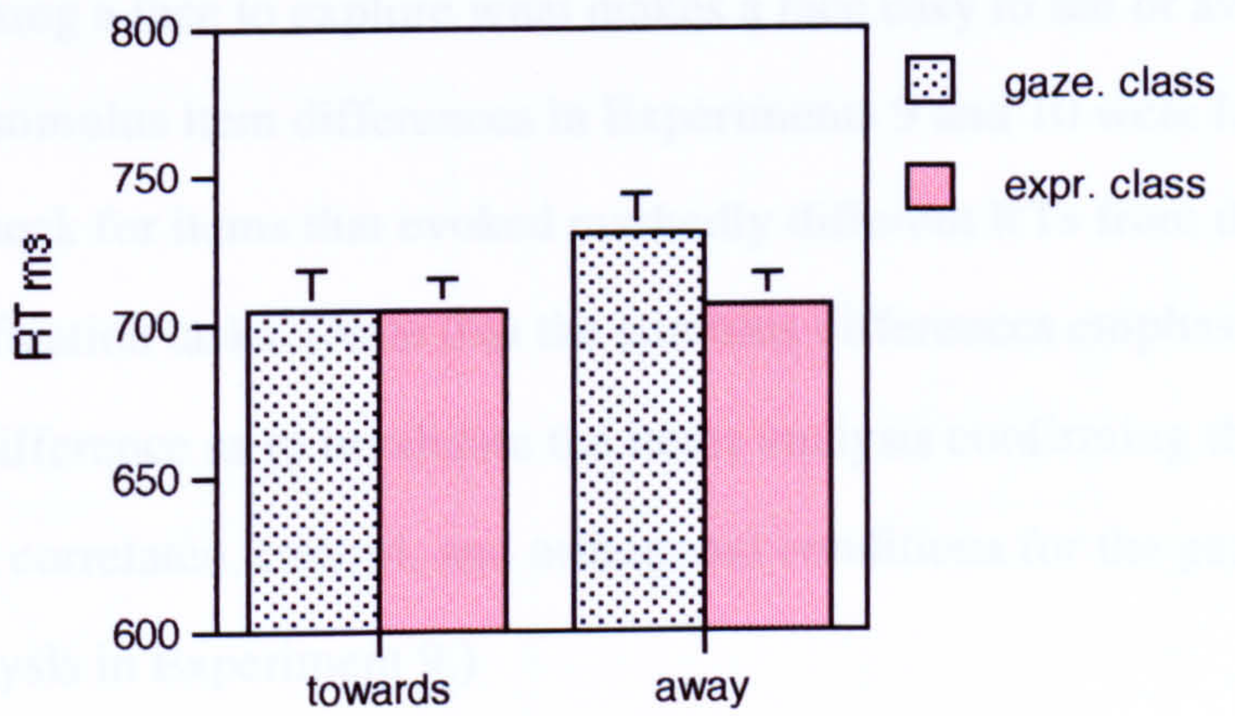
The results of Experiments 9 and 10 compared and discussed.

As the Ps used were matched approximately for age and sex and the same stimulus set was used, a comparison of these results is carried out to establish the effects of inversion on RT. Of particular interest initially was the question of whether gaze direction classification was affected more adversely by inversion compared with expression classification. Responding to gaze direction on inverted faces may be relatively more difficult because the task may rely disproportionately on spatial-relational information. Responding to the expression as either angry or happy may be easier on inverted faces when compared with a gaze direction detection task because Ps can attend to the mouth alone.

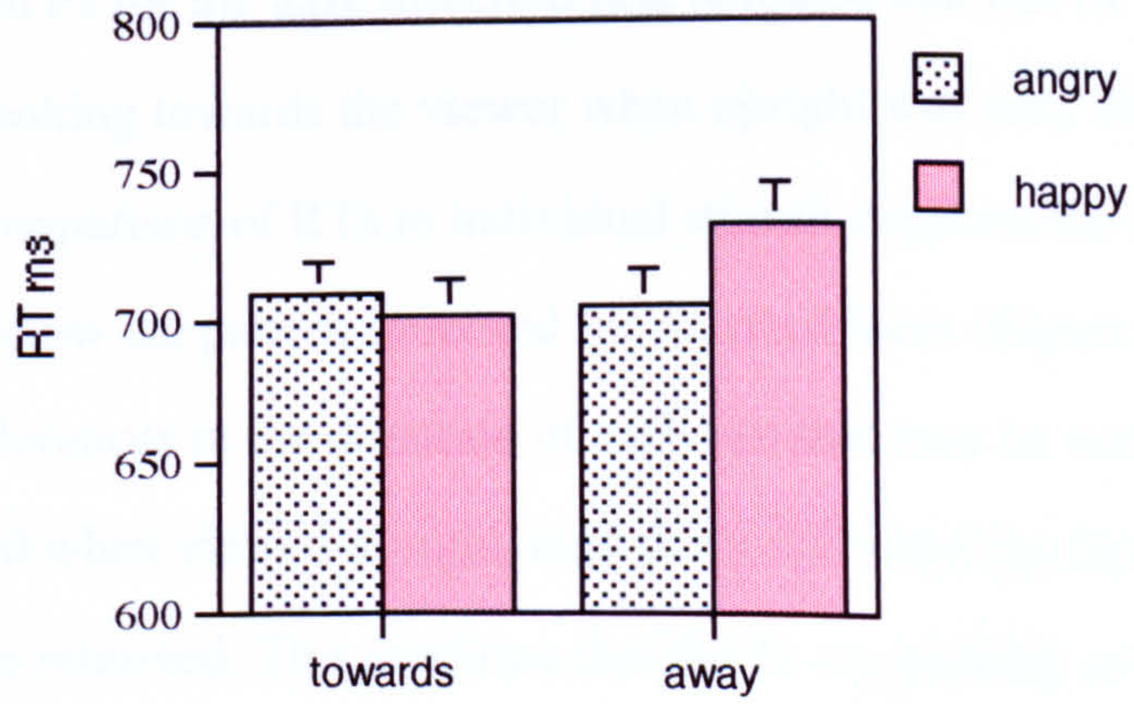
A mixed 2 x 2 x 2 x 2 ANOVA on correct RTs with task (gaze direction classification, expression classification), orientation (upright, inverted), expression (angry, happy), and gaze (towards, away) was carried out. There were main effects of orientation ($F(1, 92) = 9.92, p = .002$) with RTs to inverted faces taking longer, expression ($F(1, 92) = 4.82, p = .03$) with RTs to happy faces slightly slower than RTs to angry ones, and gaze direction ($F(1, 92) = 7.68, p = .007$), with classifications of faces looking towards the viewer faster than faces looking away. These main effects were modified by two-way interactions (Figure 39). An orientation x expression interaction ($F(1, 92) = 30.42, p < .0001$) confirmed that happy faces were responded to faster than angry faces when upright and slower when inverted. A gaze direction x task interaction ($F(1, 92) = 6.56, p = .01$) showed that RTs were only slowed to faces looking away if the task was to classify gaze direction. A gaze direction x expression interaction ($F(1, 92) = 26.67, p < .0001$) showed that RTs were delayed mostly by happy faces looking away.



(i) orientation x expression



(ii) gaze direction x task



(iii) gaze direction x expression

Figure 39. Experiments 9 and 10 compared. See text for explanation.

The task x orientation interaction, which would have indicated that gaze direction classification was affected more adversely by inversion than expression classification, failed to achieve significance ($p = .1$). However, it is noted that the numbers of Ps excluded from the data set when faces were upright were 1 P for the gaze task and 2 Ps for the expression task and, when faces were inverted, 13 Ps for the gaze task and 8 Ps for the expression task. Neither the three-way interactions nor the four-way interaction reached significance. In brief, the aversive angry faces are easy to see inverted.

Stimulus item differences in the eye and mouth regions

Prior to choosing a face to explore what makes a face easy to see or aversive in the next experiment, stimulus item differences in Experiments 9 and 10 were looked at more closely to check for items that evoked markedly different RTs from the rest of the set for both classification tasks. (Note that the stimulus differences emphasised here do not make such a difference as to invalidate the items analysis confirming the pattern of responding across correlated, control, and orthogonal conditions for the gaze direction classification analysis in Experiment 9.)

Gaze direction classification

Feedback from Ps for the gaze direction task revealed that one of the faces that looked as if was looking towards the viewer when upright was very difficult to classify upside down. A comparison of RTs to individual stimuli supports the idea that Face No. 22 does not follow the pattern observed for inverted faces (Figure 40, upper panels). Slight differences in the direction of each eye that may be compensated for so as not to be noticed when viewed upright, may delay RT when the face is inverted and contextual cues are removed. This confirms that the Ps are looking *at* the eyes to see where the eyes are gazing in inverted faces. It also suggests that the loss of the happy face advantage in inverted faces may be due in part to the more difficult discrimination task in Experiment 10, which again points to a role for the sclera at inversion in a way that may be qualitatively different for upright faces.

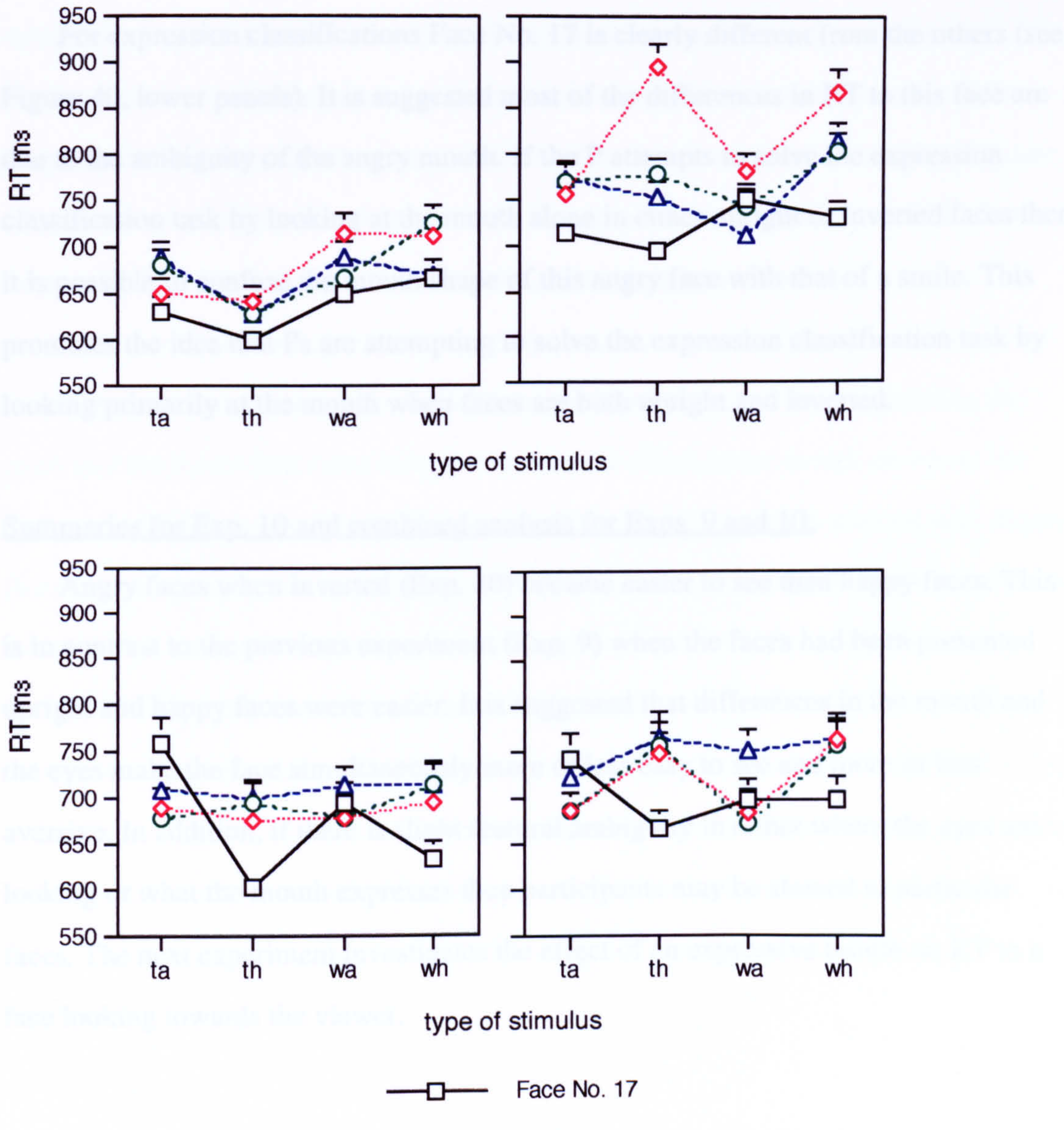


Figure 40. Data from Experiments 9 and 10. Upper panels: RTs to stimulus faces for gaze direction classification in upright faces (left panel) and inverted faces (right panel). Face No. 22 is more difficult inverted. Lower panels: RTs to stimulus faces for expression classification in upright faces (left panel) and inverted faces (right panel). RTs to Face No. 17 are different from RTs to the other faces both upright and inverted. ta = towards angry, th = towards happy, wa = away angry, wh = away happy.

Expression classification

For expression classifications Face No. 17 is clearly different from the others (see Figure 40, lower panels). It is suggested most of the differences in RT to this face are due to the ambiguity of the angry mouth. If the P attempts to solve the expression classification task by looking at the mouth alone in either upright or inverted faces then it is possible to confuse the mouth shape of this angry face with that of a smile. This promotes the idea that Ps are attempting to solve the expression classification task by looking primarily at the mouth when faces are both upright and inverted.

Summaries for Exp. 10 and combined analysis for Exps. 9 and 10.

Angry faces when inverted (Exp. 10) became easier to see than happy faces. This is in contrast to the previous experiment (Exp. 9) when the faces had been presented upright and happy faces were easier. It is suggested that differences in the mouth and the eyes make the face simultaneously more or less easy to see and more or less aversive. In addition, if there is slight featural ambiguity in either where the eyes are looking or what the mouth expresses then participants may be slowed to particular faces. The next experiment investigates the effect of an expressive mouth on RT to a face looking towards the viewer.

Experiment 11

Although interdimensional interference between expression and gaze direction has not been revealed using Garner's methodology, separate analysis of gaze direction classification showed a consistent difference between the effect of angry and happy expressions on RT to faces looking towards the viewer. Inversion of the stimuli to check that delayed responses to angry expressions were not due to angry expressive eyes being less visible showed, in fact, the reverse. Angry inverted faces were *more* visible than happy inverted ones. These results, together with more marginal

differences between angry and happy expressions for expression classification (angry upright faces were responded to more slowly here also: an effect that disappeared when the faces were inverted), have been interpreted as angry faces evoking an aversive response in the viewer that becomes marked when the viewer attempts to discriminate whether or not the face is looking at them. The implication is that the context of an expressive face is taken into account when processing gaze direction.

If the context of the face is divided into two with the upper face containing the eyes, and the lower face containing the mouth, the effect of the mouth on where the eyes are looking may be determined. An angry (aversive) mouth combined with happy (hard to see) eyes should result in slower RTs to a face looking towards the viewer than a face with a happy (attractive) mouth and happy eyes. Similarly, a happy mouth combined with angry (easy to see) eyes should result in faster RTs compared with a face with an angry mouth and angry eyes. It was decided to set up a short simple search task using a single face that had been cut and pasted (see below) to test this, rather than run a full Garner experiment.

Method

Participants

Twenty one Ps volunteered and each was paid for their participation. The data from 20 Ps (5 Male, 15 Female) with a mean age of 24.6 (SD = 6.3) years were included in the data set. One P did not achieve the inclusion criteria.

Stimuli and apparatus

Given that difficulties with gaze and expression classification arose with two of the faces (Face Nos. 22 and 17) in Experiments 9 and 10 it was decided to use either Face No. 32 or Face No. 7 for the experiment here. As Ps may be able to use subtle differences in head orientation to establish gaze direction, 16 Ps were asked in a preliminary study to see if they could determine where each face in the total stimulus

set was looking when the eyes were concealed. For the whole set Ps were at chance levels or worse for each type of stimulus. If responses to individual stimuli were considered, Ps were worse than chance or at chance for all stimuli except Face No. 7's happy towards and away expressions. Face No. 32 was therefore selected for the eye and mouth combinations used in the present experiment. Angry and happy towards half-faces divided horizontally were matched to each other and angry and happy away faces were matched to each other using Photoshop software. The complete stimulus set is seen at Figure 41.

Figure 41. Complete stimulus set for Experiment 11. Top row, left to right: happy eyes towards the viewer + happy mouth, the (same) happy eyes + angry mouth, happy eyes away from the viewer + happy mouth, the (same) happy eyes + angry mouth; Bottom row, left to right: angry eyes towards the viewer + angry mouth, the (same) angry eyes + happy mouth, angry eyes away from the viewer + angry mouth, the (same) angry eyes + happy mouth. Columns 1 and 3 are natural stimuli; Columns 2 and 4 are composite stimuli. Face No. 32.

Stimuli appeared on the screen in pairs made up of one face looking towards the viewer and one face looking away. One stimulus face was positioned to the left side of the image area and the other to the right. Each face measured 6 x 8.5 cm and there was a 2.2 cm central gap between them. The image area measured approximately 14.2 x 8.5

cm, which subtended an angle of 13.5° horizontally and 8.2° vertically at a viewing distance of 0.6 m. The stimuli were presented using "SuperLab" software on a light background on a Macintosh Quadra 800. The participant's head was kept level and in one place with the use of a chin rest.

Design

A within-subjects 2 x 2 design was used with expression of the eyes (happy, angry) and expression of the mouth (happy, angry) as independent variables. RT to the face looking towards the viewer was the dependent measure.

Procedure

Ps were asked to respond to the face looking straight ahead (towards the viewer) as quickly as possible without making errors by pressing a designated key on the same side as the target stimulus. Between each trial Ps were encouraged to look at a central fixation point that appeared for 1000 ms. Each stimulus face looking towards was paired with each stimulus face looking away and each appeared the same number of times to the left and the right of the image area. In this way there were 32 trials with each target face appearing 8 times. The experiment took approximately 5 minutes to complete. Errors were excluded and one P who made more than 10% errors overall was excluded. RTs shorter than 150 ms and longer than 2500 ms were also excluded.

Results

Errors and outliers

Overall errors were 3.4% distributed across stimuli as follows: eyes and mouth both angry, 3.3%; eyes and mouth both happy, 3.4%; angry eyes with happy mouth, 3.1%; happy eyes with angry mouth, 3.8%. Outliers made up 0.9% of the data with most of these (40%) made to the happy eyes with angry mouth face (this was the face with the longest mean RT).

RTs

A within-subjects 2 x 2 ANOVA was carried out on correct RTs. There was a significant main effect of the mouth, $F(1, 19) = 13.01$, $p = .002$, with a happy mouth speeding RT to angry eyes and an angry mouth slowing RT to happy eyes (Figure 42). Although RTs to happy eyes with happy mouth faces were slightly faster than RTs to angry eyes with angry mouth faces, this difference was not significant using this experimental method.

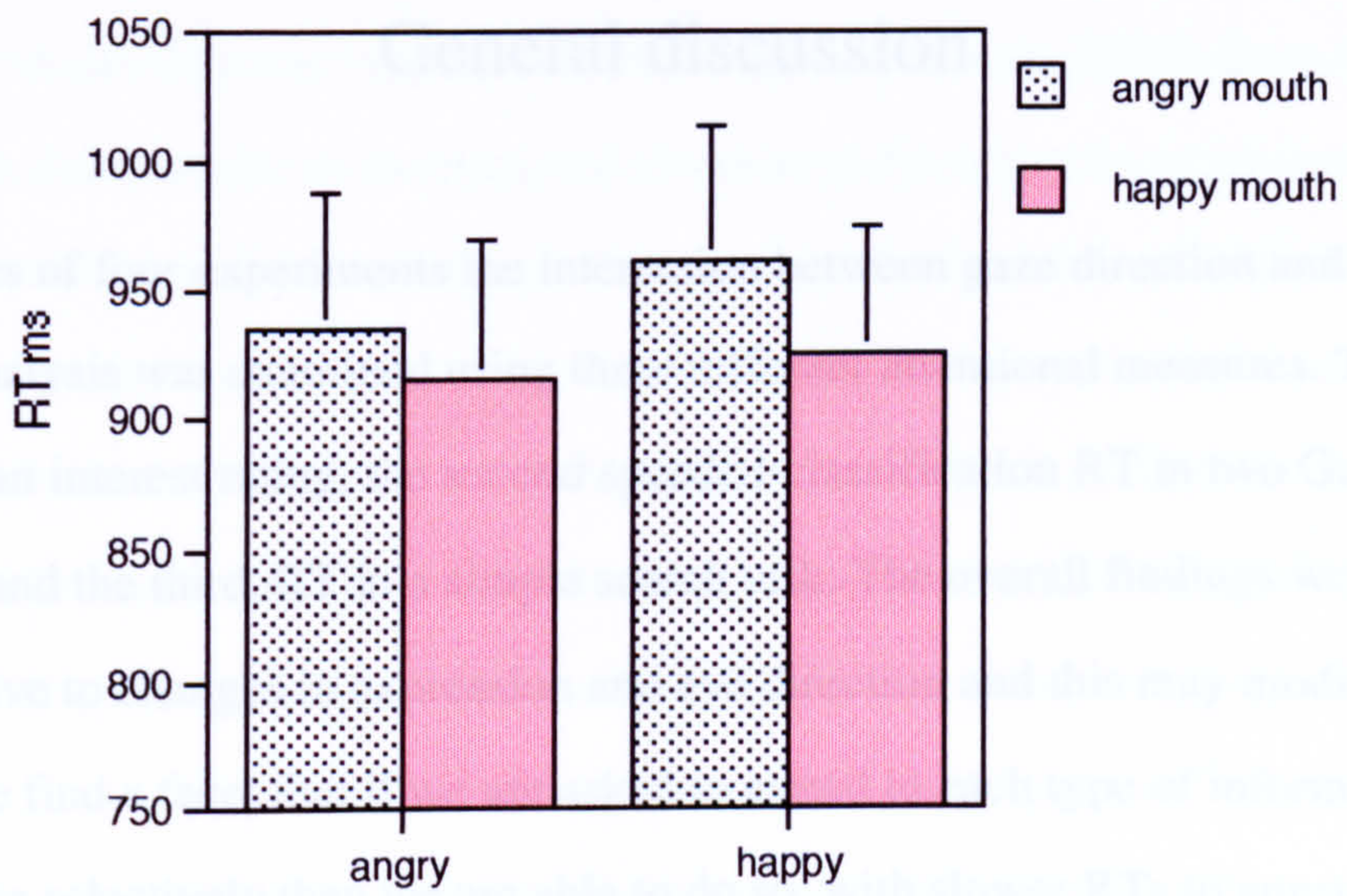


Figure 42. Experiment 11. The effect of an expressive mouth on RT to a face looking towards the viewer when the eyes are angry and when the eyes are happy. Vertical bars represent positive standard errors of the means.

Discussion

These results show an effect of the mouth on our perception of gaze direction when the task is to choose a face looking towards us compared with one looking away. The presence of an aversive mouth is sufficient to slow RT to a happy face looking at the viewer and a happy mouth speeds RT to angry eyes looking at the viewer. This demonstrates that more than the pattern of light and dark around the eye area is involved in determining where the eyes of an expressive face are looking. Compatible with the idea that several features are taken into account when interpreting an

emotional expression, the influence of the mouth has been noted previously (McKelvie, 1973; Ekman, 1979) in the interpretation of signals from the eyebrows. This influence of the mouth it seems, may be extended to a role in the determination of where the eyes are looking. The happy face advantage over angry faces observed in upright faces (Exp. 9) was not demonstrated here and it may be that this advantage only appears within a narrow focal field. Ps reported having to move their eyes away from the fixation point to carry out the task here.

General discussion

In a series of four experiments the interaction between gaze direction and expression analysis was examined using three different attentional measures. The first of these was an interest rating, the second speeded-classification RT in two Garner experiments and the third, RT in a simple search task. The overall findings were: that we are sensitive to changes in expression and eye direction and this may modify how interesting we find a face; that if we are asked to attend to each type of information in an upright face selectively then we are able to do so, with slower RTs to angry and faster RTs to happy faces showing up consistently across conditions; that the advantage for happy expressions in upright faces disappears in inverted faces with angry faces easier to see in this context; that we are slower to find a face looking at us if the mouth is angry. These results are attributed to automatic processing effects associated with the attractiveness of happy faces and the aversiveness of angry ones. No conclusion can be drawn regarding differences between the effect of faces looking towards and away from the viewer as the stimuli used were not controlled for the additive effects of head and eye direction, with faces looking towards the viewer always congruent, and faces looking away always incongruent.

So, why are we slower to respond to a face looking at us when it is angry compared with when it is smiling given that if we responded to threat faces faster we

would be on track for a survival advantage? Especially given that angry eyes may even be more visible than happy eyes in terms of signal strength. According to Oatley and Johnson-Laird (1998), each emotion has its own distinctive cognitive organisation. This includes attentional characteristics, and the results support the idea of an early response to threat-related stimuli that is characterised by avoidance (Mogg and Bradley, 1998), or possible 'capturing' (Hansen and Hansen, 1994) or 'freezing' (Le Doux, 1998), compared with an unhindered response to non-threat stimuli. Pratto and John (1991) argue persuasively for attentional vigilance induced by threat-related stimuli and the (delayed) functional response we make to these types of stimuli. While there is no evidence from these results of an enhanced response to the angry faces (unless longer reaction times can be said to represent an increase in attention), it is of interest that, somewhat paradoxically, angry faces do appear clearly visible when the faces are turned upside down and the threat is removed. Their visibility is consistent with their status as salient stimuli; a delayed response is consistent with a functional 'do nothing-think quickly' reaction to danger.

The finding that the initial reaction to a threatening face may be influenced by an impression conveyed by the lines of the mouth is consistent with findings from experiments carried out with minimal stimuli (Aronoff et al., 1992). Aronoff et al's 'V' -shaped stimuli seem to mimic the pattern of frowns rather than mouths, but these authors are alive to the generality of angularity in a furious face compared with one that is curvaceous and happy. These results also concur with Yantis' (1998) distinction, with regard to visual attention, between stimulus-driven selection when some salient attribute of the stimulus captures the viewer's attention and goal-driven visual selection which is controlled by the observer's deliberate strategies and intentions. The initial aversive effect of seeing an angry face may be brought under strategic control within the context of a Garner experiment, such that no measurable difference accumulates between trials when dimensional values are averaged. Baseline control and filtering orthogonal conditions therefore show no effect of irrelevant variation for either gaze

direction or expression classification. Overall these results suggest a complex pattern of automatic and strategic processes facilitating and delaying reaction time to expressive faces.

Overview

This chapter has introduced the reader to an exploration of the relationship between facial expression and gaze direction processing. Although an initial rating study suggested that these two dimensions may interact to influence viewers' interest in a face, in an interference task, selective attention to each in the presence of irrelevant variation in the other was possible. The analysis of dimensions separately revealed interesting stimulus specific differences between angry and happy faces that are interpreted as the viewer showing early aversive responses to angry expressions and attractive responses to happy expressions. A stimulus face with an angry mouth, in particular, has an attenuating effect when experimental participants attempt to find one of two faces looking at them. The reader is referred to the final chapter of this thesis for suggestions as to how these results might be incorporated into the Bruce and Young (1986) model of face recognition. The more immediate task of the next chapter (Chapter 6) is to evaluate the usefulness of the Garner paradigm in the study of facial dimensions, as the two following experimental chapters (Chapters 7 and 8) take the search for an influence of emotional expression processing into areas away from the face and use different experimental methods.

6

Selective attention and facial dimensions: Garner critique

In the experiments so far very little effect on the viewer has been found due to exposure to emotional expressions using Garner's selective attention methodology. The clearest evidence of general interference was found (and even this was not clear) contrasting expression and identity, with expression perception open (perhaps) to influence from information about identity. The presence of interference here is in spite of indications that this is where it might least be expected, given that the participant probably attends to invariant features in the determination of identity that are thought not to be used for the purposes of processing expression. No evidence for interference between expression and sex, and expression and gaze direction was apparent using interdimensional Garner comparisons and these are facial dimensions that were considered initially likely to be interactive. Other measures (rating studies, unidirectional measures) have, in contrast, shown mutual influence. Expression was shown to modify estimates of masculinity, expression and gaze direction to interact in interest ratings, and gaze perception to be modified by the expression of the mouth. The question is asked how useful the Garner paradigm is when testing the independence of emotional expression information from other facial dimensions.

This chapter is therefore concerned with the efficacy of the Garner paradigm using faces as stimuli and several points are raised. For example, given that strict Garner criteria for dimensional interaction were not met in most of the previous experiments, what is the status of the intradimensional differences found? Do differences found along single dimensions, for example, reveal interdimensional activity prior to the strategic allocation of attention targeted in a Garner experiment?

Garner's method(s) with faces

Garner's (1974) method of testing for selective attention is used frequently in cognitive psychology experiments because of the clarity promised in diagnosing the separation or integration of perceptual processes. However, although it is true that this paradigm has been applied extensively in the investigation of simple multidimensional visual stimuli (e.g., Garner, 1974; Garner, 1983; Pomerantz and Pristach, 1989), and auditory dimensions (e.g., Wood, 1974; Melara and Marks, 1990a; Mullenix and Pisoni, 1990), it has been applied only occasionally to facial dimensions (Etcoff, 1984; Schweinberger and Soukup, 1998; Schweinberger, Burton, and Kelly, in press; this thesis). The Garner method of testing for selective attention is known to be sensitive to a number of constraints, some of which have been touched on in the previous chapters, and an attempt will be made below to summarise what these are.

To carry out a Garner experiment stimuli consist of at least two dimensions: one is the target and the other is irrelevant information. Garner interference occurs when variation on the irrelevant dimension impairs performance and is taken to indicate that nontarget information is processed together with the target information. Our attentional 'control' over task outcome is overcome or relinquished. This could be due to stimulus factors such as discriminability or category membership, task conditions such as set size (stimulus variability) or the wording of the instructions, and participant factors

such as how much practice they have had, as much as it might be due to perceptual dimensional integration.

Discriminability seems to be the major constraint on the interpretation of any interference that shows in Garner's speeded classification task. It is a measure of the psychological distance between stimulus values along a dimension. When one task is performed as easily as the other in the baseline condition then discriminability is said to be matched. This is thought to prevent the participant using a serial processing strategy where the easier dimension is always processed first. The case in which interference is generated asymmetrically and is susceptible to manipulations of discriminability is not considered a bona fide example of integral processing (e.g., Melara and Mounts, 1993). Note that, if there is little difference between the values on the irrelevant dimension, the orthogonal condition approaches baseline.

Garner (1974) emphasises that his selective attention paradigm is but a single tool in a larger set of converging operations to uncover the relative contribution of stimulus dimensions to the mode of processing used by the viewer. Multidimensional scaling based on similarity judgements made to all possible pairs of the members of the stimulus set is another. The implications of discriminability and similarity for testing the independence of facial expression and identity information are illuminated by considering the following experiment by Sergent (1984).

Sergent (1984) asked participants to assess the dissimilarity between eight line-drawn (Photofit) faces and was able to show the relative contribution of componential (separable) and configural (interactive) processing. She also used a reaction time task (same-different assessment) with this same set of stimuli, making the likely assumption that, even with interactive dimensions, discrimination RT is a function of relative distance between each of the stimuli within the representational space. There were differences in the degree to which each of the featural dimensions manipulated

(contour: pointed or square chin; eyes: large or small; internal space: features close together or far apart) affected the matching task. However, the comparison of interest here is between the group of participants who made dissimilarity judgements *prior* to a same-different task and the group that made these judgements *after* this task. Sergent found that the judgements of the first group were best represented by placement of the stimuli within a two-dimensional space described by contour along one axis and internal space along the other. The judgements of the second group, who were more familiar with the faces, were best described by a three-dimensional space in which all three dimensions interacted. No evidence of interactive processing emerged when the faces were inverted. Sergent argued for both component and configural properties of faces that lend themselves to different processing strategies that unfold simultaneously over time.

This careful study by Sergent suggests several ways in which the design of Experiments 2-4 might be improved. Pilot studies using a matching task to ensure equivalent psychological distance between the values on identity and expression dimensions prior to running the main experiment would be one way of standardising the basis of baseline equivalence. Lack of a significant difference between control condition means for Experiment 2 (see Figure 16) was largely fortuitous, with large differences in discriminability between various members of the set making the results difficult to interpret. In Experiments 3 (Figure 19), and 4 (Figure 22), although control means are not significantly different from each other, it can be seen that baseline measures are uneven. The increased variance may be one reason why only certain values of each of the relevant and irrelevant dimensions register significant interference. A similar situation applies to the expression - sex contrast of Experiment 7 (Figure 30) (without affecting the interim conclusions reached necessarily), where errors become a cause for concern.

Having established a large stimulus set calibrated for discriminability along all the facial dimensions of interest, the influence of this factor could then be addressed systematically. In addition, asking participants to perform a substantial discrimination task and using task order as a variable (after Sergent, 1984), an assessment of any shift in integrative strategy across dimensions with increasing familiarity would be revealed. This would, hopefully, make the need for any qualitatively different distinctions such as that between 'pictorial' and 'abstract' (or 'structural') codes unnecessary in this context. Such a collection of procedures would also allow the systematic examination of practice effects (it is known that increasing practice with non-face stimuli can reduce interference, e.g., Pansky and Algom, 1999). There would be the additional advantage of controlling both increasing familiarity along the identity dimension and increasing expertise along the other dimension (expression/ sex/ gaze direction) under consideration. Practice effects are important within selective attention paradigms because the interference that does not reduce may be of structural (and possibly innate) significance.

Schweinberger, Burton, and Kelly (in press) have approached the problem of differential discriminability by using morphed faces. Stimulus faces were morphed across identity within a given emotional expression, or were morphed across emotion within a given identity. Along each dimension faces were discriminated accurately within relatively narrow category boundaries, with RTs reflecting the ease of discrimination. Garner experiments were then carried out with stimuli that were either easy or difficult to discriminate. In both cases the asymmetric pattern of interference found in their previous study (Schweinberger and Soukup, 1998) was replicated. Schweinberger et al. conclude that relative discriminability is *not* the source of interference variation in facial identity produces when classifying expression: Expression decisions are are open to modification by identity information in a way that does not happen for identity. How much these results are dependent on the use of the still image, compared with one that moves, with those features of the face determining

identity 'mistakenly' incorporated into the momentary configuration of an expression, remains to be explored. However, the fact that interference can be detected one way and not the other is consistent with a system that is interactive asymmetrically rather than one that is mutually independent. One of the implications of these results is that visual 'emotional' processing may require an object. This is reminiscent of the asymmetric relationship found between pitch and place (Wood, 1974) where pitch classification is independent and place is open to modulation, and Garner's (1976) observation that the inherent physical properties of the stimuli are such that a syllable has to have a pitch, but pitch does not have to be a syllable.

Garner (1974) also points out that there is a sense in which the concept of integral dimensions is oxymoronic. Wood and his colleagues (e.g., Wood, 1974) found in their investigation of the relationship between auditory and phonetic dimensions that where the two dimensions were from the same class there was mutual or symmetric interaction. When pitch was compared with intensity of sound (both dimensions are auditory), there was interference; when two phonetic dimensions were compared, there was again interference. When auditory and phonetic dimensions were compared, asymmetric interference, with phonetic information analysis dependent in some way on pitch was revealed. On the face of it, there is potential for the Garner paradigm to be used to explore the relationship between categorical and 'dimensional' models of expression perception. Consider the possible outcomes of a comparison of two dimensions drawn from the same category, emotional expression: arousal vs. pleasure. Participant choices would be high or not-so-high arousal, displeased (anger) or pleased (happiness). Mutual interference would be predicted by the Russell's (1980) 'dimensional' model of expression processing whereas the categorical model in contrast, would predict independence. What if, instead of complete independence, the outcome was asymmetric interference, with arousal information interfering with pleasure classification? Would we then assume that a judgement of arousal (also a judgement of intensity) might proceed regardless of variation in pleasure, but that pleasure

classification (essentially the discrimination between anger and happiness) was dependent on arousal in some way *other* than to do with stimulus relative discriminability? I have no useful suggestion for the resolution of this dilemma. I suggest instead that this is an example of when the Garner paradigm might be inappropriate for use with faces as stimuli.

Pansky and Algom (1999) and others (e.g., Mullinix and Pisoni, 1990) also consider that it is important for the size of the set on each dimension to be the same. Pansky and Algom tested the automatic activation of numerical meaning during magnitude processing by comparing pairs such as 3-7, 3-7 (magnitude held constant), 3-3, 7-7 (number held constant), with 3-7, and 3-7. Having a choice between two physical sizes of numbers on the one hand, and several numbers grouped as large or small instances on the other, would be the equivalent of testing the independence of sex and expression using one male and one female face each with several different types of surprise expressions and scowls. Size (and sex) classifications are favoured at the expense of number (and expression) classifications. While Experiments 6 and 7 avoided this pitfall, it is uncertain that a valid equivalence using faces as stimuli, can always be sustained. The argument is in favour of as many variations on each dimension as can be mustered as the likelihood of interference is increased under these conditions: difficult when a contrast with identity is sought. This refers back to the necessity of matching each task for difficulty.

Attention changes with time

Faces are complex multidimensional stimuli, encountered most usually as dynamic. A view of attentional processes as constantly changing through time, with consequent impact on the integration of facial information, is probably most helpful. In particular, and for the purposes of this critique of Garner's speeded-classification method I will make specific use of van Leeuwen and Bakker's (1995) model of how time-sensitive mandatory and strategic influences can be revealed in Garner and Stroop

(1935) experiments. (In a Stroop experiment with non-emotional stimuli, interference appears if the irrelevant dimension is incongruent with or opposite in some way to the target dimension.) Van Leeuwen and Bakker used visual stimuli (examples are illustrated at Figure 43) that are more complex than those usually used (for example, cf. red and green triangles and squares), and their several irrelevant features expanded the opportunity for different combinations of types of interference to emerge. The use of this model suggests ways in which future experiments could explore opportunities for the integration of what appear, at present, to be functionally independent facial dimensions.

A considerable number of researchers make comparisons between dimensions that may cause Garner interference and Stroop (1935) interference simultaneously (e.g., Ben-Artzi and Marks, 1995; Melara and Marks, 1990b; Melara and Mounts, 1993; Pansky and Algom, 1999). Various manipulations of discriminability and set size were seen to affect these two types of selective attention differently. This raises the question as to how Garner and Stroop measures might be different and what interference in each might mean. (For a review of some 400 studies of Stroop interference in the colour-word task see MacLeod, 1991.) Such studies usually omit the correlated condition from their investigations because of the ambiguity in the interpretation of interference here, and focus on comparisons between control (baseline) and orthogonal (filtering) conditions.

There were four dimensions contained within van Leeuwen and Bakker's (1995) stimuli: upper global contour, upper local contour, lower global contour, and lower local contour. Global and local, and upper and lower contours took the form of either a rectangular or triangular shape. The total stimulus set was made up of 16 stimuli. The two most extreme versions are shown at Figure 43. Attributes of these stimuli may be either congruent or incongruent. Such stimuli are of particular interest because they allow an estimation of the interference between local (internal) and global (external),

and upper and lower (face) attributes. This analogy with faces is difficult to push too far, for although a mouth may approximate the shape of a triangle or square, the eyes do not.

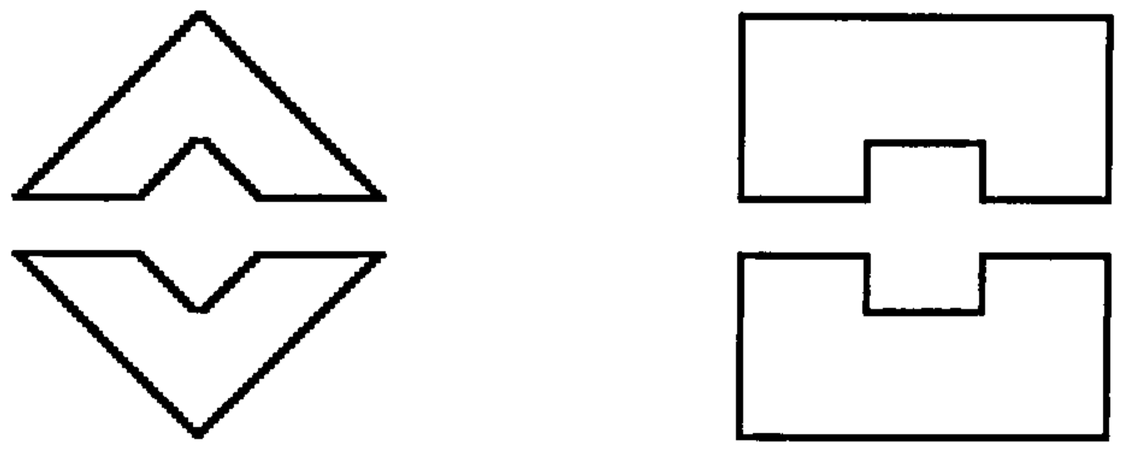


Figure 43. Examples of stimuli used in van Leeuwen and Bakker's (1995) experiments to show all combinations of Stroop and Garner interference.

Although faces may constitute a unique class of stimuli, by the device of including more dimensions than those used normally, a type of interference not found with simpler stimuli was found by van Leeuwen and Bakker. This was the presence of Stroop without Garner interference. The significance of this is that the combined presence or absence of Stroop and Garner interference has been said to distinguish cross-dimensional interaction (e.g., Pansky and Algom, 1999; Pomerantz and Pristach, 1989). Separable dimensions are characterised by the absence of both Stroop and Garner interference; integral dimensions have Garner without Stroop; and configural dimensions show both types. Stroop interference has been restricted to a within-stimulus effect, with conflicting content of the irrelevant dimension the source of the interference. However, if Stroop interference does show, this is evidence that non-target information is processed, therefore Stroop interference was said not to be able to exist in the absence of Garner interference. Again, the analogy with faces cannot be pressed as who is to say which, of person A or person B, is congruent with what choices of expression are on offer. It makes slightly more sense to say that some of the perceptual features of a female face are consistent with those that specify surprise and that those of

a male face with those that specify angry.[7] An angry or a happy face looking at the viewer are more congruent than either looking away, but this does not help to interpret differences between angry and happy faces both looking at the viewer. Maybe faces are just not appropriate stimuli to use with either type of selective interference design: they are however, examples of complex configural patterns.

Van Leeuwen and Bakker (1995) found that thinking of the source of the interference and the possibilities of location of the interference in the following way could help explain their results. Information integration without attention is seen as automatic. Automatic information integration happens when the oscillations between neighbouring units become synchronised. First of all two synchronise, then a third, and so on, with higher order synchronisation patterns forming over time. Van Leeuwen and Bakker call this process of higher order pattern formation hologenesis. Hologenesis starts at the beginning of stimulus analysis. Attention is seen as an "aspecific tuning parameter" (p. 381) of the otherwise automatic process of information integration. Attention is not split into early preattentive processes and later strategic ones. Furthermore, semantic influences early in perception are not precluded. Narrow and broad contexts are differentiated (e.g., word level and sentence level semantic contexts; near and spatially distant contexts). Hologenesis allows sensitivity to narrow context, and therefore Stroop interference, to happen early. Garner interference, sensitive to broad context, is seen as happening later. Van Leeuwen and Bakker compare and contrast their idea of attention with that of Treisman and Gelade (1980) where attention is understood in terms of capacity limitations on the process of binding together object attributes (location, colour, different aspects of shape etc.) that are initially separate. They also compare their model with Pomerantz, Pristach, and Carson (1989) who

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[7] Inspection of Figure 31 suggests that an analysis of the Stroop interference present for sex classifications (control and orthogonal conditions only) *may* be significant, but that it would not for expression classifications.

propose a model suggesting that an additional channel processing emergent features is responsible for processing integral dimensions and that cross-talk during perceptual processing produces both Garner and Stroop effects (not Stroop alone). Van Leeuwen and Bakker share this concept of cross-dimensional integration producing interference but emphasise that the way analyses may change through time needs to be considered.

Key to the operation of van Leeuwen and Bakker's model is the concept of coherence length. This is the length of time that a process will proceed before it is disrupted. A short coherence length denotes a non-integrative strategy, and a longer coherence length an integrative strategy. Attention is seen as modulating the integration of information by changing the coherence length of the automatic information-integration process of hologenesis. Coherence length is then the mechanism by which instructions, set size, preferences, and so on will have an effect. The non-integrative strategy suppresses interference, whereas the integrative strategy allows a wider spatiotemporal incorporation of information. Non-integrative and integrative strategies are seen as "ideal types" (p. 382) with the dimension of integration continuous. Strategies are not necessarily fixed and may change from integrative early in analysis to non-integrative later and vice versa.

To test their idea that Stroop (without Garner) interference results from an early integrative strategy, van Leeuwen and Bakker repeated their experiment, incorporating presentation time as a variable by masking the stimuli at intervals between 60 and 200 ms. They were able to show that, depending on whether the source of the interference was near, intermediate to, or far from the target (e.g., in the same half of the figure or further away in the other half of the figure: refer to Figure 43), maximal Stroop interference at these locations occurred within different time windows. Analysis switched from integrative to non-integrative processes as attention stretched to cover more of the figure, and moved beyond. All Stroop interference was over by 166 ms. It

would be very interesting to construct a similar time-sensitive profile using facial dimensions.

In the experiments in the previous chapters where stimuli were on display until the participant pressed the response key, early integrative processes would not necessarily have been revealed. If identity classification (given clearly discriminable values) is assumed to be non-integrative, both early and late in hologeneis, and interference suppressing, and expression classification follows an integrative strategy, masking the stimuli might function to increase the asymmetric interference obtained. In addition, the gaze-direction - expression contrast did not find cross-dimensional interaction in the presence of stimulus-specific differences, and it would be interesting to find out if the consistent cross-condition effects observed are susceptible to early Stroop-like mechanisms. If we are in fact 'tuned' to pick up threatening expressions from faces looking at us, then a time-sensitive attentional design like that used by van Leeuwen and Bakker (1995) might reveal an early advantage for aversive faces and a later advantage for attractive ones.

Overview

In summary then, if the Garner paradigm is to be used with faces, the major constraints of discriminability, set size, and practice need to be taken into account during preliminary testing and throughout the main experiments. It is also useful to have in mind a model of attention that does not rely on oppositional notions of preattentional (mandatory) vs. strategic processes and pre- and post-semantic integration, but to engage with a model that emphasises the production of interference as the outcome of changing integrative processes through time. In this way, a more accurate picture of the timing of dimensional interaction may remove the need to establish the status of intradimensional vs. cross-dimensional interaction. The next

chapter sets the Garner paradigm to one side, but continues to explore the idea that we may have different responses to angry aversive expressions compared with happy attractive ones. A unidirectional method is chosen therefore in which our exposure to these expressions is contrived to be incidental to the task set the participant, and an investigation into the relationship our exposure to emotional expressions might have with our perception of time is initiated.

7

Expression and time

My interest in this chapter is not in the finely honed consideration of interference in relation to a changing profile of attention discussed in the last chapter, but in exploring how our reaction to an emotional expression seems to slow down or speed up our sense of time passing. In particular, is there any evidence to suggest that the aversive response we have to an angry face that showed up in the previous studies on gaze, affects our time perception?

Our ability to estimate intervals of time is helped by many factors both internal and external to us. Feeling hungry means it must be a few hours since we ate, day night periodicity orients us to 24 hour intervals, how much we manage to achieve divides morning from afternoon, and so on. Some of us also look at our watches! However, it is possible to experience instances of when subjective time seems not to relate to clock time. Time seems to spin out longer if we see an accident about to happen: Holidays pass in a moment. Experimental psychologists have targeted time as reflecting mental processes and the reaction time measure is ubiquitous in laboratory experiments. There is also evidence, for example, that time-defined electrophysiological indices of cognitive operations such as event-related potentials (e.g., the P3 or P300 waveform

that occurs around 300 ms after the presentation of a stimulus), may be influenced by the personal relevance and affective nature of stimuli (e.g., Erhan, Borod, Tenke, and Bruder, 1998; Johnson, 1986). The development of some of our thinking about the significance of time in relation to mental processes, and possible connections with affect, are outlined below.

Critical time periods for the integration of information

If the mind is modelled as a collection of more or less independent and dissociable processors that can either be revealed as such through neurological impairment, brain scans, or even through the set of a laboratory task, how is it that we perceive the world as integrated? We may prioritise some types of information over others at any one moment, nevertheless, our phenomenal experience of a familiar friend, for example, is not as fragmented as scientific and psychological evidence suggests it could be. Some scientists have conceptualised our awareness of the world as coherent and of ourselves as an integrated part of it, as consciousness. At some point in time, the products of those systems we have identified as functionally modular require coordination, thus enabling integrated actions and thoughts. Scientists working on understanding the nature of consciousness have called this process the 'binding problem' (Crick and Koch, 1990).

The study of reaction time and the application of this paradigm to the chronometric description of thought or decision processes goes back to Donders (1868/1969) who posed the question "What happens in the brain during the processes of sensation, reason and will?" (p. 413). He was inspired by the measurement of electrical impulses along the nerves. This achievement was, he notes, the result of the theoretical prediction that, as the transmission of a nervous impulse was likely to be chemical and electrical in nature, it was not likely to be so fast it could not be measured. His studies of how long it took to respond to stimuli such as vowel sounds and symbols were based on the premise that this would also be true for the duration of thought. He concluded that the

"development of a conception" (p. 425) which was the difference between the time taken to make a response to a known sound and the longer time required to respond to one of two unknown sounds, took just over 39 ms.

Crick and Koch (1990) suggest that there is an attentional mechanism that synchronises the spikes of responding neurons in the visual cortex at around 40 Hz (see also Gray, König, Engel, and Singer, 1989) so that they oscillate together and join the information into a coherent percept. This approach to attention is in tune with the ideas of van Leeuwen and Bakker (1995) advocated in the previous chapter. Pöppel (1994), writing of the concept of consciousness, argues that it is useful to distinguish between two levels of temporal binding. He argues as well for a temporally significant window of 30-40 ms (backed up by psychophysical data) and, in addition, for one of 3 s (based in part on studies of short term memory capacity). The first of these binding operations is seen as operating on three levels. The primary level is presumed to be presemantic and automatic. Binding proceeds in windows of accessibility approximately 30 ms apart, and accomplishes the binding of "identical features within one sensory modality" (p. 186), possibly by the means of synchronous oscillations. Secondary and tertiary levels deal respectively with the semantic properties of objects, and intersensory binding. This preliminary linking of spatially distributed activities provides a framework for the binding process of approximately 3 s duration which connects successive events.

Three orders of duration were identified by Fraisse (1984) within which, he claims, processing is qualitatively different: an interval of less than 100 ms, at which there is a perception of instantaneity; 100 ms -5 s, during which perception is in the perceived present; greater than 5 s, when the estimation of duration involves memory. Fraisse also makes a distinction between the perception of duration which involves the psychological present and the estimation of duration when memory is used to link two events, one or both of which occur in the past.

The estimation of intervals

Curiosity about the perception and estimation of time is given impetus by these links of significant intervals with awareness. Time estimation tasks dealing with a wide range of intervals have been shown sensitive to task demands with outcomes often dependent on attention. Zakay (1993) summarises the main factors influencing our performance of time estimation tasks. They are as follows: the method of estimation, for example whether the participant gives a verbal estimate *or* reproduces the interval *or* makes a comparative judgement; duration of the interval; the task to be performed during the interval and the information load on the participant; whether the participant knows before the start of the target interval that the task is one of time estimation (prospective time estimation) *or* they don't know until after the interval that an estimate is required (retrospective time estimation); whether or not the estimate is requested immediately after the target interval or after some delay.

The literature on time estimation contains many contradictions, which is not surprising given so many qualifying factors (see Allan, 1979, for a review). There have been two main cognitive approaches taken to understanding how we estimate time intervals. The memory approach (e.g., Poynter, 1983) explains our tendency to report filled (cf. unfilled) intervals as longer on the grounds that there are more psychological markers available to the participant. These markers generate referents in memory with which to reconstruct the time period. The more things change, the longer we think the interval lasts. The attentional approach (e.g., Thomas and Weaver, 1975) proposes that a (functional) cognitive timer exists which counts off time units. Stimulus processing and the timer both require resources and the more difficult a task is, fewer resources are available to dedicate to the timer, so more difficult tasks are estimated as shorter. Most studies have used neutral stimuli such as coloured lights or auditory tones. Treisman and his colleagues (1963; Treisman, Faulkner, Naish, and Brogan, 1990) propose an additional notion as to how we perceive time. The suggestion is that there is an internal

clock that generates output pulses. These may change depending on the specific state of arousal of the pacemaker which can be altered by external inputs (for recent applications of Treisman's ideas see Gibbon, Malapani, Dale and Gallistel, 1997; Meck, 1996).

Emotional state and the integration of information

Andreassi (1989) presents evidence supporting the claim that strong and excited emotions such as fear, rage, and anxiety are associated with an electroencephalogram (EEG) pattern that is desynchronised. This wave form is of low to medium amplitude and made up of fast mixed frequencies and associated with a state of restricted awareness that is diffuse, hazy, and confused such as when attention is divided. It is, in terms of efficiency of information processing, very poor and disorganised, showing a lack of control with a tendency to freeze up. Happy and neutral emotions correspond more to an alert attentiveness and relaxed wakefulness. Partially synchronised, mainly fast low-amplitude waves containing more alpha (8 - 12 Hz) rhythm, are associated with this state. The latter EEG pattern is also associated with selective attention, concentration and anticipation, and efficient, selective, quick reactions that are organised for serial responses.

Different coloured lights also affect the degree to which our EEG is synchronised. Ali (1972) found that the cortical habituation response to red and blue lights differed. After exposure to blue light participants' alpha recovery was greater than after exposure to red. Further to this, Ali (1973) found that when Ps were asked to estimate the duration of a light that was on for 60 seconds, if the light was red the mean was 58.52 seconds, significantly longer than if the light was blue, 47.50 seconds. Time appeared to pass more quickly when the red light was on.

There is evidence that other psychophysiological measures may be distinctive for different emotional states. For example, Winton, Putnam, and Krauss (1984) measured

heart rate (HR) and skin conductance (SCR) while participants looked at slides that had been previously judged to be pleasant, unpleasant, unusual, scenic, or sexual. They asked Ps to rate each stimulus on a pleasant-unpleasant dimension. Judgements of facial expression pleasantness and intensity were also made by raters who looked at videotapes of Ps responding to the stimuli. HR increased monotonically with self-ratings of pleasantness of affect and the judges' ratings of facial pleasantness. SCR, in contrast, was highest at extremes of the pleasant-unpleasant scale as were judges' ratings of intensity. SCR was lowest with neutral stimuli. Winton et al. make the point that the facial and autonomic manifestations of emotion are likely to have different profiles for at least positive and negative emotions. This conclusion is in agreement with Ekman, Levenson, and Friesen's (1983) more specific findings for directed facial muscle contraction and remembered emotional experience, which had different effects on measures of HR and skin temperature change, depending upon which expression and which emotion was generated.

If an analogy may be made between the more desynchronised pattern produced by red light and that produced by fear, rage and anxiety and a similar analogy made between the blue light effect on alpha recovery and a pleasant emotional state, then the following prediction may be made. Our subjective experience of stimuli that elicit anger or fear (even given there may be emotion-specific differences) is that they will last longer than those stimuli we experience as pleasant.

Emotional stimuli and time estimation

Studies that have been concerned directly with the effects of emotional stimuli on time estimation are few. An early example is that of Thayer and Schiff (1975), mentioned in Chapter 5, who measured responses to an actual person revealed at the start of the experiment from behind a curtain. They were concerned with the effect of eye contact and expression on female participants. In a control condition participants simply waited for a 12 s interval to pass. They then reproduced this interval using a

stop watch. After exposure to either a male or female confederate, smiling or scowling and maintaining eye contact for 12 s, they once again reproduced the time interval. Thayer and Schiff found that female-female eye contact with an angry expression resulted in reproduced intervals that were longer compared with when the confederate was smiling. Thayer and Schiff also attempted to prevent participants from counting. While participants may have complied, it is difficult to see how else they would have attempted to accomplish the task.

A more contemporary example of a study investigating the relationship between time and affect is that of Angrilli, Cherubini, Pavese, and Manfredini (1997) who looked at estimates to colour photographs from the International Affective Picture System (IAPS; Centre for the Study of Emotion and Attention) over intervals of 2, 4, and 6 s. Use of the IAPS set allowed the systematic control of affective valence and arousal. No main effect of either valence or arousal was found but they did find an interaction between valence and arousal. For low-arousal stimuli, negative slides lasted less time than positive slides and for high-arousal stimuli, negative slides lasted longer than positive slides. Angrilli et al. invoke two different motivational systems controlled by the level of arousal, one emotional, the other attentional. Thayer and Schiff and Angrilli et al. both used prospective time estimation tasks.

Experiment 12

The first experiment in this chapter on the possible effect of emotional expression on time estimation asks whether the perceived duration of an angry facial expression is overestimated relative to that of a happy expression. Participants are asked to estimate a 10 s interval while viewing each stimulus. The beginning of the interval is when the stimulus appears and the end of the interval is signalled by the P pressing the space bar, at which point the stimulus disappears. This is a modification of Thayer and Schiff's

(1975) method as participants are not asked to reproduce intervals after they have finished viewing the stimuli but to undertake time estimation *concurrent* with viewing the stimulus. They are also not 'prevented' from counting. If angry expressions are experienced as lasting longer, the 10 s estimates made will be *shorter* in clock time as Ps will be counting more rapidly and reach 10 s sooner while viewing these expressions. This is consistent with the observation that, if stimuli were on equal amounts of time (as for Thayer and Schiff) and the P has to estimate how long each was displayed, then Ps counting more rapidly would estimate more clock time as passing when viewing an angry face. Shorter 10 s intervals when viewing angry faces (cf. happy faces) are therefore expected using the method here.

Method

Participants

Thirty-two undergraduate psychology students (16 Male, 16 Female) volunteered and each was paid for their participation.

Stimuli and apparatus

Male and female angry, happy and neutral expressions were used from the Jenkins (1997) face set of expressions. (This experiment was set up before the collection of my own database and Jenny Jenkins very kindly agreed to let me use her stimuli.) Angry and happy expressions achieved recognition agreement of 100% as angry or happy. Mid-grey rectangles, the same size as each face, were included. Stimuli were presented using "SuperLab" software on a light background on a Macintosh Quadra 800. Stimulus size measured 16.6 x 15.0 cm which subtended an angle of 15.8° horizontally and 14.3° vertically at a viewing distance of 0.6 m.

Design

A mixed 2 x 8 design was used with the between-subjects variable of sex of participant or Psex (M, F), and the within-subjects variable of stimulus type at 8 levels

(male and female angry faces, ma and fa; male and female happy faces, mh and fh; male and female neutral faces; and two identical sets of grey rectangles). Note that not all items were included in the analysis as neutral faces and grey rectangles were included as foils to try and prevent Ps forming hypotheses about what the experiment was about. The dependent measure was the clock time taken for the participant to estimate 10 seconds.

Procedure

Instructions to Ps were as follows: "You will see a stimulus (either a face or a grey rectangle) come up in the centre of the screen. Your task is to press the space bar when you think the stimulus has been on the screen for 10 seconds." Each stimulus item was repeated 6 times. As pilot studies had revealed large order effects (see also Rose and Summers, 1995), with time passing more rapidly at the beginning of a sequence, the stimuli were ordered as follows: Eight MPs and 8 FPs saw the first block of 8 items Latin square ordered, the next 16 items (2 of each stimulus) ordered randomly; the next 8 reverse Latin square ordered and the last 16 again ordered randomly. For the other 8 MPs and 8 FPs the places of the Latin square ordered stimuli and the reverse Latin square ordered stimuli were exchanged. Thus, there were a total of 16 sequences ordered differently, and each was seen by 2 Ps (1 M and 1 F).

Results

Mean estimates in seconds and standard deviations for angry, happy, and neutral faces were as follows: 12.6 (3.7); 12.7 (3.7); 12.6 (3.7). Mean estimates to grey rectangles were 12.5 (3.7) seconds. These means can be seen to be very similar to each other, however, as the comparisons of interest were those between the sex of the participant, the sex of the stimulus, and angry and happy expressions, a 2 x 2 x 2 ANOVA including these variables was carried out. A significant interaction between Psex and the stimulus expression was revealed, $F(1, 30) = 4.45$, $p = .04$, (see Figure 44). A simple main effects analysis indicated that there was an effect of Psex for angry,

(F(1, 60) = 108.52, p < .0001), and for happy expressions, (F(1, 60) = 38.26, p < .0001). There was also an effect of expression on FPs (F(1, 60) = 8.34, p = .005). Male estimates of angry and happy expressions were not significantly different from each other. Female Ps counted faster (reached 10 s sooner) than men, for both angry and happy expressions, and counted faster still when angry rather than happy expressions were displayed. The three-way interaction was not significant (p = .8).

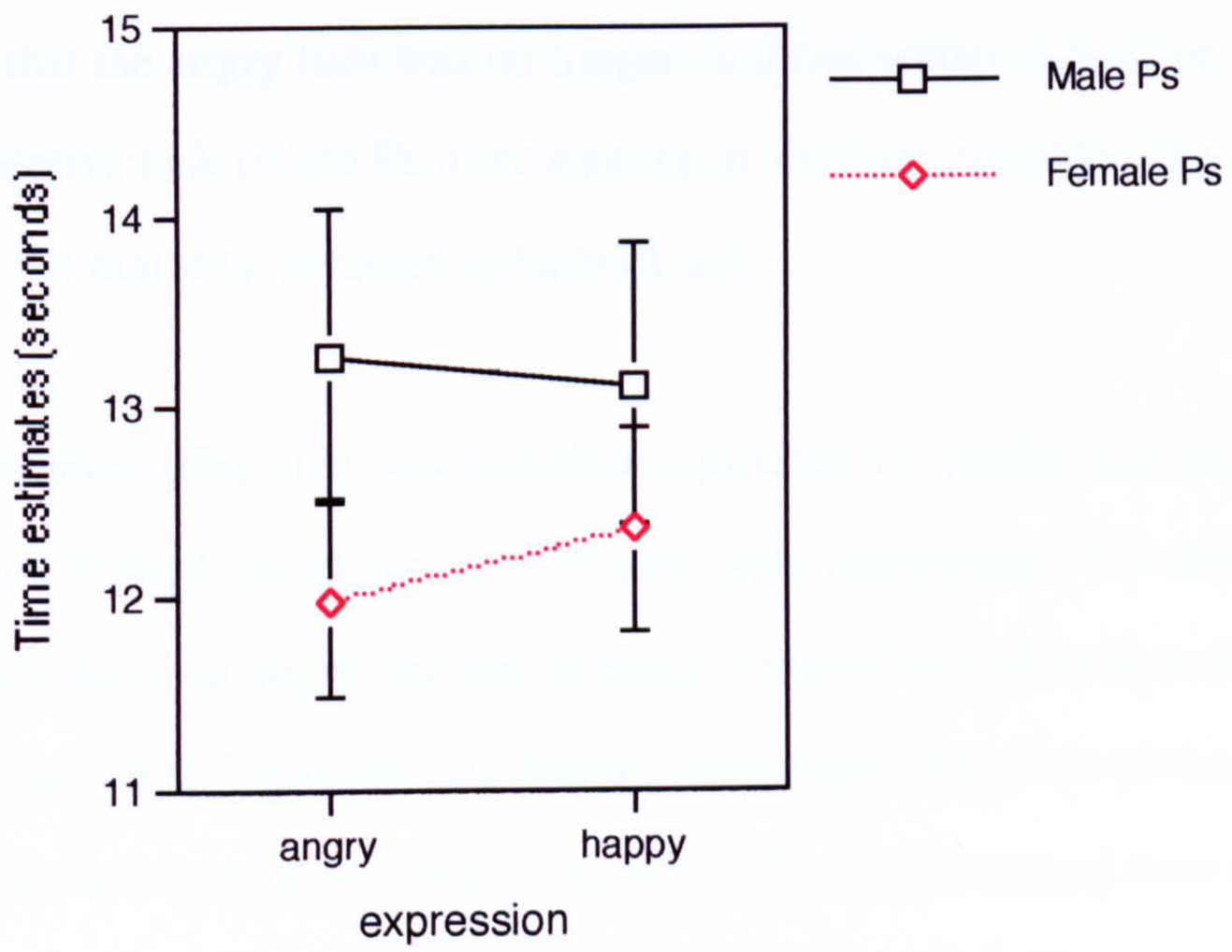

Figure 44. Experiment 12. Mean estimates of 10 s intervals for Male and Female Ps while viewing angry and happy faces.

Discussion

The finding that Female participants think a 10 s interval is shorter when viewing angry faces (i.e., overestimate the amount of time the faces are on for) is in partial agreement with Thayer and Schiff (1975). No evidence was found for an interaction of participant sex with the sex of the stimulus face. It was decided to test intervals of a different length to see over what time period this finding might hold.

Prior to setting up the next reported experiment (Exp. 13) an additional experiment was carried out using a 22 s interval (after Zakay, 1993). Prospective and retrospective estimates to male and female angry and happy expressions were compared for Male

and Female Ps. Participants saw only two faces, one male (angry or happy) and one female (happy or angry), and both were displayed for 22 s. They were asked which face was on longer and how long each was on for. The results offered support for complex sex and expression interactions similar to those found by Thayer and Schiff (1975). However, an overriding difficulty with this length of interval was that Ps had plenty of time to form ideas about what the experiment was about. For the prospective task (when they knew the experiment was about time) some said that they thought they were supposed to think that the angry face was on longer, and had compensated for this. During the retrospective task (when Ps were looking at the faces not knowing what was expected of them) the majority expected a memory test.

The next experiment (Exp. 13) was intended to proceed so rapidly that participants would not have time to think about how or why they were responding. The difference in duration judgements between angry and happy faces is therefore explored at time intervals of the order of milliseconds. There are two further advantages. The first of these is that shorter time intervals are seen as approximating more closely the natural time course of a response to an emotional expression. Estimates of the timing of an affective response range from immediate to 2 - 3 seconds (e.g., Rosenthal, 1982). Morris et al. (1996), in an MRI study detected differential activity within 3 second exposure times for responses to static fearful and happy expressions. The second advantage is that very short exposure durations should be sufficient to have an effect given what we know about critical time periods for the integration of information (Crick and Koch, 1993; Donders, 1868/ 1969; Pöppel, 1994). Scherer (1994) also suggests that the effect of an emotional stimulus on the viewer, is likely to be almost immediate, if the function of emotions is to decouple the stimulus and response to allow flexible responding. Indeed, Kunst-Wilson and Zajonc (1980) present evidence that indicates preferences are formed at very short exposure times (1 - 3 ms). The idea that there may be an immediate automatic component to an emotional response, with a longer period of appraisal when priorities are, if necessary, reordered in the light of incoming information, was introduced in Chapter 1. Also consistent with this

view of expression processing is van Leeuwen and Bakker's (1995) concept of early attentional influences during visual processing that are affected by the further integration of information that was introduced in Chapter 6.

In his review of the time perception literature, Fraisse (1984) discusses evidence that the threshold for determining when one stimulus is succeeding another is as little as 20 ms. Hence, intervals between the 20 - 100 ms range, were tested for the effect of expression on judgements of stimulus duration. A version of the technique used by Hughes, Lishman, and Parker (1992), who were interested in the apparent duration of high- and low-pass filtered images, was used to determine whether the apparent duration of an angry expression was judged to be longer than that of a happy expression. Hughes et al. used probe exposure times of 20, 40, 60, or 80 ms that Ps compared with a 40 ms standard. Ps were asked to say which of the pair appeared to have the longer duration. An additional interval of 100 ms is included in the present experiment and the standard used is 60 ms. Also, although equal numbers of Male and Female Ps were tested, angry and happy faces of one male actor only were chosen as stimuli. As in the Hughes et al. experiments, Ps were asked to say which of a pair of stimuli presented sequentially appeared to have the longer duration. It is predicted that when the angry expression is compared with the happy expression the P will make more 'longer' judgements to the angry expression.

Experiment 13

Detailed predictions for this experiment are that when the second face is angry, fewer longer judgements will be made to the happy compared with the angry first face, and when the second face is happy, more longer judgements will be made to the angry compared with the happy first face. This may only apply to Female participants.

Method

Participants

Fifty Open University students (25 Males with a mean age of 36.6 (SD = 7.8) years; 25 Females with a mean age of 36.1 (SD = 10.2) years) volunteered to take part.

Design

A 2 x 5 x 2 within-subjects design with type of first stimulus at 2 levels (angry, happy), presentation time of the first stimulus at 5 levels (20, 40, 60, 80, and 100 ms), and type of second stimulus also at 2 levels (angry, happy). The second stimulus was always shown for 60 ms. The dependent variable was the number of longer judgements made to the first stimulus. (Note that due to the screen refresh rate, the absolute values of these display times are unlikely to be accurate. Some indication is therefore required that participants can make comparative judgements at levels well above chance and calibrate to the task. This is demonstrated in the results section that follows.)

Stimuli

Happy and angry expressions were chosen from one male actor (Face No. 27, see Figure 45). The expressions had rated arousal levels of 6.9 (happy) and 7.1 (angry), and rated pleasure levels of 7.3 (happy) and 0.8 (angry). These faces were both high on arousal and contrasted clearly on valence. Note that recognition agreement of 100% as happy and angry was achieved for these two expressions (Chapter 2, Table 1). Mean pixel grey-levels (brightness) were 172 (SD = 60) for the happy expression and 175 (SD = 55) for the angry expression.

Figure 45. Stimuli for Experiment 13. Left: happy; Right: angry. Face No. 27.

Procedure

The instructions, which were read from the screen by the participant prior to the task, were as follows: "You will see pairs of faces sometimes showing different expressions. Try to ignore the expressions while you do the task below. In each pair the faces are presented sequentially, that is, one after the other. Your task is to judge which face from each pair is on the screen longest. Press the 'z' key for the first image on longest and the '.' (full stop) key for the second image on longest."

Each trial was made up as follows: 1000 ms blank screen; the first stimulus of the pair (which was presented for a variable amount of time: 20, 40, 60, 80, or 100 ms); a blank period of 1000 ms; the second stimulus of the pair (always 60 ms). Twelve practice trials, made up of happy and angry expressions first, each for 100, 60, and 20 ms, with 60 ms happy and angry expressions following, preceded the experimental trials. All possible stimulus pair combinations were viewed and each pair was seen 5 times. Stimulus pairs were arranged in blocks of 20 and presented randomly within these blocks to make up a total of 100 experimental trials. The experiment took approximately 8 minutes.

Results

Mean values for the number of 'longer' judgements to both angry and happy first stimuli when the second stimuli were either angry or happy are shown in Table 3 below.

A 2 x 5 x 2 ANOVA with type of first stimulus at 2 levels (angry, happy), presentation time of the first stimulus at 5 levels (20, 40, 60, 80, and 100 ms), and type of second stimulus also at 2 levels (Angry, Happy) showed a main effect of presentation time, $F(4, 196) = 81.2, p < .0001$, which indicated some degree of calibration to the task. Longer judgements made to the first stimulus when the first and second stimuli were both 60 ms achieved an overall mean value of 2.61 ($SD = 1.08$) indicating the expected bias in favour of making longer judgements to the first stimulus. A value of 2.5 would indicate no bias. There was also a main effect of the second stimulus, $F(1,49) = 4.1, p = .05$, with

more longer judgements being attributed to the first stimulus when the second stimulus expression was happy. Although less longer judgements were made to the first stimulus in happy - angry pairs ($M = 2.19$, $SD = 1.3$), and more longer judgements were made to the first stimulus in angry - happy pairs ($M = 2.36$, $SD = 1.4$), the interaction between first and second stimuli was not significant ($p = .2$). Note that when judgements to these pairs are compared, all differences are in the predicted direction (1.08 cf. 1.10 at 20 ms, 1.54 cf. 1.74 at 40 ms, etc.).

Table 3. Means at all presentation times for the number of longer judgements made to angry and happy first stimuli when second stimuli are Angry or Happy. (Max. score = 5)

First stim.	Second stim.	First stimulus presentation time (ms)					
		20	40	60	80	100	*M*
angry	Angry (60 ms)	1.28	1.70	2.46	3.00	3.14	2.32
	Happy (60 ms)	1.10	1.74	2.58	3.10	3.30	2.36
M		1.19	1.72	2.52	3.05	3.22	2.34
happy	Angry (60 ms)	1.08	1.54	2.54	2.78	3.00	2.19
	Happy (60 ms)	0.92	1.76	2.84	3.02	3.44	2.40
M		1.00	1.65	2.69	2.90	3.22	2.29

To check differences between Male and Female Ps, a further 2 x 2 x 2 ANOVA was carried out with Psex, type of first stimulus, and type of second stimulus as variables. The main effect of the second stimulus was confirmed, $F(1, 48) = 4.06$, $p = .05$, with slightly more longer judgements made to the first stimulus when the second was happy ($M = 2.25$, $SD = .60$, cf. 2.38, $SD = .58$). This was however, further modified by a significant three-way interaction, $F(1, 48) = 5.73$, $p = .02$. This interaction is represented graphically in Figure 46. Responses by Male Ps (left panel) showed no difference between angry and

happy first faces when the second stimulus was angry, with a tendency to make longer judgements to angry compared with happy first faces when the second stimulus was happy. This is in the direction of the prediction. For Female Ps, more longer judgements were made to the angry compared with the happy first face when the second stimulus was angry. It was as if they were ignoring the happy face: This is also in the direction of the prediction. However, Female Ps made fewer longer judgements to angry faces compared with happy faces presented first when the second stimulus was happy: This is against the prediction. But, the response to angry first faces when the second face was happy is no different to that when the second face was angry, with the difference showing when both faces were happy.

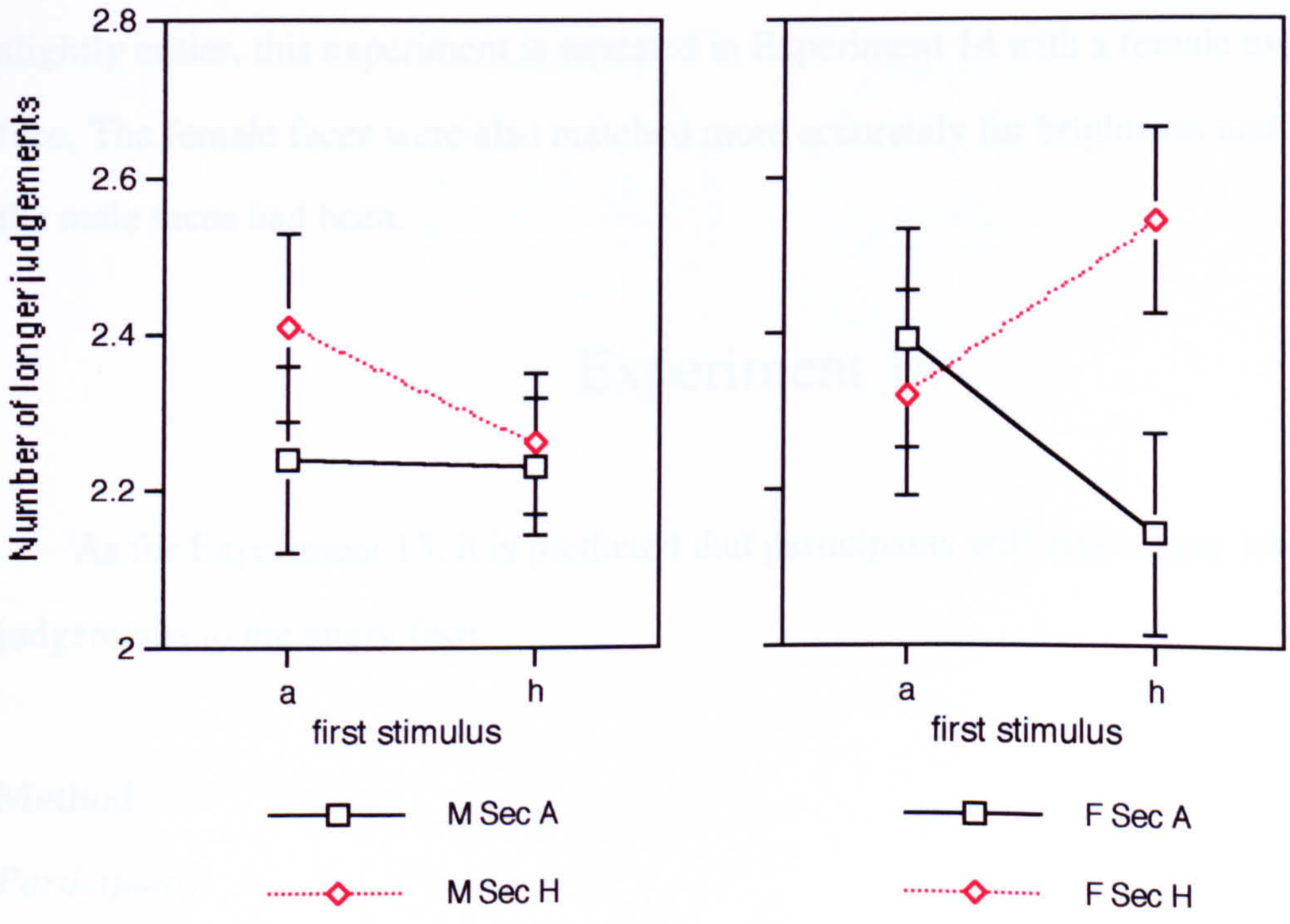

Figure 46. Experiment 13. Mean number of longer judgements to angry (a) and happy (h) first stimuli when second stimuli are angry (secA) and happy (secH). Left panel: Male (M) Ps. Right panel: Female (F) Ps. Vertical bars represent standard errors of the means.

Discussion

When the second stimulus was happy significantly more longer judgements were attributed to the first stimulus. (Conversely, when the second stimulus was angry, more longer judgements were attributed to the second stimulus.) These results provide further

support for the idea that the apparent duration of an angry expression is longer than that of a happy one at brief durations. The effect however is very slight when the total participant sample is considered and a large number of participants were used in this within-subjects design for this to show. Female Ps have a different pattern of responding than Males in that a happy first face was afforded more longer estimations when paired with a happy second stimulus. This may indicate the reinstatement of the primacy response to the first stimulus as being on for longer when both are happy, though why this is different for Females compared with Males is a puzzle. It was decided to see what responses would be made to a female expressive face in the next experiment.

With adjustments to the time intervals used so that the discrimination task became slightly easier, this experiment is repeated in Experiment 14 with a female expressive face. The female faces were also matched more accurately for brightness and contrast than the male faces had been.

Experiment 14

As for Experiment 13, it is predicted that participants will make more longer judgements to the angry face.

Method

Participants

Twenty-five students (7 Males with a mean age of 21.6 (SD = 2.2) years; 18 Females with a mean age of 23.2 (SD = 5) years) volunteered to take part. Note that this sample did not contain equal numbers of Male and Female participants.

Design

A 2 x 5 x 2 within-subjects design with type of first stimulus at 2 levels (angry, happy), presentation time of the first stimulus at 5 levels (50, 80, 110, 140, and 170 ms),

and type of second stimulus also at 2 levels (angry, happy). The second stimulus was always shown for 110 ms. The dependent variable was the number of longer judgements made to the first stimulus.

Stimuli

Happy and angry expressions were chosen from one female actor (see Figure 47). The expressions had arousal levels of 5.7 (happy) cf. 8.6 (angry), and differed clearly on rated valence with rated pleasure values of 7.4 (happy) cf. 0.3 (angry). There was 100% recognition agreement of these expressions as happy and angry. Mean pixel grey - levels (brightness) were 171 ($SD = 61$) for the happy expression and 171 ($SD = 60$) for the angry expression.

Figure 47. Stimuli for Experiment 14. Left: happy; Right: angry. Face No. 9.

Procedure

As for Experiment 13.

Results

Mean values for the number of longer judgements to both angry and happy first stimuli when the second stimuli were either happy or angry are shown in Table 4. A 2 x 5 x 2 ANOVA showed a main effect of presentation time, $F(4, 96) = 74.69$, $p < .0001$ which again indicated that Ps were reasonably accurate at the task. An overall mean value of 2.82 ($SD = 1.3$) longer judgements was made to the first stimulus when the first and second stimuli were both 110 ms indicating a bias in favour of making longer judgements

to the first stimulus. A value of 2.5 would indicate no bias. There was also a main effect of second stimulus, $F(1, 24) = 9.53$, $p = .005$, with more longer judgements being attributed to the first stimulus when the second stimulus expression was angry. If angry - happy pairs are compared with happy - angry pairs, it can be seen that in every case the comparisons go *against* the prediction (0.8 cf. 1.32, 1.36 cf. 1.80, etc.). This effect of the second stimulus was modified by an interaction between the first and second stimuli, $F(1, 24) = 12.03$, $p = .002$, such that for angry - happy pairs, fewer longer judgements to the first stimulus were made compared with any other pairs. This interaction is represented graphically at Figure 48. In summary, the happy expression was thought to last longer, and when angry - happy pairs were presented in this order, and it was as if angry expressions were being ignored. (When Male Ps were excluded from this analysis both the main effect of the second stimulus ($p = .009$), and the interaction ($p = .006$) remained significant.)

Table 4. Means at all presentation times for the number of longer judgements made to angry and happy first stimuli when second stimuli are Angry or Happy. (Max. score = 5)

First stim.	Second stim.	First stimulus presentation time (ms)					
		50	80	110	140	170	*M*
angry	Angry (110 ms)	1.36	2.04	2.96	3.76	4.28	2.88
	Happy (110 ms)	0.80	1.36	2.08	3.20	3.64	2.22
M		1.08	1.70	2.52	3.48	3.96	2.55
happy	Angry (110 ms)	1.32	1.80	3.08	3.68	4.12	2.80
	Happy (110 ms)	0.80	1.84	3.16	3.76	4.16	2.74
M		1.06	1.82	3.12	3.72	4.11	2.77

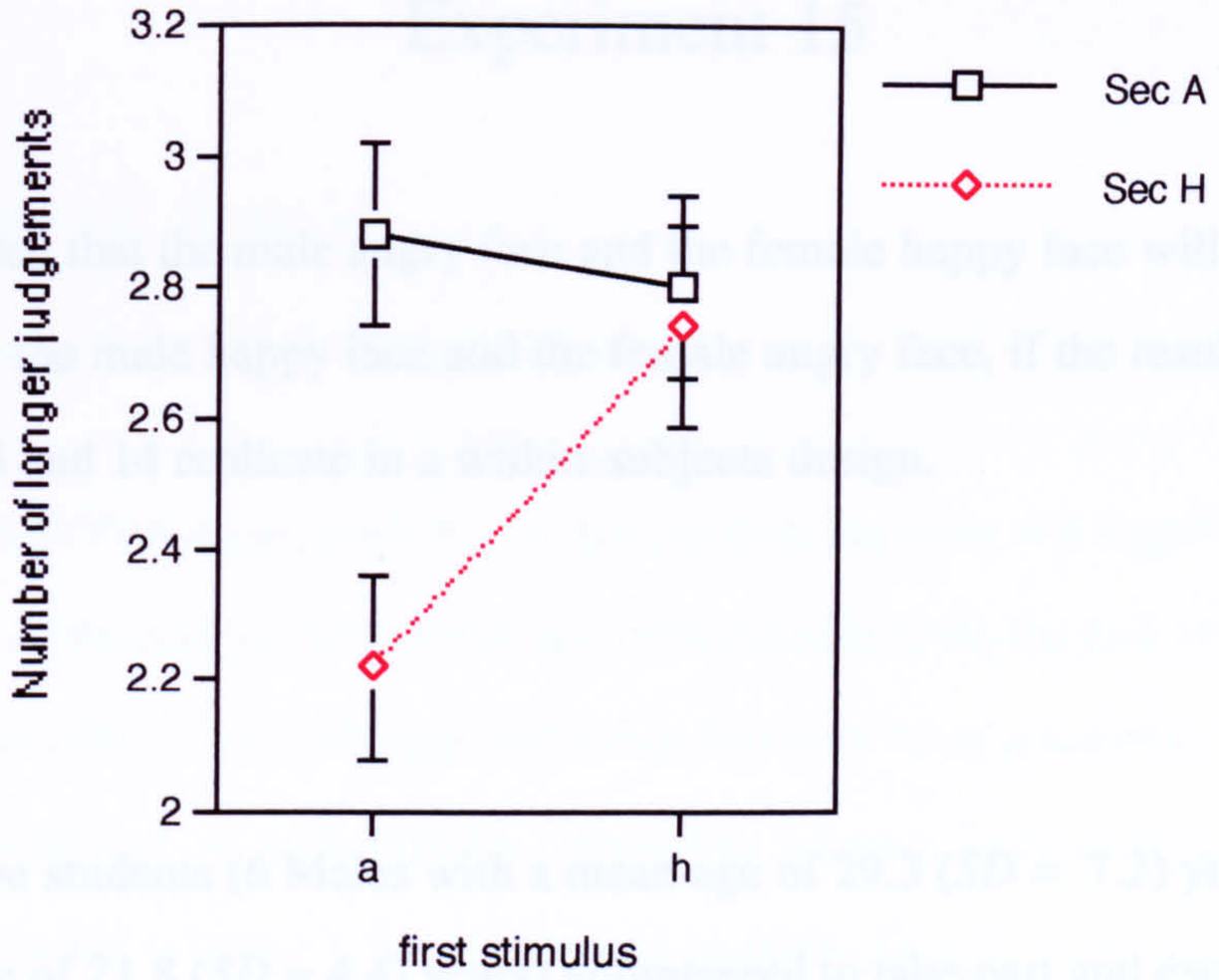

Figure 48. Experiment 14. Mean number of longer judgements to angry (a) and happy (h) first stimuli when second stimuli are angry (secA) and happy (secH). Vertical bars represent standard errors of the means.

Discussion

The female happy face was accorded more longer judgements in this study indicating that the findings of the previous experiment did not generalise. Whether or not an angry expression appears to last longer than a happy one depends on what face it is and may depend on the sex of the sender.

The next experiment is to check that the effects found for these two faces replicate in a within-subjects design. The design is therefore modified to include both faces and the participants are volunteers from the younger Stirling University population (as in Experiment 14) compared with the slightly older Open University population (as in Experiment 13).

Experiment 15

It is expected that the male angry face and the female happy face will be judged to last longer than the male happy face and the female angry face, if the results of Experiments 13 and 14 replicate in a within-subjects design.

Method

Participants

Twenty-five students (6 Males with a mean age of 29.3 (SD = 7.2) years; 19 Females with a mean age of 21.8 (SD = 4.4) years) volunteered to take part and each was paid for their participation. Note that this sample did not contain equal numbers of Male and Female participants.

Design

There were five independent variables in this 2 x 2 x 2 x 2 x 5 within-subjects design; Type of first stimulus face (Angry, Happy), Sex of first stimulus face (Female, Male), type of second stimulus face (angry, happy), sex of the second stimulus face (male, female), and duration of the first stimulus at 5 levels (50, 80, 110, 140, and 170 ms). The second stimulus was always shown for 110 ms. The dependent variable was the number of longer judgements made to the first stimulus.

Stimuli

Stimuli were as shown in Experiments 13 and 14 with the additional small modification of making the brightness and contrast levels of all stimuli equivalent. Each stimulus was seen compared with every other stimulus at all five levels of duration four times in all (that is, the maximum score for any category of discrimination was 4). The midpoint is therefore 2.0 in this experiment compared with 2.5 in Experiments 13 and 14. This was done to keep the time it took to complete the experiment to less than 30 minutes.

Procedure

As for Experiments 13 and 14.

Results

A one-way ANOVA with Level as the independent variable was significant, $F(4, 96) = 70.52$, $p < .0001$, and demonstrated that Ps were able to do the task at levels much greater than chance (even though they often felt they were guessing). A 2 x 2 x 2 x 2 ANOVA was carried out with variables named as follows: Type of first stimulus face (A = Angry and H = Happy); Sex of the first stimulus face (F = female and M = Male); Type of second stimulus face (a = angry and h = happy); sex of second stimulus face (f = female and m = male). This revealed a significant two-way interaction between the expression and sex of the second stimulus face, $F(1, 24) = 13.74$, $p = .001$. This interaction is represented graphically at Figure 49. (When Male Ps were excluded from this analysis the interaction between the expression and sex of the second stimulus face was significant at the level of $p = .002$).

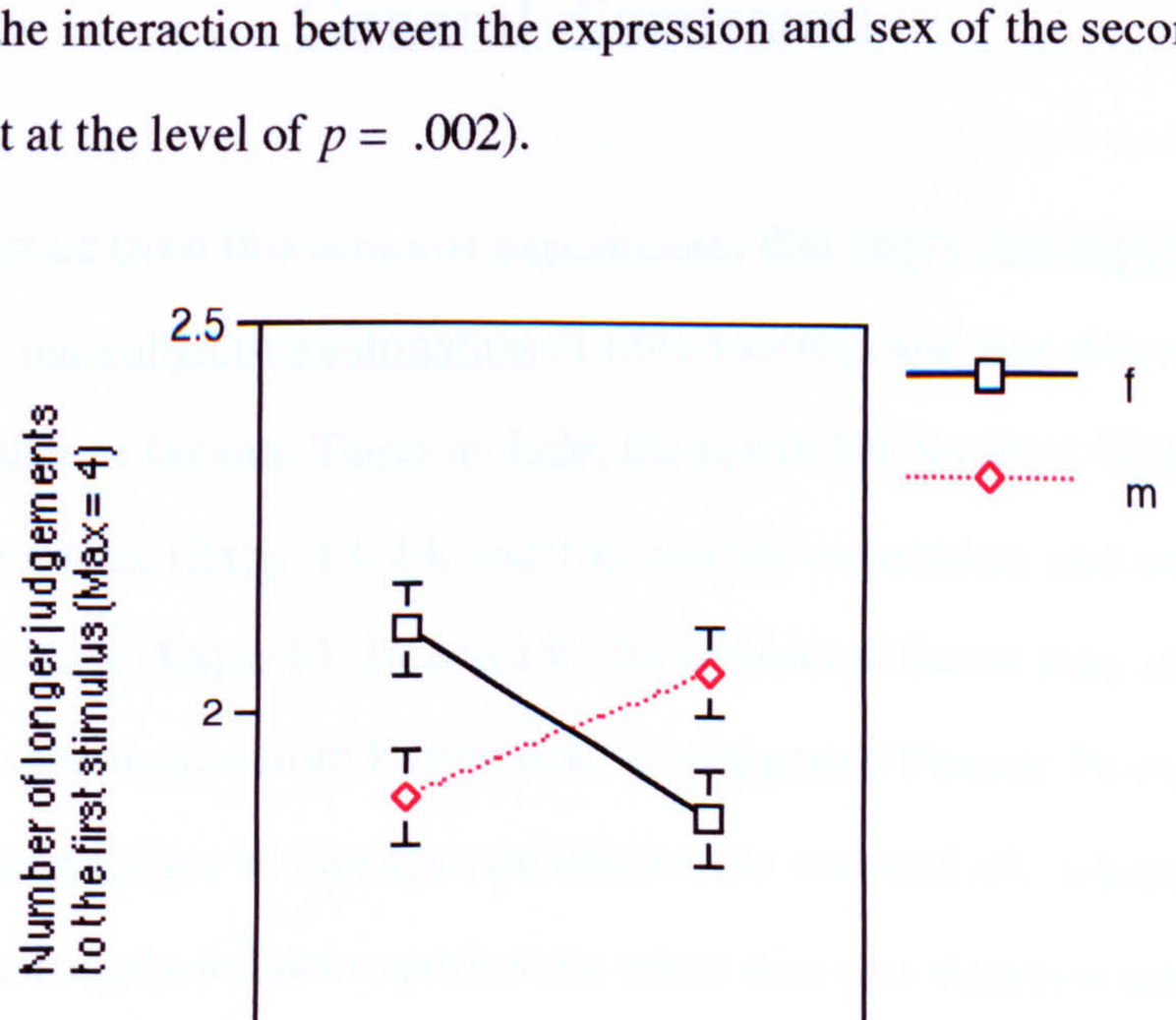

Figure 49. Experiment 15. Mean number of longer judgements to the first stimulus face varies with the expression and sex of the second stimulus face.

This replicates the findings of the previous experiments (13 and 14).

Discussion

The finding that the perception of the duration of the stimulus seen first varies according to the expression and sex of the stimulus seen second appears to be robust for these two faces and for Female Ps. If an angry male face is seen second, then fewer longer judgements are made to faces that appear beforehand compared with when an angry female face is seen second (i.e., the male angry face is attended to preferentially and the female angry face is avoided). If a happy male face is seen second, then more longer judgements are made to faces that appear beforehand compared with when a happy female face is seen second (i.e., the male happy face is ignored and the female happy face is attended to, or, as above, the male angry face is attended to and the female angry face is avoided).

General discussion

There is evidence from this series of experiments that angry and happy expressions may indeed affect our subjective estimation of time passing, and that this effect is sensitive to a number of factors. These include, the sex of the receiver (Exps. 12 and 13), the sex of the sender (Exps. 13, 14, and 15), and the expression and order in which the sender's face is seen (Exps. 13, 14 and 15). An additional factor may also include the type of task, as the results from Experiment 12 suggested Female Ps experienced angry faces as lasting longer when exposure times were counted off, whereas this was not confirmed consistently in later experiments when stimulus duration comparisons were made. The contrasting time intervals involved may also be responsible for this divergence. In summary, the most intriguing finding from this series of experiments is that duration comparisons made by Female participants to stimuli presented for brief exposure times interact with the sex and expression of the stimulus face that is seen second.

The implication of these results is that the processing of a time code draws on the same resources as those required for processing emotional expressions and face sex. Consider for a moment possible alternative explanations for the results of the brief duration experiments. It may be that differences other than sex differences are influencing the results. Although brightness and contrast levels were balanced overall, the angry male face differs in local contrast compared with the other three because his mouth is closed. The length of time taken to discriminate the image may influence perceived duration. It is however, difficult to apply a similar argument as to why female angry and happy expressions are responded to differently as both expressions are open-mouthed.

Differences in light and dark across the image may also influence responses in an affective way. They are certainly coincident with, and may be responsible for, the difference in rated arousal of the male angry image (7.1), which is not as high as the female angry face (8.6) where her teeth show. Even though these expressions may be equally recognisable categorically as angry, they may differ in the intensity or level of anger expressed which may in turn influence perceived duration. We do react differently to someone who is extremely, rather than just mildly, angry with us. If this interpretation of the results is pursued and compared with what Angrilli et al. (1997) found for lower arousal negative slides and the male angry face here is considered to have comparatively lower arousal, then the results of Experiment 15 are not consistent with what Angrilli et al. found. The duration of this type of slide was underestimated in their study, and in the present study it is overestimated compared with the more highly aroused female negative face if the negative female face is seen second.

Alternatively, incongruent images may take longer to process and so appear to last longer. There is some evidence for example, to suggest that women are believed to smile more than men (Briton and Hall, 1995). In Experiment 15, where all three other

types of face are seen before the angry or happy second face, only one face seen prior to the male happy face is incongruent compared with two seen before the male angry face, which would predict more longer decisions to faces prior to the angry male face and fewer before the happy male face and this is not what was found. The argument is similar for female faces. If however, incongruent faces are ignored, rather than persevered with, then this would fit. Inverting the faces would destroy the effect of the expressions and differences in congruence without altering the contrast of the images, and it would be interesting to see if these results replicated with the two items used in Experiments 13-15 under these circumstances.

It is also difficult to reconcile these results with simple memorial and attentional models of time perception that are based on experimentation to do with nonaffective stimuli. Consider first the attentional model that suggests the more we attend to something the less time we have to do anything else. If it is assumed that we *do* pay attention to an angry face, and each click of an hypothetical or real internal clock takes resources, then why, for some faces at least, should angry faces appear to last longer than happy relaxed ones? Consider next that, according to the memorial model, if our experience of angry faces is more active and intense than our experience of happy ones and we remember them better due to more memorial markers, why, for some faces at least, should happy faces appear to last longer than angry ones? And finally, consider Treisman's (1963; Treisman et al., 1990) idea that an internal clock generates arousal sensitive outputs. The notion of an internal clock, susceptible to both attentional factors and our experience of characteristic time intervals is attractive. Whilst in danger of being so flexible that such a mechanism could not be disproved, Treisman and colleagues' later work has set out to specify the characteristics of such a mechanism (e.g., a frequency of 12.4 Hz or multiples of this) using auditory stimuli. Some way of testing the duration estimation of affective visual stimuli against the model might yield interesting results.

Finally, further experiments are necessary to see if the results found here generalise to different male and female angry and happy faces. There may be something specific to these two faces that produced these results, and prior to finding out if the effect is consistent, explanations must wait.

Overview

Some evidence was found consistent with a report in the literature (Thayer and Schiff, 1975), that Female Ps experience angry faces as lasting longer when estimating 10 s intervals. At exposure times much shorter than this, however, duration judgements were found to interact in a complex way, not only with the sex of the participant, but the sex and expression of the stimulus face and the order in which comparative stimuli were presented. More experiments are required to see whether or not the results obtained for interactions between emotional expressions and our estimation of time intervals are more than merely item specific. In the next chapter the possible interaction of emotional expressions that are aversive and attractive with another fundamental ability is explored. This is the ability to learn about the probability with which events occur. And, if exposure to emotional expressions does affect this ability, does it also affect our memory for what those events were?

8

Expression and probability learning

Emotional experiences, many of which are generated in interactions with others, are a major source of information we use to guide our everyday choices. On a specific level, some evidence for the idea that we avoid someone who shows anger (at us or more generally) and are attracted to those who show happiness has been found in the previous experiments. Another major source of information we use to guide our choices is our knowledge of the probability with which events are likely to happen. Although there are notable exceptions to this latter generalisation (many people buy lottery tickets knowing it is highly improbable they will win), most behaviours are motivated according to our expectation of one outcome over another (we use a car if public transport is erratic, for example). This chapter is concerned with the possible interaction between processing aversive emotional expressions and probability learning.

Most of our knowledge of the likelihood of events is acquired implicitly, and a large amount of research has been dedicated to the project of finding out how we acquire such knowledge in the absence of any conscious attempt to do so. (See Schachter, 1987 for a review of the evidence for implicit memory.) To find out about this, there is a laboratory version of probability learning that has been used as an

analogue of event learning in everyday situations. This task will be used here as a tool to explore the acquisition of event probabilities when those events are expressive faces. Although there may be modifications of the basic design (Reber, 1989; Reber and Millward, 1968), laboratory experiments follow a two-choice procedure in which each trial of a sequence of trials is made up of a "respond now" signal, a prediction by the participant, and an outcome event. Events occur in a random sequence with the proportion of each type of event held constant for the period of interest. The researcher uses how accurate the participant becomes at predicting the most frequently occurring event as a measure of learning. Some of what we know about probability learning and the way in which emotions and responses to emotional expression might be involved are outlined below before two experiments exploring a possible interaction are described.

How does probability learning work?

The degree to which the acquisition of tacit knowledge is made up of distinctively different unconscious components is a matter for debate. Reber (1989) separates the processes involved into two types: 'primitive' and 'sophisticated'. The first of these is not influenced by the meaning or interpretation of an event. It is affect-free and includes processes such as direct perception (Gibson, 1979), records of frequency information (Hasher and Zacks, 1984), and learning the covariance of features. This last includes a wide range of phenomena from the learning of synthetic grammars (e.g., Reber, 1976) to how events interrelate within a manufacturing system (e.g., Broadbent, Fitzgerald, and Broadbent, 1986). Reber (1989) suggests probability learning is an example of this primitive automatic unconscious type of process, whose general function is to pick up critical knowledge about categories and about the covariation of aspects within categories. In Reber's model, the second of these processes, the sophisticated unconscious, deals with functions that involve meaning and affect. Forced-choice recognition tests are used as an index of sensitivity to this type of process (Marcel, 1983). The operation of the sophisticated unconscious is seen as more

developed evolutionarily and derived from the knowledge acquired by the primitive unconscious. Whether or not frequency of exposure to a stimulus alone interacts with affect is also a matter for debate (e.g., Kunst-Wilson and Zajonc, 1980; Matlin, 1971, Hasher and Zacks, 1984).

Theoretical explanations of probability learning have been based on studies using affectively neutral stimuli (e.g., coloured lights, left or right position). Stimulus sampling theory (e.g., Estes, 1957) predicts that, over a sequence of trials in a learning experiment, the participant will show a typical learning curve that begins with around 0.5 correct responses (Event 1) and reaches an asymptotic level equal to the probability of E1 at input (see Bower, 1994, for a review of this theory). Hay and Jacoby (1996) observe that probability matching is not the optimal strategy when participants are trying to maximise accuracy. It would be better to predict the more frequent event every time, but humans and animals are resistant to abandoning a matching strategy. However, probability matching does not occur in every case and instances of asymptotes approaching more extreme values than those at input (when greater than 300 trials have been used) have been reported for probability levels of 0.3, 0.4, 0.6, and 0.7 (Edwards, 1961). Sequential effects and the 'gamblers fallacy' (if 'heads' has come up 8 times in a row, 'tails' is more likely to be considered due) modify the basic pattern.

How might emotions and emotional expressions be involved?

The experiments in this chapter are concerned with how emotional stimuli may modify the basic probability matching pattern. That affect might be involved in just such a learning situation is feasible if Rolls' (1990) theory of emotion is considered. In this theory, emotions are considered to be states produced by reinforcing stimuli. Rolls defines different emotions as different states (e.g., fear) produced by either a primary reinforcer (e.g., pain) or by the learning of a stimulus (e.g., a tone) - reinforcement (i.e., pain) association. Stimuli are considered positively reinforcing if they increase the probability of a contingent response and negatively reinforcing if they decrease the

probability of a response. When emotional states are elicited by reinforcing stimuli (which can be expressive faces) certain functions are fulfilled. These include preparing the body for action (e.g., increasing heart rate), responding in a flexible way (e.g., avoiding punishment, and acting to reduce fear), motivating the organism (e.g., the organism will work to avoid negative reinforcers or to obtain positive ones), evaluating events, facilitating the storage of memories, and other functions that are to do with communication, social bonding, and genetic selection for feelings that have survival value.

Other researchers have also been interested in the predictive functions of emotions and the idea that we discriminate expressions in order to better predict the behaviour of others. In particular, Rosenhan and Messick (1966) speculated that some reinforcement value may be contained within the meaning of the expressive face itself and either enhance or reduce the reinforcements imposed by the probability learning format. They found that sequences made up of smiling and angry faces did influence the ability of experimental participants to predict the upcoming event. When a set of 150 cards with schematic (line drawn) smiling and angry faces (see Figure 50) were presented to participants in a randomised order in the proportions of 70% smiling to 30% angry faces, accuracy scores averaged 68.2%. When the ratio was 70% angry to 30% smiling faces, accuracy fell to 57.5%. Rosenhan and Messick found that, in addition to reduced predictions at the beginning of sequences where the dominant affective input was negative, the acquisition curve was flatter and the asymptotic level lower than for positive value inputs. Differences between the majority positive group and majority negative group stabilised and diminished towards the end of the 150 trials. They explain their findings in terms of the aversiveness of the negative stimulus and/ or the attractiveness of the positive stimulus and suggest that participants learned to respond to the "objective" stimulus inputs as trials progressed, overcoming the affective value of the stimuli. The women in Rosenhan and Messick's sample were affected more markedly than the men, tending to overestimate the smiling face input when it was the

majority stimulus and to underestimate the angry face input when that was the majority face. These researchers suggest that men are more "motivationally biased" to resist the influence of affect and respond more to the objective inputs.

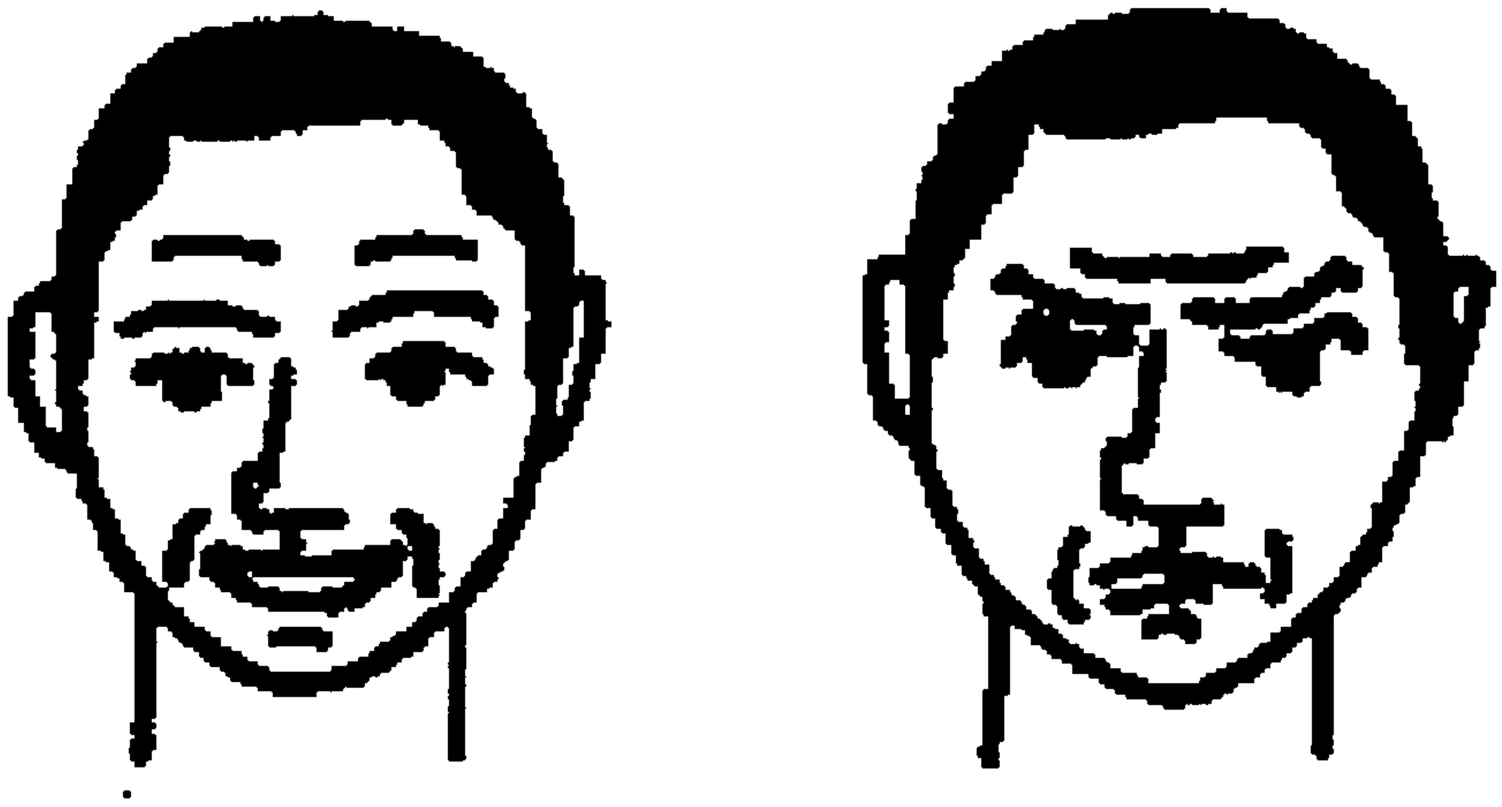

Figure 50. Happy and angry line-drawn stimuli used by Rosenhan and Messick (1966).

The following experiment attempts to replicate Rosenhan and Messick's (1966) basic finding of reduced probability learning with majority angry sequences compared with majority happy ones. Angry and happy stimulus faces are photographic rather than line drawn, and presented on the computer rather than on card. Rosenhan and Messick (1966) used as their affectively 'neutral' control stimuli line drawn big and little kangaroos and predicted that responses to this sequence would lie in between the 70: 30 (smiling: angry) and the 70: 30 (angry: smiling) responses. They did, but Rosenhan and Messick also found that, although the control sequence responses were statistically significantly different from the smiling: angry condition, they were no different from the angry: smiling condition. Rosenhan and Messick concluded from this that their control stimuli served only as a comparison and were not sufficiently neutral. The affectively neutral comparison in the following experiment is changed to fields of dots and dashes.

Experiment 16

If the predominance of angry faces in the 70: 30 angry: happy (ah) condition depresses accuracy and the comparison stimulus combination is affectively neutral, then accuracy scores are predicted to be highest for the 70: 30 happy: angry (ha) sequence, next highest for the neutral sequence, and lowest for the ah sequence.

Method

Participants

Thirty-six Female Ps between the ages of 18 and 47 years volunteered to take part. Approximately 80% of this sample were Greek postgraduate students who had recently arrived in Scotland to study.

Stimuli and apparatus

Angry and happy expressions from one male (from Jenkins, 1997) were used as expressive stimuli with fields of dots and dashes used as neutral stimuli (Figure 51). They were presented centrally on a light background on a Macintosh Quadra 800 using "SuperLab" software. The faces measured 5.5 x 7.5 cm on the screen and each image subtended an angle of 5.2° horizontally and 7.2° vertically at a viewing distance of 0.6 m. The fields of dashes and dots covered a similar area to that of the faces.

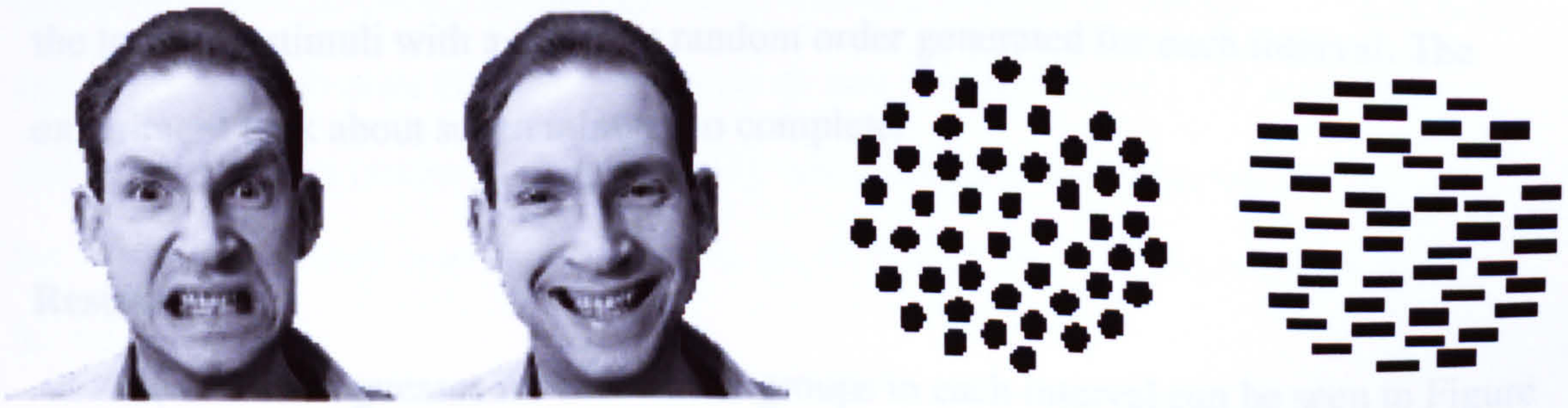

Figure 51. Angry and happy faces and 'neutral' dots and dashes used for Experiment 16.

Design

A 3 x 15 mixed design with group at 3 levels (Group ah, where the ratio of expressive faces was 70: 30 angry: happy; Group ha, with 70: 30 happy: angry faces; Group do, with a ratio of 70: 30 dashes: dots), and the within-subjects variable of interval at 15 levels (v1 = trials 1 - 10, v2 = 11 - 20, etc., to v15 = 141 - 150). The dependent measure was accuracy of prediction to the majority stimulus.

Procedure

Participants in Groups ah and ha were told they would see a sequence of angry and happy faces come up one after the other in the centre of the screen. Between each face there would be a question mark. Their task was to guess which type of face would come up after the question mark and to try and get as many guesses right as possible. For Group do instructions about expressive faces were substituted by instructions about dashes and dots. Participants were not aware of the probability with which either stimulus would occur.

At the beginning of the sequence the participant saw a question mark. They made their first guess and the first face of the sequence appeared for 1000 ms. The next question mark appeared, and the participant made another guess. For each interval (made up of ten stimuli and ten question marks), seven of the majority stimuli were combined in a random order with three of the minority stimuli. This was repeated for the total 150 stimuli with a different random order generated for each interval. The experiment took about seven minutes to complete.

Results

Mean correct guesses for each of the groups in each interval can be seen in Figure 52. A 3 x 15 ANOVA with the between-subjects variable of group at 3 levels and the within-subjects variable of interval at 15 levels revealed significant main effects of

group, $F(2, 33) = 7.11$, $p = .003$, and interval, $F(14, 462) = 4.41$, $p < .0001$, with a significant group x interval interaction, $F(28, 462) = 2.48$, $p < .0001$.

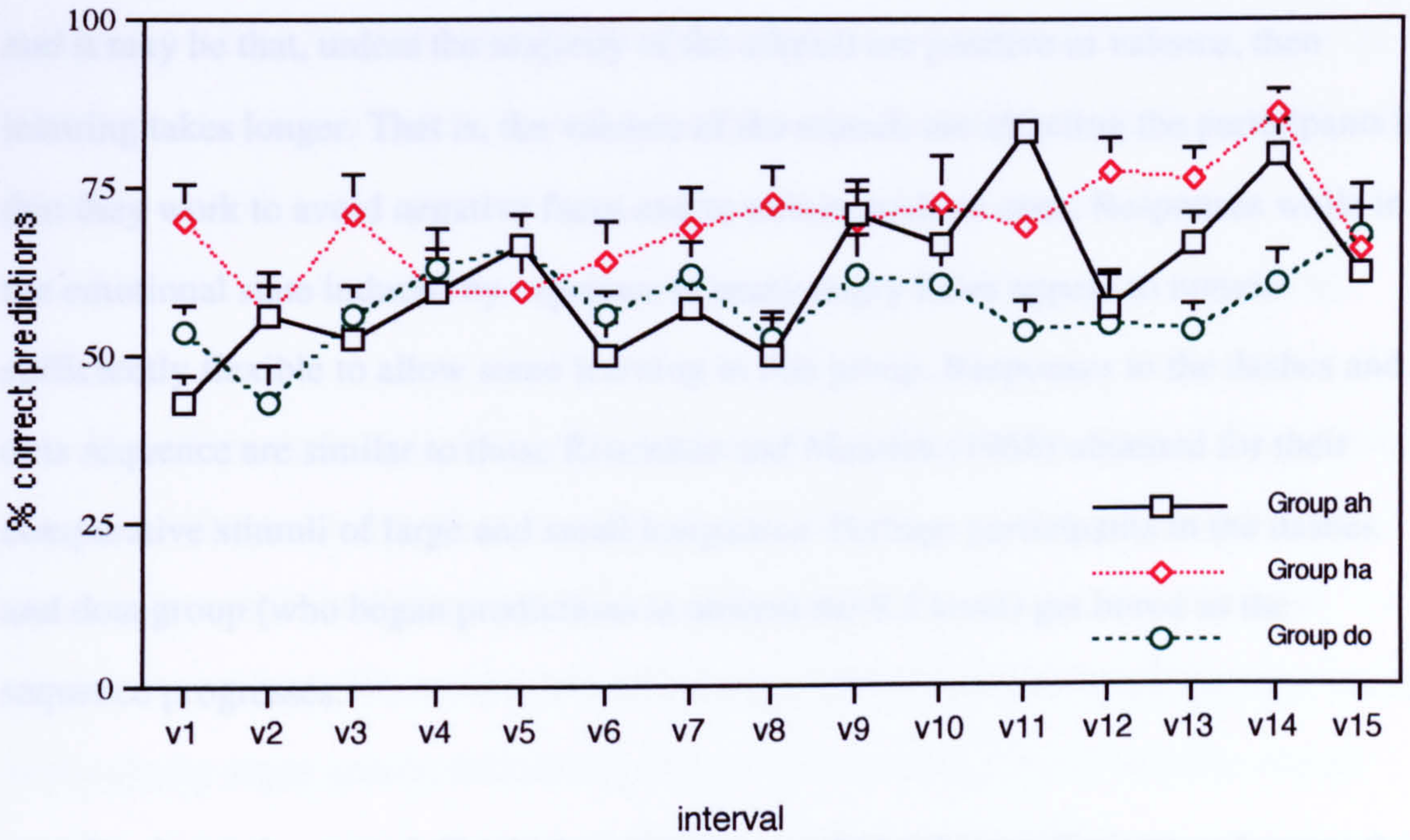

Figure 52. Experiment 16. Mean percent correct guesses to the majority stimuli for each group in each interval (v) of the sequence. Vertical bars represent the positive standard errors of the means. Group ah = 70: 30 angry: happy faces; Group ha = 70: 30 happy: angry faces; Group do = 70: 30 dashes: dots.

A Newman-Keuls comparison of group means (alpha = .05) for all 150 trials showed that predictions in Group ha were significantly different from both Group ah and Group do, and these latter were no different from each other (means are Group ha, 69.3%, *SD* = 19.9; Group ah, 61.4%, *SD* = 19.3; Group do, 57.7%, *SD* = 18.1). This difference between Group ha and the others was also reliable for the first 10 trials (v1) and for the last 40 trials (v12 - v15): Group ah was not significantly different from Group do for these intervals. Comparability with Rosenhan and Messick's (1966) data for expressive stimuli is as follows: Group ha, 69.3% cf. 68.2%; Group ah, 61.4% cf. 57.5%.

Discussion

These results provide some support for Rosenhan and Messick's (1966) claim that if the majority stimulus of a probability learning sequence is affectively positive

prediction is more accurate than if it is negative. This effect is present from the first interval and a higher level of asymptote is achieved for the majority happy group. Performance for the majority angry group improves slightly as the sequence proceeds and it may be that, unless the majority of the stimuli are positive in valence, then learning takes longer. That is, the valence of the stimuli are affecting the participants in that they work to avoid negative faces and to obtain positive ones. Responses while in the emotional state induced by exposure to many angry faces appear to remain sufficiently flexible to allow some learning in this group. Responses to the dashes and dots sequence are similar to those Rosenhan and Messick (1966) obtained for their comparative stimuli of large and small kangaroos. Perhaps participants in the dashes and dots group (who began predictions at around the 0.5 level) get bored as the sequence progresses.

An alternative to an 'affective' explanation could be that predictions, at least at the beginning of sequences, reflect participants' expectations that the proportion of each type of stimulus will reflect the frequency with which it occurs in everyday encounters. Personal experience suggests that happy faces are encountered more than angry ones and fields of dashes and dots are encountered not at all. Hasher and Zacks (1984) emphasise the crucial role of frequency in probabalistic decisions and point out that in many experiments these two types of information are confounded. Estes (1976) contrasted frequency and probability in an experiment in which the task was to choose who of two candidates would be a more likely winner. The probability of winning was higher for one candidate than another, but the other won more frequently and was chosen more often as a likely winner. Reber's (1989) suggestion that probabilistic choices are derived from the knowledge of frequency is supported by this work.

However, a mere frequency explanation need not be exclusive of an affective component. Taylor (1991) reviews evidence that suggests negative events evoke stronger responses than positive events. These cause the organism to become more

'mobile' (physiologically, cognitively, and behaviourally) initially and then to 'damp down', 'minimise' and even 'erase' the impact of that event. This effect of negativity on probability learning appears to be present in studies where frequency has been manipulated independently (e.g., Fiske, 1980). Work with highly anxious patients as well as normal controls also suggests biased processing of threat inducing stimuli (e.g., Mathews, 1994), although results can be inconsistent. Thus the affective state of the decoder as well as the affective content of the stimulus is implicated in processing.

The effect obtained in this experiment, while significant, is not large. In an attempt to confirm the generality of the findings, a replication was carried out on a different participant sample including both Male and Female Ps, this time with a different neutral comparison. The results from this study suggested that although majority happy and majority angry groups differed significantly on the first interval and the overall trend was in the expected direction, a comparison between overall group means showed that they were not significantly different from each other. It was decided to attempt a further replication of Experiment 16 with a larger sample of Female Ps and to combine this with a recognition test for the faces afterwards to see if any effect that showed up was also represented by an effect on memory.

Experiment 17

This experiment took place in two phases. Phase 1 followed the probability matching procedure of Experiment 16, with modifications. The most important of these was that instead of seeing only one person, participants saw ten actors with happy and angry expressions. Phase 2 was a test to determine the effect of seeing a sequence of majority angry faces compared with seeing a sequence of majority happy faces on our ability to recognise the same actors later. The test stimuli in Phase 2 included neutral faces of the same actors from the sequences in Phase 1 as well as the *same pictures* of

angry and happy expressive faces. The task the participant carried out was therefore 'picture' recognition for expressive faces, and 'familiar' person recognition for those neutral faces of the actors they saw in Phase 1. Note that none of the actors were familiar (either in the sense that they were personally familiar or famous) to the participants at the beginning of the experiment. Equal numbers of neutral, angry, and happy expressions from actors not seen before were included as distracters and required rejection.

As for Experiment 16, probability learning is expected to be better in the majority happy group than in the majority angry group. It is not known whether the differences in exposure to stimuli in Phase 1 will affect recognition in Phase 2. Consider first, the effect of simple repetition of the stimuli. The amount of exposure each face receives in each group is different. With the stimuli used here the angry face from each of the ten actors is seen seven times and each happy face three times in the majority angry group. This is reversed in the majority happy group with each happy face seen seven times and each angry face seen three. If repetition alone is considered, the majority angry group should recognise more angry faces at test than happy, and the majority happy group should recognise more happy faces at test than angry.

A frequency of occurrence explanation for the differential effects of positive and negative affective stimuli on probability learning predicts that less learning takes place for angry expressions on the grounds that they are less frequently seen than happy expressions prior to the experiment. Consider the possible consequences for the later recognition test. For the majority angry group frequency is altered for the duration of the experiment and angry expressions are experienced temporarily as more frequent. Happy expressions however start off by being more frequent and remain so for both majority angry and majority happy groups. On this account (and regardless of the level of performance achieved at the Phase 1 task) the recognition of angry expressions repeated at test may be elevated for the majority angry group and worse for the

majority happy group with the recognition of happy expressions high in both groups. The occurrence of the angry expressions as the more frequent stimulus in the majority angry group may have a temporary effect on the happy expressions such that the recognition of happy faces is depressed for this group, but if it is assumed that frequency estimates are independent of affect (e.g., Hasher and Zacks, 1984; Reber, 1989) and this is reflected in their later recognition, this would be unlikely.

An affective explanation includes two predictive possibilities. If we simply ignore or avoid negative stimuli it might be expected that recognition memory for the angry expressions will be poor for each group and particularly poor in the majority happy group. A similar outcome in the memory test would be expected if angry faces are attended to thoroughly, and prediction scores are low for the majority angry group during probability learning because angry expressions inhibit storage and we don't think angry faces recur as frequently as they do because we forget them. If, however, angry stimuli are attended to, even though they may not be predicted in Phase 1, angry faces may be remembered well by both groups, perhaps better than the happy ones in both groups, if they provoke stronger reactions (e.g., Taylor, 1991).

It is also of interest to see whether the recognition of actors' faces over a change in expression is better for majority angry or happy groups. In Phase 1 of the experiment here it is the expression of the face that is taken into consideration when the participant makes a prediction and gets feedback about whether their guess was correct or not. The request in Phase 2 is for identity information ("Have you seen these people before?"). It is an open question as to exactly how many exposures to a face are required before that face becomes personally familiar in a laboratory situation. Schweinberger and Soukup's (1998) findings and Experiments 2-4 (this thesis) suggest that some processing of identity proceeds when expression decisions are made to unfamiliar faces. Experiments 3-4, Schweinberger and Soukup (1998, Exps. 1 and 2), and Schweinberger et al. (in press) also suggest that the perception of identity can proceed independently from

expression. The explicit memory test proposed here is an opportunity to find out how perceiving faces over varying expressions is related to the later memory for them. It is predicted that, if identification analysis proceeds regardless of affect, then equal numbers of old actors will be recognised equally quickly in both groups (shown by responses to neutral expressions). If, on the other hand, affect biases actor identification, then there will be a difference depending on whether previous exposure to a majority of angry expressions makes these actors more or less memorable.

Method

Participants

Eighty Female Open University students (mean age = 40.3, *SD* = 9.8 years) volunteered to take part.

Stimuli and apparatus

Angry and happy expressions from ten actors (female Face Nos. 7, 9, 13, 16, and 17, and male Face Nos. 23, 26, 32, 38, and 41) were included as stimuli for Phase 1 of the experiment (probability learning) (Figure 53). Neutral expressions from these actors and angry, happy, and neutral expressions from a further ten actors (female Face Nos. 4, 6, 8, 15, and 42 and male Face Nos. 22, 24, 27, 31, and 33) were included in Phase 2 (recognition memory). Stimuli were presented as for Experiment 16 and measured 6.2 x 8.0 cm on the screen. Each image subtended an angle of 5.9° horizontally and 7.6° vertically at a distance of 0.6 m. Image size and viewing distance were the same for both phases of the experiment. Line-drawn ellipses were included as neutral stimuli.

Design

Phase 1 of the experiment had a 4 x 10 mixed design with the between-subjects variable of group at four levels (Group ah with a 70: 30 ratio of angry to happy faces; Group ha, 70: 30 happy: angry; Group fl, 70: 30 horizontally oriented (flat) ellipse: vertically oriented (upright) ellipse, Group up, 70: 30 upright ellipse: flat ellipse.

Accuracy of prediction was the dependent measure. Phase 2 of the experiment had a 2 x 2 x 3 mixed design with group at 2 levels (ah, ha), the status of the stimulus items at 2 levels ("old", "new") and expression at 3 levels (a, h, and n or neutral). Dependent measures were correct recognition scores for people seen in Phase 1, correct rejection scores for people not seen previously, and time taken to make these decisions (RT). RTs longer than 5 seconds were excluded from the analysis.

Figure 53. Stimuli used in Experiment 17. Angry (left) and happy (right) expressions from female Face Nos. 7, 9, 13, 16, and 17 used in Phases 1 & 2, and neutral (centre) expressions used in Phase 2. See following page for male faces.

Figure 53 cont. Stimuli used in Exp. 17. Angry (left) and happy (right) expressions from male Face Nos. 23, 26, 32, 38, and 41 used in Phases 1 & 2, and neutral (centre)expressions used in Phase 2.

Procedure

The procedure was the same as for Experiment 16 for Phase 1 of the experiment except that the number of trials was reduced to 100 (cf. 150). Ps were then asked to perform a short 'filler' task lasting 2 to 3 minutes. After this they were given

instructions for Phase 2 which read as follows: "Indicate which of these people you saw before (i.e., in the previous experiment) by pressing the '.' (full stop) key for an "old" person and the 'z' key for a "new" person. Make your decisions as fast as possible without making mistakes." Hand of response was balanced for both Phases 1 and 2 across participants within each group. That is, half the Ps (ten) in each group used their right hand to respond to the majority stimulus and half used their left. Half of these Ps (five) used their right hand to respond to "old" people in the memory test (consequently, they used their left hand to respond to "new" faces) and half used their left hand to respond to "old" faces. Phases 1 and 2 of the experiment took 12 minutes to complete.

Results

Phase 1

A 4 x 10 ANOVA with group as the between-subjects variable and interval as the within-subjects variable revealed a main effect of group that approached significance ($F(3, 76) = 2.31, p = .08$), and a significant main effect of interval, $F(9, 684) = 14.56, p < .0001$, with no interaction between these two variables. Means for the Groups ah, ha, fl, and up were 55.8% ($SD = 22.3$), 62.8% ($SD = 17.5$), 60.1% ($SD = 20.1$), and 61.9% ($SD = 18.5$) respectively. A Newman-Keuls comparison of group means (alpha = .05) showed that predictions for Group ah were significantly less accurate than those in Group ha and that the means of Groups fl and up were not significantly different either from each other, or from the other group means. The main effect of interval shows that predictions at the beginning of the sequence were less accurate than later predictions. Mean correct predictions for Groups ah and ha for each interval can be seen in Figure 54.

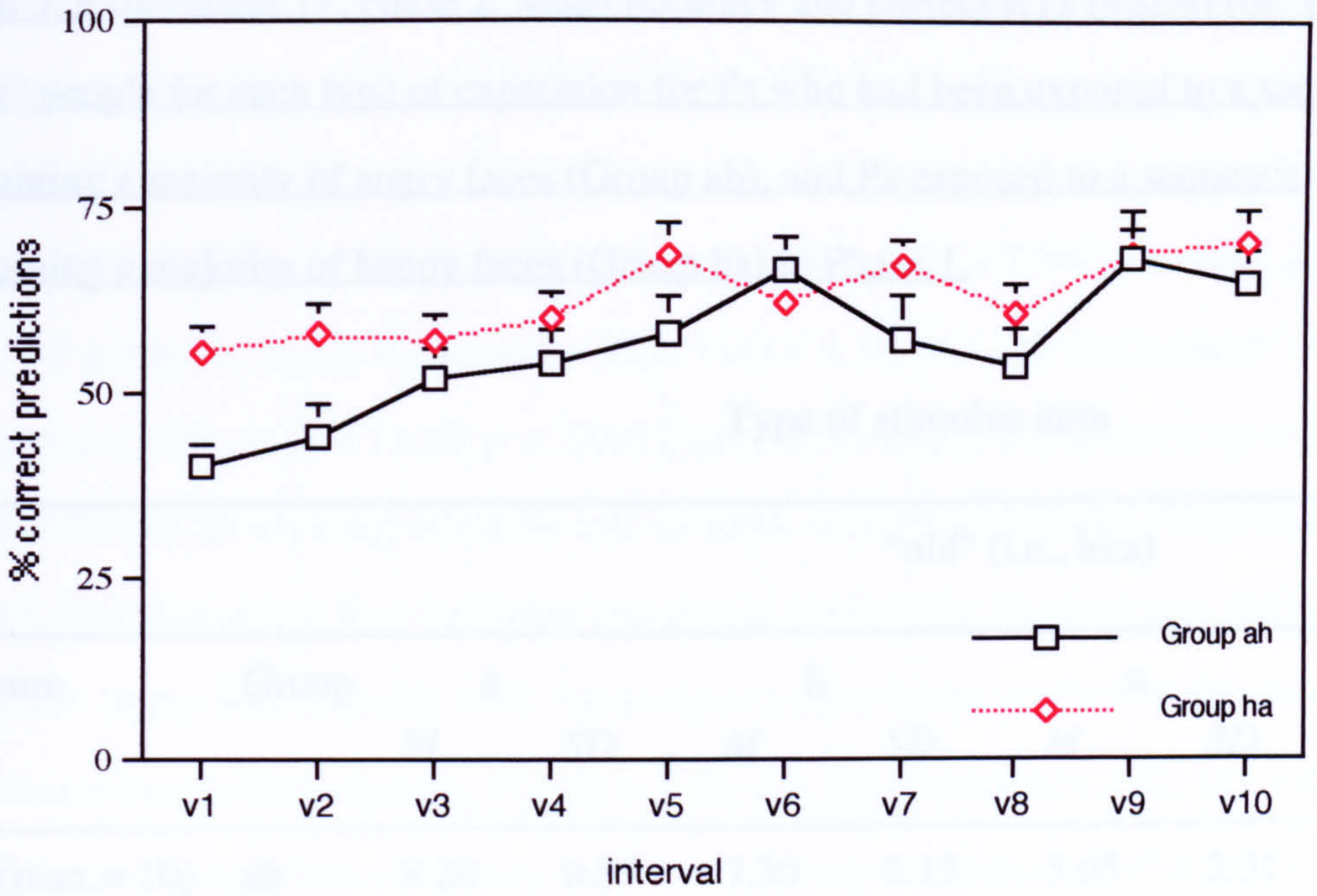

Figure 54. Experiment 17, Phase 1. Mean percent correct guesses to the majority stimuli for each group in each interval (v) of the sequence. Vertical bars represent the positive standard errors of the means. Group ah = 70: 30 angry: happy faces; Group ha = 70: 30 happy: angry faces.

Phase 2

Mean accuracy and RT (+*SD*s) for Ps in Groups ah and ha when correctly recognising "old" peoples' faces and correctly rejecting "new" peoples' faces are at Table 5. Five correct responses, three to "old" faces and two to "new" faces were longer than 5 seconds and excluded from the RT analysis. Two separate 2 x 3 mixed ANOVAs with group and expression as variables were carried out on recognition scores (hits) and RTs for "old" stimuli. Analysis of hits showed a significant main effect of group, $F(1, 38) = 4.62$, $p = .04$, with Group ha more accurate overall than Group ah, and a significant main effect of expression, $F(2, 76) = 42.98$, $p < .0001$. Post hoc Newman-Keuls comparisons (alpha = .05) showed that means for angry, happy and neutral expressions were all significantly different from each other.

Table 5. Experiment 17, Phase 2. Mean accuracy and correct RTs (+*SD*s) for "old" and "new" people for each type of expression for Ps who had been exposed to a sequence containing a majority of angry faces (Group ah), and Ps exposed to a sequence containing a majority of happy faces (Group ha) in Phase 1.

measure	Group	a		h		n		
		M	*SD*	*M*	*SD*	*M*	*SD*	*M*
						Type of stimulus item		
						"old" (i.e., hits)		
acc. (max.= 10)	ah	9.20	0.89	7.30	2.15	5.05	2.31	7.18
	ha	8.70	1.34	8.50	1.47	7.15	2.08	8.12
M		8.95	1.15	7.90	1.92	6.10	2.42	7.65
RT (ms)	ah	863	206	1068	427	1087	329	1006
	ha	937	187	974	215	1076	337	996
M		900	198	1021	337	1082	329	1001
						"new" (i.e., correct rejections)		
acc. (max.= 10)	ah	7.85	1.23	7.70	1.42	8.45	1.23	8.00
	ha	7.15	1.66	6.95	1.67	7.50	1.57	7.20
M		7.50	1.49	7.33	1.59	7.98	1.48	7.60
RT (ms)	ah	1151	410	1191	459	1100	389	1147
	ha	1141	352	1118	295	1059	302	1106
M		1146	377	1155	383	1080	344	1127

These two main effects were modified by a two-way group x expression interaction, $F(2, 76) = 9.02, p < .0001$, shown at Figure 55. Simple main effects analysis of the interaction showed that there was an effect of expression for Group ah ($F(2, 152) = 44.73, p < .0001$) and for Group ha ($F(2, 152) = 7.34, p = .001$), and an effect of group for happy expressions ($F(1, 114) = 4.54, p = .04$) and neutral expressions ($F(1, 114) = 13.89, p < .0001$), but not for angry expressions ($p = .4$). That is, Ps in Group ah were significantly less accurate than Ps in Group ha with happy and neutral faces for actors they had been exposed to previously. Both groups did however recognise angry faces equally well. An analysis across items confirmed this with significant main effects (group, $F(1, 9) = 7.66, p = .02$; expression, $F(2, 18) = 61.98, p < .0001$), and a significant two-way interaction (group x expression, $F(2, 18) = 13.76, p < .0001$). Analysis of RTs showed a significant main effect of expression only, F(2, 76) = 11.16, p <.0001. Post hoc comparison of expression means showed that RTs to angry faces were significantly faster than both happy and neutral faces, and that these latter were not significantly different from each other. Although the two-way interaction did not reach significance, ($p = .1$), RTs followed the same pattern as the accuracy data.

Two separate 2 x 3 mixed ANOVAs with group and expression as variables were carried out on correct rejection scores and RTs for "new" stimuli. An analysis of the scores showed a significant main effect of group, $F(1\ 38) = 5.69, p = .02$, with Group ah achieving higher overall accuracy than Group ha. The main effect of expression approached significance ($p = .06$). An analysis across items confirmed the main effect of group, $F(1, 9) = 6.66, p = .03$, but not the effect of expression. Analysis of RTs showed no significant main effects or an interaction, though the main effect of expression approached significance, ($p = .05$), with neutral expressions rejected more quickly than either happy or angry expressions.

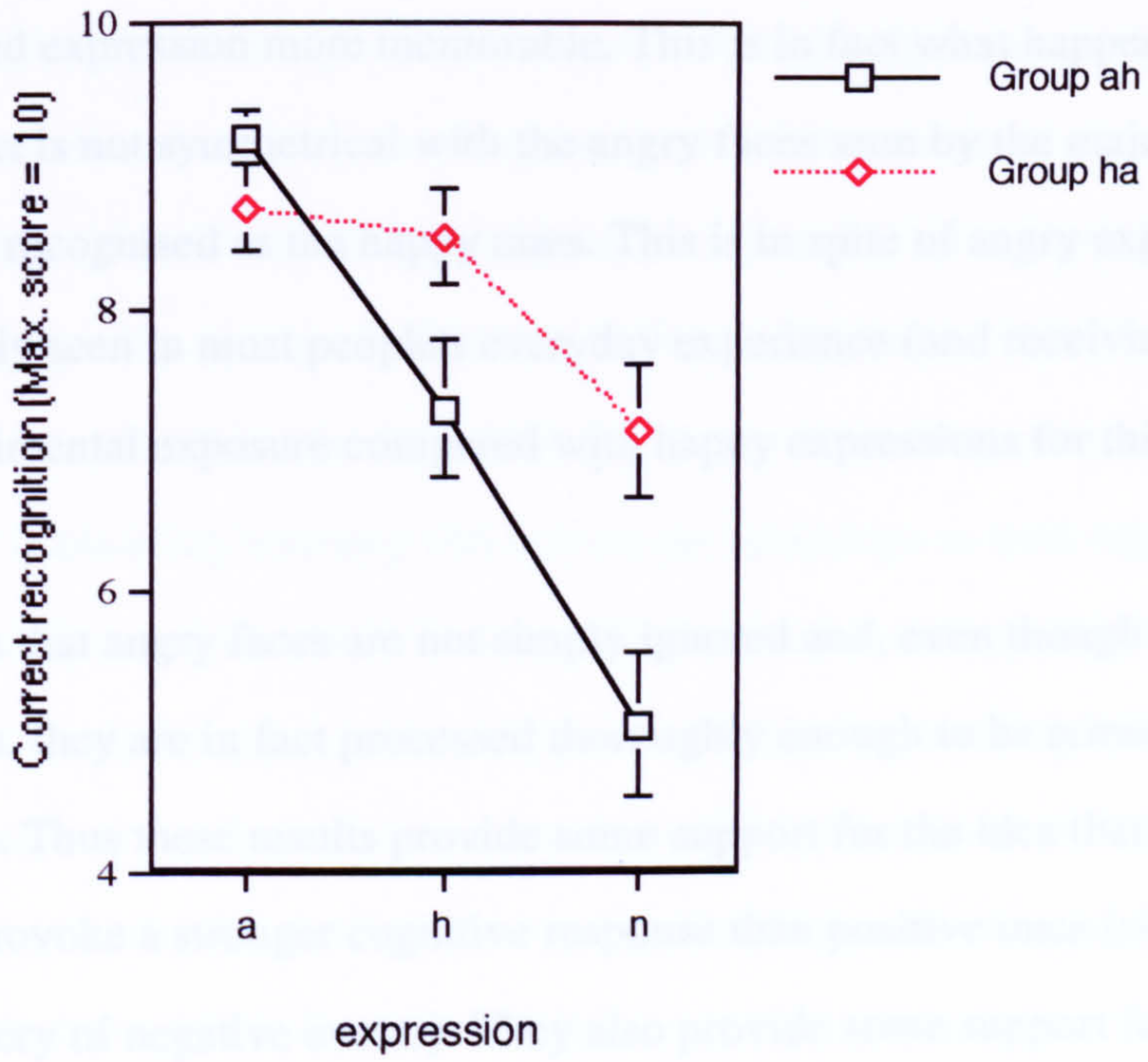

Figure 55. Correct recognition scores (hits) for Groups ah and ha for angry (a), happy (h) and (n) faces in Experiment 17, Phase 2.

Discussion

These results show that Ps exposed to a majority of angry faces in Phase 1 are worse than those exposed to a majority of happy faces at predicting the probability with which these faces will show up in the sequence. They are also worse overall at recognising these faces in Phase 2. However, in Phase 2, it is not the recognition of angry faces that suffers in this group, it is the recognition of happy face (pictures) and the new neutral expressions of actors seen previously.

The number of times each stimulus is repeated in Phase 1 of the experiment does not predict the accuracy with which each type of stimulus face is remembered in Phase 2. For this to have been so, the pictures of angry faces in Group ha should have been remembered on a level comparable to that of the happy faces for Group ah.

A frequency of occurrence explanation of these results would have predicted happy expressions equally well recognised in Phase 2 by the majority angry group

unless the temporary displacement of angry expressions over happy ones made the less frequently presented expression more memorable. This is in fact what happened for this group, but the effect is not symmetrical with the angry faces seen by the majority happy group equally well recognised as the happy ones. This is in spite of angry expressions being less frequently seen in most people's everyday experience (and receiving less than half the experimental exposure compared with happy expressions for this group).

It appears then that angry faces are not simply ignored and, even though they are predicted less often, they are in fact processed thoroughly enough to be remembered as well as happy ones. Thus these results provide some support for the idea that negative expressions may provoke a stronger cognitive response than positive ones (similar to Taylor's, 1991, theory of negative events). They also provide some support for the idea that exposure to angry faces may bring about a negative affective state that in turn affects the breadth and focus of the Ps' attention (e.g., Nash, 1989, cited in Griffiths, 1998) where the focus of attention implies a "loss of consciousness of other facts and events" (p. 38). The simultaneous high recognition performance for angry expressions for the majority angry group, together with their poorer performance in the probability learning task and poorer memory for happy expressions and neutral faces, is suggestive of a narrowing of attention to the angry faces alone, regardless of either the content of the other stimuli or the overall sequential context of Phase 1. This is supported also by the asymmetry observed in the majority happy group, where the recognition of angry expressions is still high.

Participants' ability to abstract the identity of the person they saw before, measured by their recognition of that person with a neutral expression, also suffers in the majority angry group. Identity is seen as susceptible to interference from expression information in this context. However, an alternative to an attentional explanation for the asymmetric differences in recognition of angry and happy pictures, and the subsequent poor recognition of the neutral expressions in the majority angry group could lie in

differences in distinctiveness between these three expressions in addition to the frequency with which they were exposed previously. Consider for a moment that the angry faces are remembered well because they are more distinctive than either the happy or neutral ones. Also, if neutral expressions are more similar to happy ones (the reader can form a subjective opinion by looking at Figure 53) then, when neutral expressions are presented to the majority happy group, the more frequent exposure to happy faces during probability learning will convey an advantage to both happy and to neutral expressions. How easy it would be to get distinctiveness ratings that were not influenced simultaneously by any negative (or positive) response we might have to the expressions is difficult to say. In addition, even if angry faces are more distinctive than happy ones, they may not be discriminated or recognised better than happy ones (e.g., Jenkins, 1997; McAndrew, 1986; Russell, 1994).

In relation to this last point, there is some recent work (Yoshikawa, 1999) that suggests that angry expressions might be discriminated better than happy or neutral expressions. Yoshikawa presented a face that could be one of three identities and either angry, happy, or neutral, peripheral to the participant's field of view for a short exposure time. The task was to match this target to a nine-face sample that included all of the different identities and expressions. Ps were more accurate with angry full-face stimuli than they were with happy or neutral faces. Together with further experiments with faces that appeared not to look at the viewer, these results are interpreted as suggesting that we are indeed predisposed to detect faces that threaten us. Whether this is primarily a perceptual, or an affective response is not certain. If these experiments were replicated with inverted faces, on the basis of the findings in Chapter 5 (gaze-expression contrast), it would be expected that the angry faces would sustain their advantage. They may not, however, and this could lend support to an aversive response unable to function with upside-down faces. Whether angry expressions are easier than happy or neutral ones to discriminate (or not) and are possibly more memorable, such

an explanation still does not account for the poorer performance of the majority angry group at probability learning.

Two possible explanations for the results here are therefore viable and may not be mutually exclusive. An affective one in which angry faces are avoided but processed thoroughly, and a perceptual one in which distinctiveness determines memorability and/or the ability to abstract a code specifying identity. Implications of the former include an effect of expression on identity processing such that if some kinds of emotional responding are accorded processing priority (e.g., the detection of threat) then identity analysis may be depressed. Expressional distinctiveness could also be described as arising out of an evolutionary advantage for signals that are as different as possible for oppositional action responses. Atypicality may work in favour of rapid emotional responding at the cost of processing other information. Experimentation with different expressive faces rated for distinctiveness would go some way towards clarifying the situation.

Overview

Angry emotional expressions have been found detrimental in probability learning experiments, a laboratory procedure thought to be little influenced by the affective content of events. In addition, previous exposure to a sequence of faces in which the majority of the stimuli show anger, depresses recognition for pictures of happy expressions seen previously and the ability to recognise these same people with neutral expressions. An explanation is put forward which is in accordance with evidence that negative emotional states affect the breadth and focus of the participants' attention. This explanation is rivalled by one that suggests the distinctiveness of the faces seen (or perhaps their distinctiveness in the service of an emotional message) is responsible for the memory effect observed. In the following and final chapter the results of all the

experiments in this thesis will be summarised, the implications for the various theoretical approaches used considered, and future work will be suggested.

9

Summary, future work, and conclusions

As the reader has tracked the progression of the experiments of the previous chapters, one of the main characteristics of this thesis will have become apparent, and may appear to some as the opposition of conceptual chalk and cheese. This is the combination of work in earlier chapters on aspects of face recognition with work in later chapters based on cognitive models of time perception and probability learning. In the earlier experiments emotional expressions were considered a functionally coherent set of socially significant signals from the face[8] with other facial information viewed as potentially competitive. In the later experiments, expression information was assumed to be competitive with codes required to process the passage of time and the probability of events. No necessary equivalence between the types of codes formed was assumed. Earlier experiments have benefited from the conceptual clarity provided by the Bruce and Young (1986) model of face recognition while the later ones charted more obscure territory. The question however, remained the same in all cases: How is the viewer's experience altered as a consequence of exposure to the emotional expressions of

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[8] Note that, in the future, differences between expressions may render this assumption obselete.

others? Measures made have included ratings, RTs, errors, estimates, predictions, and recognition scores. The presence of interference was taken to indicate shared resources between expression and other information processing, that is, the additional information supplied by the stimulus and the experimental context. In this final chapter, the experimental findings are summarised, the most promising areas of future work indicated, and conclusions drawn.

An evolutionary context and stimulus set assembly

Chapter 1 introduced the reader to the ambivalence many cognitive psychologists have towards emotion processing as at once fundamental and irrational. The involvement with emotional stimuli is incomplete (with some notable exceptions) in the construction of psychological concepts. The experiments in this thesis attempt to work with emotional stimuli within an information processing framework to find out if their affective qualities do have any impact on responding in experimental designs that are said to index attention and memory. These experiments make use of the face as a stimulus and of the way the face can reveal an internal emotional state through expression. Expression processing is encapsulated within the evolutionary framework supplied by Darwin (1847/ 1948), and the logical progression of recognition research is of ever more specific identification of dedicated neural networks matched to specific expressions. (How far can the project to connect what we experience emotionally to the 'brain in its bony cage' go? And is there a 'street number' within the amygdala where the encoding and decoding of a certain kind of fear *only* will be resident? And does this correspond specifically to micromuscle configurations of the upper eyelid?) To wit, the evolutionary approach has done most to facilitate both neurobiological and psychological understanding of what emotional phenomena actually are (see Griffiths, 1998 for a comprehensive critique of current models of emotion). While the stated larger aim of understanding emotional interaction with cognition stands in place, the small patch of turf considered in this thesis is limited to those emotional expressions we suspect may have systematic phylogenetic origins.

These expressions are (with some dispute), anger, disgust, fear, happiness, sadness, and surprise, and their collection is described in Chapter 2. 'Neutral' expressions were also collected for use as non-expressive control stimuli. The primary aim of this task was to produce a set of faces that could then be used in experiments. This was achieved and approximately one third of the 179 images that reached criterion agreement have been used. An overall recognition accuracy of approximately 70% found in the rating study supports the idea that consistency in the production of expressions is reflected by consistency of recognition, although this does apply more to some expressions (e.g., happy) than others (e.g., sad). Sometimes views of the face similar to those rated, but not rated themselves, have been used in the experimental chapters. These include views of the face looking to the right or left, and those with the face forward but with the eyes looking to the right or left. Images have at times been cropped, inverted, and montaged. Sometimes faces were used that were not in the set, as the experiments were carried out prior to completion of stimulus collection. This applies to two faces, each with three expressions, in Experiment 12 and one face, with two expressions, in Experiment 16. The stimulus set collected here is a resource with potential for experimentation beyond the scope of this thesis.

An additional aim of Chapter 2 was to inform myself about what happens when collecting posed emotional expressions and getting them assessed. In spite of the many points at which validity might appear to have been compromised (e.g., decisions about eliciting scripts, edits, etc. made by only one person), at the very least, the procedure should be replicable. At most, it is hoped the assessment procedures have convinced the reader that there is a role for still posed images of expressions in addressing the issue of emotional information interaction. What is unknown of course, is the differing degree of reality each image had for each participant. There may have been impact to do with the referent 'coming alive' for the viewer: alternatively some may have treated each as (merely) a picture. Each of these options was of course, task and context dependent.

Further subsidiary aims of Experiment 1 were 'opportunistic' in the sense that advantage was taken of the necessity to put together an assessed stimulus set to explore controversial issues to do with expression processing rather than ensuring these aims fulfilled the role of 'linear drivers' for the thesis experiments that followed. Either the categorical or the dimensional models of expression perception inform many of the simplest expression experiments and it was of interest to discover how much this particular set conformed with each. Expression profiles were particularly useful. The 'psychological distance' between anger and disgust categories, for example, is not necessarily equivalent to that between happiness and any of the others. Neither did the set conform completely to Russell's (1980) dimensional map. The opportunity was taken also to check sex of encoder and decoder differences as it has somehow become 'popular' to think that women are much better at emotions than men. No large differences were found here and this may be something that varies between particular stimulus sets and populations. Thesis experiments did benefit from this rigorous pretesting. Best 'prototypes' could be selected and arousal and pleasure matched or contrasted as far as possible, and decoder sex differences found can be assumed more reliable than they would have been otherwise.

Expression and identity

Evidence that supports the independent analyses of functionally distinct types of information from the face together with recent experiments that hint at interaction (e.g., Schweinberger and Soukup, 1998; Walker, Bruce, and O'Malley, 1996) was presented in the introductory chapter. Continuing on from this, the Bruce and Young (1986) model of face recognition was outlined in more detail in Chapter 3, and Schweinberger and Soukup's (1998) experiments on the independence of expression and identity were selected for replication. On the whole, the basic tenet of independent identity analysis was supported. Insofar as the Garner paradigm measures our ability to attend selectively to each, we can keep the structural codes for identity and expression

separate if the task is to classify identity. This does however break down and the two dimensions become mutually interactive if an expressive face of either identity looks similar to that of the other (Exp. 2). This was interpreted as differences, in addition to intended dimensional variation, between images in the stimulus set influencing our ability to make classificatory identity decisions to unfamiliar faces independently of irrelevant variation in expression. Experiment 3 went on to maximise the chance that participants would form an abstract representation of each identity. Under these conditions no interference from variation in expression was detected, which suggests that distinct representations had indeed been formed for each person. However, this outcome also obtained in a situation where the hair only was changed between 'identities' (Exp. 4). If the formation of a structural representation specific to each identity shown (usually thought to incorporate identity-specific information such as the spatial relationships between features, shape from shading, etc.) had really been formed, these representations would have overlapped with the single exception of the hair difference (and any configural influence generated by this feature change). Neither the experiments here, nor the ones carried out by Schweinberger and Soukup (1998) pre-rated faces for similarity and it seems likely that the independence of unfamiliar face processing in these Garner experiments is dependent to a large extent on how easy it is to tell one identity apart from the other.

Whether or not expression analysis proceeds independently of irrelevant variation in identity is more uncertain. When identities are confusible it does not (Exp. 2). When identities are not confusible, which was the situation in Experiments 3 and 4, some expressions showed a small amount of interference. Such clear cut results as those obtained by Schweinberger and Soukup for the asymmetric independence of identity and expression were not obtained here. Schweinberger and Soukup (1998) argue for the informational encapsulation and priority of identity processing and suggest that expression processing is, in contrast modulated by additional associations in a way that identity processing is not. It is possible, for example, that the identity of a face, as it

becomes familiar, becomes an influential context for emotional decisions that is automatically taken into account. This would account for the slight interference observed in Garner experiments with initially unfamiliar faces when making expression classifications (Exps. 2, 3, and 4 this thesis; Schweinberger and Soukup, Exps. 1 and 2, 1998). However, pictorial differences that result in easier or more difficult classificatory decisions cannot be ruled out as the cause of the interference observed. More recent work by Schweinberger, Burton, and Kelly (in press) with morphed faces has indicated that ease of discrimination may not in fact be a factor in the asymmetric susceptibility of expression processing to variation in identity. Until more work is done, a position that remains open to the modification of the Bruce and Young (1986) model of mutual independence is therefore recommended. This question could be further explored using famous expressive faces and by taking into consideration the points raised in the methodological critique of Garner's paradigm in Chapter 6.

Expression and sex

The independence of expression and sex-of-face analysis was explored in Chapter 4. The results of a rating study suggested that surprised faces were thought more feminine. This is in agreement with some work by Campbell, Wallace, and Benson (1996) who implicated a large lid-to-brow distance as influencing sex-of-face judgements. However, in a Garner experiment when decisions were male or female *or* angry or surprised, it was shown possible to attend to either type of information independently of variation in the other. Participants did get confused about the sex of a face when lowered brows and clenched lips and teeth made faces look male and raised brows and a circular mouth made surprised faces look female, but *if* they got the sex of the face right at the beginning of the experiment, no interference from either irrelevant variation was observed in this speeded-classification format. This implies that even with impoverished stimuli (Exp. 7) where the major sex discrimination cues of hair and jawline were cropped out, we use more than a large lid area to process sex information,

and are able to keep the information required to generate sex and expression codes from the same stimulus separate.

Campbell et al. did not contrast sex-of-face and expression specifically. Their experiments used pictures of faces that were either looking at the viewer or looking down, and it may be that there is some way gaze direction and sex information interact that is to do with something other than a large lid-to-brow distance. Alternatively, speeded responses to the sex of the face may have been influenced by visual information consistent with sex decisions in a way similar to the errors that were made to angry female and surprised male faces in the experiments reported here. In a Garner experiment where dimensions are tested for their influence on each other, combinations that can speed and delay responses cancel each other out when RTs are averaged (Garner, 1976; see also Pomerantz, Sagar, and Stoever, 1977). The interpretation of an interdimensional relationship rests critically on a comparison of the mean of the condition in which the irrelevant variable is kept constant with the mean of the condition in which the irrelevant variable is varied orthogonally. Differences between responses to the *values* on each dimension (as when influenced by congruent or incongruent perceptual detail) are to do with differences specific to those stimuli, and are not considered diagnostic of interdimensional interaction (Garner, 1976). To test for dimensional interaction, a bidirectional task is required.

Expression and gaze direction

This last point is also relevant to tests of the independence of expression and gaze direction information carried out in Chapter 5. Once again a rating study indicated that these two types of information might interact on an attentional measure (Exp. 8), and once again they were found independent using Garner's (1976) criteria. That is, it was possible to say whether the face was looking towards or away from the viewer *or* whether the face was angry or happy regardless of irrelevant variation in the speeded response task when condition means were compared (Exp. 9). However, when single

dimensions were analysed, it was shown that participants responded more quickly to happy faces looking at them compared with angry faces looking at them. This difference was consistent across experimental conditions, indicating the presence of 'automatic' processes independent of selective attention. This effect did not hold when the faces were inverted: In fact it is assumed that the angry faces were easier to see upside down for both gaze direction and expression classification as they were responded to more quickly than happy ones (Exp. 10). A further experiment (Exp. 11) to find out whether or not there was an effect of the mouth on participants' ability to choose a face that was looking at them found that an angry mouth slowed RT while a happy mouth speeded it up. This is interpreted as a means by which expression may sustain an automatic perceptual configural influence on our response when someone is looking at us.

Summary of expression 'independence' from other facial dimensions

One interpretation of the results from the previous three experimental chapters is that, although we may have different emotional responses to different expressions, it is still possible to attend selectively to expression information as a functional category while identity (though the evidence is less clear cut in this case), sex, and gaze direction information vary, and vice versa. For identity, this supports the functioning of separate structural codes for expression and unfamiliar face (visually directed processing) analyses as set out in the Bruce and Young (1986) model. The Garner experiments carried out here did not eliminate the possibility that small amounts of interference from (mutually or asymmetrically) interactive pictorial codes, formed as a result of differences between pictures within the stimulus set (rather than any difference between the identities or expressions) may show up. More work is needed therefore on expression and identity processing with familiar faces before incorporating Schweinberger and Soukup's (1998) idea that identity-specific (characteristic) expression information filters through into the construction of an expression code. It is also suggested that sex information analysis remains where Bruce and Young place it,

under the visually directed processing mantle, for the time being. A notable absence from the Bruce and Young model to date has been gaze direction analysis and it is tentatively suggested that gaze processing may warrant its own 'box' and 'arrows' parallel to expression, and visually directed processing (see Figure 56).

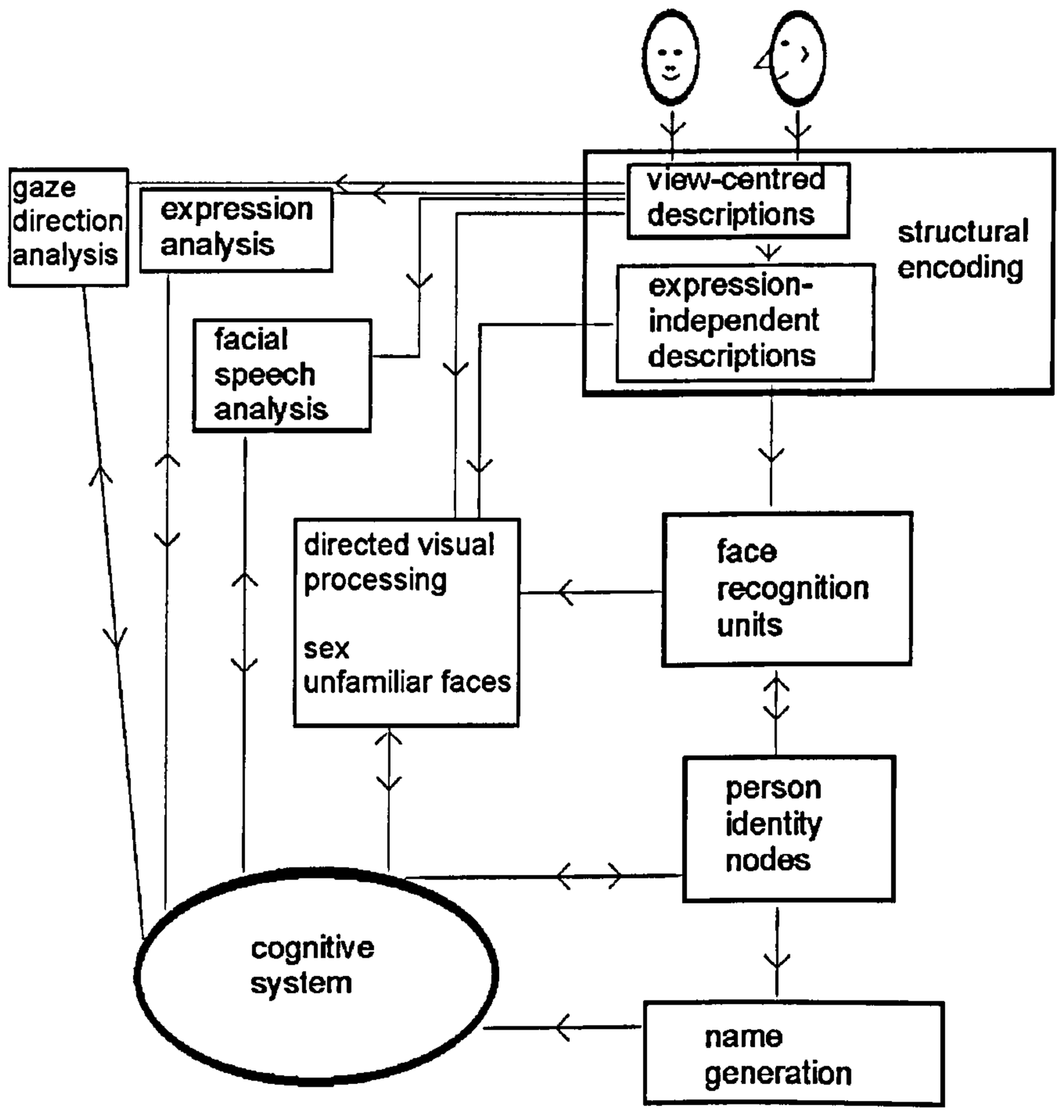

Figure 56. The Bruce and Young (1986) model of face recognition modified to indicate the proposed independence of gaze direction and expression processing. Independence of gaze direction analysis from other functional dimensions awaits experimental investigation.

It is suggested that gaze direction analysis is more likely to proceed from view-centred descriptions prior to any normalisation for expression that may take place, in order to allow for the intradimensional differences found. The different effects of anger and happiness that were observed are assumed to take place prior to our ability to screen out irrelevant information. The location of automatic pre-selective attention

effects (or, in van Leeuwen and Bakker's (1995) terms, an integrative strategy early in hologenesis), is, in the Bruce and Young framework, pushed nearer view-centred descriptions rather than towards any route through the cognitive system. Subtle functional connections between gaze direction and expression (e.g., Dimberg and Ohman, 1983) await replication and extension. As Watt (1995) has suggested, expression, facial speech, and gaze direction information are likely to be communicated by the mobile features of the face. In contrast, sex, age, and unfamiliar face processing do not sustain such an obvious connection with movement: Situating gaze direction analysis within visually directed processing is a less favoured option. Selective attention experiments on gaze direction and expression processing that include the larger cue of both head and eyes directed away from the viewer contrasted with head and eyes looking at the viewer may show greater interference from expression information. Intuitively however, and on the basis of the outcome of the identity - expression contrasts in Experiments 2 - 4, this would be more likely to make gaze direction classification easier and even less susceptible to interference from variation in expression. Indeed, using head and eye congruent cues oriented to the side make it more likely that the discrimination of expressions would be more difficult. In this case, more susceptibility to interference from gaze variation on the grounds of discriminability alone would be expected, with the easier task being processed prior to the more difficult one (e.g., Garner, 1983).

Evidence for affective cognitions so far

The intradimensional differences between happy and angry faces of Chapter 5 (Exp. 9) are the first in the experiments so far that provide any support for reports in the literature that suggest differential responses to positive and negative faces (e.g., Dimburg and Ohman, 1983; Hansen and Hansen, 1994). (The evidence is not yet sufficient to decide the question of whether or not this is a categorical or a valenced response.) Consider for a moment the expressions that have been looked at so far. In Experiment 2 happy and sad expressions were compared and RTs to sad were

significantly faster for identity classification, with RTs to happy significantly faster for expression classification; in Experiment 3 where happy and surprised expressions were compared, RTs to happy expressions were significantly faster for identity classifications with no difference between these two expressions during expression classification; in Experiment 4 where sad and surprised were chosen, RTs to surprised expressions were marginally faster for expression classification; in Experiments 6 and 7 where angry and surprised expressions were chosen for the expression - sex contrast no significant main effects of expression were observed with RTs to anger and surprised not significantly different from each other in both tasks. The data from these experiments is not supportive of any interpretation in terms of what might be aversive or attractive to the participant. This may be because agreed positive and negative expressions were not always used. Surprise, if it is considered a basic expression at all, is considered by some to be of neutral valence (Russell and Bullock, 1985). However, in Experiment 2, where a confirmed positive - negative contrast *was* made, sad was responded to more quickly in one case while happy was responded to more quickly in the other. It was only when expression and gaze direction information were varied in relation to each other that consistent differences related to opposing valence emerged. Two explanations at least are possible. Firstly, the difference between happy and angry expressions may be *because* valence is contrasted clearly, thus the opportunity for a differential response is presented. Additionally, as both gaze direction and expression supply information to the decoder related to the encoder's intentions, affective early attentive mechanisms may allow the modification of one by the other. Attenuation of RT to a face looking at the viewer by an angry mouth (Exp. 11) suggests a visual mechanism that may be involved in driving this process. The results of this experiment support the findings of Bradley et al. (1997) who have reported an attentional bias in a non-clinical population with low negative affect (i.e., not depressed) towards happy faces and away from angry ones. Slower responses to aversive faces looking at the viewer are however difficult to reconcile with Yoshikawa's (1999) findings that target angry faces presented peripherally are more accurately discriminated from a panel of

distracters, than either happy or neutral ones. It is likely that future experiments will find complex interactions between gaze direction and the perception of threat.

Expression and time

The findings from Chapter 7 pose more questions than they answer, and the experiments are best seen as the very start of a systematic enquiry into the effect of expression on our ability to estimate time intervals. Does emotional expression have an effect on time perception? Yes, possibly. If the experiments undertaken were actually varying expression (which they were) and expression was the variable that was having the effect (which is questionable), then type of expression may in some circumstances speed up or slow down our sense of time passing. In brief the results were: Female participants make longer time estimates when viewing angry faces (Exp. 12); a male angry face is thought to last longer than a male happy face (Exp. 13) although, within this overall result, Male and Female Ps respond differently to the same face; a female happy face is thought to last longer than a female angry face (Exp. 14); the results of Experiments 13 and 14 hold true in a repeated measures design (Exp. 15). These results may reflect genuine expression, sex of decoder, sex of stimulus, or methodological (e.g., length of time interval chosen) interactions, or they may reflect item differences: they await replication. If the results do reflect item-specific variation that is other than that of expression or sex difference, it would be interesting to know what this is.

Expression and probability learning

The experiments of Chapter 8 (Exps. 16 and 17) confirm a little known effect of angry expressions on our ability to estimate the future probability of events (Rosenhan and Messick, 1966), and subsequent recognition memory for those events. If participants are exposed to a sequence of faces, in which the majority (70%) are angry and the minority (30%) are happy, they are significantly worse at predicting what type of face turned up next in the sequence than participants who are exposed to a sequence in which the majority are happy and the minority are angry. Angry faces seen by

participants exposed to both types of sequence are remembered very well, with the overall performance of the majority angry group worse than that of the majority happy group. Poor performance of the majority angry group at probability learning is seen as an aversive response to the angry faces and a reluctance to predict that one will come next. Recognition memory for pictures seen previously and new pictures of the same actors were affected in a way that is not explained simply by the frequency with which these pictures are presented in the experiment. Nor is memory performance explained by the frequency with which we see angry and happy faces on a daily basis. (It is assumed that most people see happy faces more frequently than angry ones.) It is suggested that the aversion caused by exposure to angry faces is characterised by an attentional mechanism (possibly narrowing) and a memory bias that impair probability learning and target memorial resources to pictures of angry faces.

General support from these last experiments is offered for Oatley and Johnson-Laird's (1998) notion of emotion-specific profiles, each with its own attentional characteristics and memory biases, and the data are also compatible with Rolls' (199()) model of emotion in which emotional states may be induced by reinforcing stimuli. The probability learning results also concur with those of Bradley et al's. (1997) mentioned above in connection with the gaze direction experiments of Chapter 5 suggesting that participants with low levels of negative affect (such as is assumed in the student population here, although they were not actually assessed for mood or emotional state) show a bias away from threatening facial expressions and towards positive ones. It would be interesting to combine a recognition memory test with Bradley et al's modified selective attention design to see if the memory bias for faces observed in Phase 2 of the probability learning experiment here replicates with low-level negative affect participants. Mathews, Mogg, May, and Eysenck (1989) have already carried out a study that suggests anxious people do not sustain explicit memory biases for threat-related words, but do score well on implicit word completion tests.

In addition, there is evidence for a narrowing of attentional and memorial focus in the presence of threat from studies on eyewitness testimony (see Egeth, 1994 for a review) and memory for emotional events in spider phobics (Wessel and Merckelbach, 1997). The association of anxiety with enhanced distractibility and a narrowing of attention was tested by Koksal (1992, as cited in Eysenck and Keane). Participants with high levels of anxiety made more errors in a motion detection task in large displays compared with participants with low levels of anxiety, whereas no difference was found between these types of participant when smaller displays were used.

Reconciliation of approaches used in this thesis

Garner's selective attention paradigm suggests that on one level it is possible to attend selectively to different types of information from the face. However, very fast emotional reactions may occur to another's expression that are not revealed by this paradigm and may show up in rating studies that seek an 'opinion', or as consistent intradimensional differences across conditions in a Garner experiment, or in experiments that target preattentive processing and where strategic responding is not required. Such responses may be dependent on context ('evolutionary' and/ or 'learned'), with this context established prior to the experiment. Van Leeuwen and Bakker's (1995) integrative model and their demonstration of shifts in attention with time suggests that Garner interference is reflective of integrative strategies proceeding later in analysis. It is possible, for example, that the identity of a face, as it becomes familiar, becomes an influential context for emotional decisions that is automatically taken into account. In Rolls' (1990) framework, known people fulfil roles as reinforcers.

Differences in responses to expressions, if they are fast and automatic, may rely on more subtle instruction for detection. The participant, on being asked to ignore the irrelevant information in a Garner experiment, or a time estimation experiment may do just that. Experiments revealing interference from expression processing may be restricted to those in which the strategic allocation of attention is not required: the

difficulty with this type of experiment is then to determine whether or not the strategic allocation of attention is possible. It is interesting that, in order to detect an attentional difference to threat-related compared with non-threat-related stimuli, people working on emotion processing biases have developed a paradigm called the dot probe task (Bradley et al., 1997; MacLeod, Mathews, and Tata, 1986; Mathews, 1994). The participant is asked to detect the location of the dot. The dot is presented after two emotional stimuli have been displayed (one either side of a fixation point) at the location of one of the stimuli. The idea is that, if the participant's attention is drawn to the threatening stimulus, their eyes are likely to be in the same place and they will, on appropriate trials, detect the dot faster. It would be interesting to see whether or not attentional effects can be sustained for participants under instruction to ignore word meaning or facial expression. Hansen and Hansen (1994) have developed a converging experimental design studying the eye movements of observers in a detection task to show the way in which angry expressions will 'capture' attention. Participants in these experiments are asked to detect either an angry face or a happy face in a blocked design. In the emotional probability learning paradigm, resurrected from the literature for use in this thesis, the participant's attention is directed only incidentally towards the type of emotional expression in a way similar to the dot probe and 'capture' tasks mentioned. The use of this probability learning task may provide opportunities for further convergent findings, and consequent expansion of our understanding in this field.

Future work

The task of this section is to pull together the various suggestions made at intervals throughout the preceding document.

The shortcomings of the Garner paradigm in determining the interactive status of the expression dimension with the other facial dimensions of identity, sex, and gaze direction were outlined in Chapter 6. Use of this method without extensive pre-

experimental stimulus calibration can lead to problems in interpretation, and maybe, missing out on early cross-dimensional interaction altogether. It is therefore recommended that the Garner paradigm be combined with stimulus similarity assessment and discriminability matching for each task, that as many instances of each value on each dimension as possible be included and the number of these instances are kept equal, that simultaneous analysis of possible congruency effects (Stroop interference) is carried out, and that stimuli are masked to get some idea of the attentional time course of any interaction. With these caveats, the independence of identity and expression dimensions could be tested using either personally familiar or famous faces. Continued use of the Garner paradigm with unfamiliar faces could track the process by which unfamiliar faces become familiar simultaneously with the presence or absence of interactions with expression. The major advantages of Garner's method are that it is bidirectional and assesses interactive effects of dimensions on each other, and that it can be used to establish a time window within which it can be said selective attention is or is not possible. The Bruce and Young (1986) model of face perception and recognition may be restricted in that it represents a snapshot in time. It may, for example, miss out on separable very early processes, slightly later interactive effects, and account for later 'strategic' separable analyses. Findings that indicate the effect of expression information, such as that of an aversive mouth on gaze direction decisions from undirectional studies and single dimensional analyses (within the overall context of a Garner design), have yet to be incorporated into our current understanding of face perception.

Future work on expression and time perception would be better incorporated more directly with a bidirectional interference design. Although the indications are that the integration of emotional information from a facial expression with other aspects of cognition proceeds over a relatively lengthy period, it is recommended that there is the most to gain initially by concentrating on shorter time intervals.

Experiments 16 and 17 on expression and probability learning have produced clear evidence for a processing bias induced by negatively valenced stimuli. It has been suggested above that combining exposure to expressions at different probabilities of occurrence with other techniques looking for effects of expression on perception, attention, learning, and memory might be a worthwhile strategy. For example, majority angry and majority happy sequences could be used to induce mild stress or contentment prior to visual search experiments to see if angry faces 'pop out' under stress. As an immediate follow on from Experiment 17 in this thesis, the hypothsis that exposure to a sequence of majority angry faces in the probability learning task narrows the focus of attention could be tested by using Koksal's display size technique mentioned above.

In addition, 'on-line' methods of measuring levels of brain activation (event-related brain potentials - ERPs, scanning techniques etc.) might be used in conjunction with some of the above suggestions. For example, Johnson (1986) put forward a model identifying subjective probability, stimulus meaning, and information transmission as components of P300 amplitude. He further identified several components of each of these broad categories, and factors relating to stimulus meaning include task complexity, stimulus complexity (which can include the number of features relevant to the task that have to be processed), and stimulus significance or value. Information transmission deals with factors such as stimulus discriminability that create equivocation, and others affecting the allocation of attention. Johnson and his colleagues have experimented with time estimation (Johnson and Donchin, 1978) using neutral stimuli at varying levels of discriminability (intensity) over 1 s intervals, which presents the opportunity to study stimulus emotional significance building on their method and findings. More recent studies have investigated the electrophysiological correlates of exposure to expressions and faces. For example: a difference between exposure to happy and fearful faces in several ERP components has been found for infants (Nelson and DeHaan, 1996); gender differences in P300 processes after

exposure to male and female faces have been interpreted as reflecting affective processing (Oliver Rodriguez, Guan, and Johnston, 1999).

Conclusions

The central aim of this thesis was to look for interference between emotional expression processing and the processing of other types of information. Looking for interference with other types of facial information was largely unsuccessful using the Garner paradigm and it was concluded that, at the level of selective attention, expression is for the most part independent from identity, sex, and gaze direction analyses. When single dimensions were analysed for the identity - expression Garner experiments however, slight interference from identity information during expression classification was found. A similar analysis of single dimensions in the gaze direction - expression comparison revealed attenuated responses to angry expressions consistent across conditions. This finding was interpreted as an aversive response to angry (cf. happy) faces and a following experiment revealed that an angry mouth did indeed delay reaction time to a face looking towards the viewer. Unidirectional rating studies found the perceived masculinity of faces modified by surprised and angry expressions, and expression (happy cf. angry) and gaze direction interacted to make a face more or less interesting to look at.

An exploration of the interaction between valenced expressions and time perception showed this field of research daunting in its complexity. Some indication of what interacting variables (sex of the viewer and of the stimulus, type of expression, length of interval chosen, mode of instruction) would have to be accounted for, before a truly systematic onslaught on this area of enquiry is attempted, was attained.

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APPENDIX A
Rating sheet used for emotional expression assessment.

FACE No._____

1) Indicate what emotional expression you think the photographer was trying to elicit from this actor. Please mark only one O .

anger	o
disgust	o
fear	o
happiness	o
neutral	o
sadness	o
surprise	o

2) Please say how successful you think the photographer was. Mark only one O.

0 = not at all successful 9 = very successful

0	1	2	3	4	5	6	7	8	9
o	o	o	o	o	o	o	o	o	o

3) You <u>may or may not</u> think this face is expressing a blend of emotions at different intensities. Please fill out the following 'profile' for this face. Make one mark for <u>each</u> of the seven options (anger, disgust, fear, happiness, neutrality, sadness, surprise).

0 = not at all intense 9 = very intense

	0	1	2	3	4	5	6	7	8	9
anger	o	o	o	o	o	o	o	o	o	o
disgust	o	o	o	o	o	o	o	o	o	o
fear	o	o	o	o	o	o	o	o	o	o
happiness	o	o	o	o	o	o	o	o	o	o
neutral	o	o	o	o	o	o	o	o	o	o
sadness	o	o	o	o	o	o	o	o	o	o
surprise	o	o	o	o	o	o	o	o	o	o

4) Indicate how much arousal you think this face is showing.

0 = not aroused (eg. as if asleep) 9 = very aroused

0	1	2	3	4	5	6	7	8	9
o	o	o	o	o	o	o	o	o	o

5) Indicate how much pleasure you think this face is showing.

0 = maximum displeasure 9 = maximum pleasure

0	1	2	3	4	5	6	7	8	9
o	o	o	o	o	o	o	o	o	o

APPENDIX B
ANOVA Summary Tables

Chapter 2. Exp. 1 (p. 41): accuracy. Psex x fsex x Book.

SOURCE: grand mean

Psex	fsex	Book	N	MEAN	SD	SE
			140	70.4847	10.3150	0.8718

SOURCE: Psex

Psex	fsex	Book	N	MEAN	SD	SE
FP			70	70.0000	10.2741	1.2280
MP			70	70.9694	10.4071	1.2439

SOURCE: fsex

Psex	fsex	Book	N	MEAN	SD	SE
	f		70	71.7857	10.8213	1.2934
	m		70	69.1836	9.6854	1.1576

SOURCE: Psex fsex

Psex	fsex	Book	N	MEAN	SD	SE
FP	f		35	69.9319	11.7651	1.9887
FP	m		35	70.0680	8.7059	1.4716
MP	f		35	73.6394	9.5996	1.6226
MP	m		35	68.2993	10.6287	1.7966

SOURCE: Book

Psex	fsex	Book	N	MEAN	SD	SE
		A	20	70.5952	8.1487	1.8221
		B	20	73.2738	7.7222	1.7267
		C	20	65.9524	8.0316	1.7959
		D	20	77.3809	10.0274	2.2422
		E	20	67.3809	7.0841	1.5841
		F	20	63.5714	14.2669	3.1902
		G	20	75.2381	8.3342	1.8636

SOURCE: Psex Book

Psex	fsex	Book	N	MEAN	SD	SE
FP		A	10	69.0476	8.6213	2.7263
FP		B	10	75.0000	8.4924	2.6855
FP		C	10	65.7143	7.5459	2.3862
FP		D	10	75.9524	7.5668	2.3928
FP		E	10	67.8571	7.8768	2.4908
FP		F	10	59.7619	13.2066	4.1763
FP		G	10	76.6666	7.2566	2.2947
MP		A	10	72.1428	7.7802	2.4603
MP		B	10	71.5476	6.8663	2.1713
MP		C	10	66.1904	8.8946	2.8127
MP		D	10	78.8095	12.2670	3.8792
MP		E	10	66.9047	6.5878	2.0832
MP		F	10	67.3809	14.9346	4.7227
MP		G	10	73.8095	9.4574	2.9907

SOURCE: fsex Book

Psex	fsex	Book	N	MEAN	SD	SE
	f	A	10	74.5238	7.5334	2.3823
	f	B	10	77.5000	8.2038	2.5943
	f	C	10	68.8095	9.3536	2.9579
	f	D	10	80.7143	8.8697	2.8049
	f	E	10	69.2857	5.7724	1.8254
	f	F	10	58.8095	13.7487	4.3477
	f	G	10	72.8571	6.8457	2.1648
	m	A	10	66.6666	7.0093	2.2165

m	B	10	69.0476	4.3470	1.3746
m	C	10	63.0952	5.5271	1.7478
m	D	10	74.0476	10.4358	3.3001
m	E	10	65.4762	8.0351	2.5409
m	F	10	68.3333	13.7945	4.3622
m	G	10	77.6190	9.3368	2.9526

SOURCE: Psex fsex Book

Psex	fsex	Book	N	MEAN	SD	SE
FP	f	A	5	72.3809	9.6127	4.2989
FP	f	B	5	81.9048	5.4814	2.4513
FP	f	C	5	64.7619	10.8327	4.8445
FP	f	D	5	74.7619	6.4330	2.8769
FP	f	E	5	68.0952	6.8594	3.0676
FP	f	F	5	55.2381	16.3577	7.3154
FP	f	G	5	72.3809	7.0630	3.1587
FP	m	A	5	65.7143	6.8594	3.0676
FP	m	B	5	68.0952	3.6109	1.6148
FP	m	C	5	66.6666	2.9161	1.3041
FP	m	D	5	77.1428	9.1597	4.0963
FP	m	E	5	67.6190	9.6127	4.2989
FP	m	F	5	64.2857	8.5847	3.8392
FP	m	G	5	80.9524	4.7619	2.1296
MP	f	A	5	76.6666	4.8795	2.1822
MP	f	B	5	73.0952	8.5371	3.8179
MP	f	C	5	72.8571	6.2088	2.7766
MP	f	D	5	86.6667	6.8595	3.0676
MP	f	E	5	70.4762	4.9372	2.2080
MP	f	F	5	62.3809	11.2183	5.0170
MP	f	G	5	73.3333	7.4154	3.3163
MP	m	A	5	67.6190	7.8246	3.4993
MP	m	B	5	70.0000	5.2164	2.3328
MP	m	C	5	59.5238	5.3240	2.3810
MP	m	D	5	70.9524	11.7127	5.2381
MP	m	E	5	63.3333	6.4330	2.8769
MP	m	F	5	72.3809	17.7057	7.9182
MP	m	G	5	74.2857	12.0703	5.3980

FACTOR:	subs	Psex	fsex	Book	data
LEVELS:	70	2	2	7	140
TYPE :	RANDOM	BETWEEN	WITHIN	BETWEEN	DATA

SOURCE	SS	df	MS	F	p
Psex	32.8900	1	32.8900	0.354	0.554
s/PB	5205.8545	56	92.9617		
fsex	236.9712	1	236.9712	4.009	0.050
fs/PB	3310.1645	56	59.1101		
Pf	262.4006	1	262.4006	4.439	0.040 *
fs/PB	3310.1645	56	59.1101		
Book	3118.2603	6	519.7100	5.591	0.000 ***
s/PB	5205.8545	56	92.9617		
PB	452.1581	6	75.3597	0.811	0.566
s/PB	5205.8545	56	92.9617		
fB	1453.8614	6	242.3102	4.099	0.002 **
fs/PB	3310.1645	56	59.1101		
PfB	716.9790	6	119.4965	2.022	0.078
fs/PB	3310.1645	56	59.1101		

Chapter 2. Exp. 1 (p. 43): accuracy. Psex x fsex x expression.

SOURCE: grand mean

Psex	fsex	expre	N	MEAN	SD	SE
			980	70.4847	30.2835	0.9674

SOURCE: Psex

Psex	fsex	expre	N	MEAN	SD	SE
FP			490	70.0000	30.5073	1.3782
MP			490	70.9694	30.0814	1.3589

SOURCE: fsex

Psex	fsex	expre	N	MEAN	SD	SE
	f		490	71.7857	29.4558	1.3307
	m		490	69.1836	31.0648	1.4034

SOURCE: Psex fsex

Psex	fsex	expre	N	MEAN	SD	SE
FP	f		245	69.9319	30.0007	1.9167
FP	m		245	70.0680	31.0670	1.9848
MP	f		245	73.6394	28.8427	1.8427
MP	m		245	68.2993	31.1010	1.9870

SOURCE: expression

Psex	fsex	expre	N	MEAN	SD	SE
		angry	140	65.4464	29.6635	2.5070
		disgu	140	75.2381	26.2563	2.2191
		fear	140	48.3333	28.9918	2.4503
		happy	140	96.0714	11.4166	0.9649
		neutr	140	77.3809	25.3727	2.1444
		sad	140	49.2559	30.5421	2.5813
		surpr	140	81.6666	22.6449	1.9138

SOURCE: Psex expression

Psex	fsex	expre	N	MEAN	SD	SE
FP		angry	70	61.4285	30.5008	3.6455
FP		disgu	70	74.2857	26.5708	3.1758
FP		fear	70	46.6666	27.7439	3.3160
FP		happy	70	95.7143	11.2381	1.3432
FP		neutr	70	73.3333	25.6007	3.0599
FP		sad	70	52.3809	32.8817	3.9301
FP		surpr	70	86.1905	20.4561	2.4450
MP		angry	70	69.4643	28.4525	3.4007
MP		disgu	70	76.1904	26.0946	3.1189
MP		fear	70	50.0000	30.2964	3.6211
MP		happy	70	96.4286	11.6625	1.3939
MP		neutr	70	81.4286	24.6624	2.9477
MP		sad	70	46.1309	27.8952	3.3341
MP		surpr	70	77.1428	23.9382	2.8612

SOURCE: fsex expression

Psex	fsex	expre	N	MEAN	SD	SE
	f	angry	70	67.7976	32.2118	3.8501
	f	disgu	70	79.5238	23.7695	2.8410
	f	fear	70	53.5714	28.2177	3.3727
	f	happy	70	94.2857	13.8678	1.6575
	f	neutr	70	75.0000	26.4286	3.1588
	f	sad	70	48.7500	28.9141	3.4559
	f	surpr	70	83.5714	20.1630	2.4099
	m	angry	70	63.0952	26.9031	3.2155
	m	disgu	70	70.9524	28.0450	3.3520
	m	fear	70	43.0952	29.0056	3.4668

	m	happy	70	97.8571	7.9862	0.9545
	m	neutr	70	79.7619	24.2260	2.8956
	m	sad	70	49.7619	32.2896	3.8593
	m	surpr	70	79.7619	24.8818	2.9739

SOURCE: Psex fsex expression

Psex	fsex	expre	N	MEAN	SD	SE
FP	f	angry	35	59.0476	33.9027	5.7306
FP	f	disgu	35	79.0476	23.6888	4.0041
FP	f	fear	35	50.0000	28.0056	4.7338
FP	f	happy	35	94.2857	12.7462	2.1545
FP	f	neutr	35	70.9523	26.3036	4.4461
FP	f	sad	35	50.9523	28.2793	4.7801
FP	f	surpr	35	85.2381	21.6823	3.6650
FP	m	angry	35	63.8095	26.9609	4.5572
FP	m	disgu	35	69.5238	28.7216	4.8548
FP	m	fear	35	43.3333	27.4755	4.6442
FP	m	happy	35	97.1429	9.4676	1.6003
FP	m	neutr	35	75.7143	25.0303	4.2309
FP	m	sad	35	53.8095	37.2866	6.3026
FP	m	surpr	35	87.1428	19.4221	3.2829
MP	f	angry	35	76.5476	28.2613	4.7770
MP	f	disgu	35	80.0000	24.1861	4.0882
MP	f	fear	35	57.1428	28.3782	4.7968
MP	f	happy	35	94.2857	15.0939	2.5513
MP	f	neutr	35	79.0476	26.3036	4.4461
MP	f	sad	35	46.5476	29.7814	5.0340
MP	f	surpr	35	81.9047	18.6871	3.1587
MP	m	angry	35	62.3809	27.2194	4.6009
MP	m	disgu	35	72.3809	27.6955	4.6814
MP	m	fear	35	42.8571	30.8607	5.2164
MP	m	happy	35	98.5714	6.2249	1.0522
MP	m	neutr	35	83.8095	23.0394	3.8944
MP	m	sad	35	45.7143	26.3035	4.4461
MP	m	surpr	35	72.3809	27.6955	4.6814

FACTOR:	subs	Psex	fsex	expression	data
LEVELS:	70	2	2	7	980
TYPE :	RANDOM	BETWEEN	WITHIN	WITHIN	DATA

SOURCE	SS	df	MS	F	p
Psex	230.2294	1	230.2294	0.255	0.615
s/P	61433.9080	68	903.4398		
fsex	1658.7984	1	1658.7984	2.940	0.091
fs/P	38367.0310	68	564.2210		
Pf	1836.8047	1	1836.8047	3.255	0.076
fs/P	38367.0310	68	564.2210		
express	254323.8383	6	42387.3064	65.049	0.000 ***
es/P	265862.8995	408	651.6248		
Pe	9089.4761	6	1514.9127	2.325	0.032 *
es/P	265862.8995	408	651.6248		
fe	7311.6786	6	1218.6131	1.953	0.071
fes/P	254600.3892	408	624.0206		
Pfe	3117.8069	6	519.6345	0.833	0.545
fes/P	254600.3892	408	624.0206		

Chapter 3. Exp. 2 (p. 69): error data. Task x condition.
(i = identity, x = expression, r = correlated, c = control, o = orthogonal)

SOURCE: grand mean

task	condi	N	MEAN	SD	SE
		144	2.2656	2.0335	0.1695

SOURCE: task

task	condi	N	MEAN	SD	SE
i		72	1.7014	1.6292	0.1920
x		72	2.8299	2.2424	0.2643

SOURCE: condition

task	condi	N	MEAN	SD	SE
	r	48	2.0182	2.0997	0.3031
	c	48	2.2396	2.0174	0.2912
	o	48	2.5391	1.9907	0.2873

SOURCE: task condition

task	condi	N	MEAN	SD	SE
i	r	24	1.5625	1.2901	0.2633
i	c	24	1.4062	1.2534	0.2558
i	o	24	2.1354	2.1565	0.4402
x	r	24	2.4740	2.6290	0.5366
x	c	24	3.0729	2.3013	0.4698
x	o	24	2.9427	1.7628	0.3598

FACTOR:	subs	task	condition	errors
LEVELS:	48	2	3	144
TYPE :	RANDOM	BETWEEN	WITHIN	DATA

SOURCE	SS	df	MS	F	p	
task	45.8442	1	45.8442	5.522	0.023	*
s/t	381.9227	46	8.3027			
conditi	6.5592	2	3.2796	1.989	0.143	
cs/t	151.7036	92	1.6490			
tc	5.2789	2	2.6394	1.601	0.207	
cs/t	151.7036	92	1.6490			

Chapter 3. Exp. 2 (p. 69): error data for identity classification. Condition x identity x expression.
(r = correlated, c = control, o = orthogonal, A = Person A, B = Person B, h = happy, s = sad)

SOURCE: grand mean

condi	ident	expre	N	MEAN	SD	SE
			288	1.7014	2.4720	0.1457

SOURCE: condition

condi	ident	expre	N	MEAN	SD	SE
r			96	1.5625	1.8585	0.1897
c			96	1.4062	1.9471	0.1987
o			96	2.1354	3.3043	0.3372

SOURCE: identity

condi	ident	expre	N	MEAN	SD	SE
	A		144	1.7535	2.3851	0.1988
	B		144	1.6493	2.5632	0.2136

SOURCE: condition identity

condi	ident	expre	N	MEAN	SD	SE
r	A		48	1.6146	2.0297	0.2930
r	B		48	1.5104	1.6901	0.2439
c	A		48	1.4062	2.0568	0.2969
c	B		48	1.4062	1.8527	0.2674
o	A		48	2.2396	2.9282	0.4226
o	B		48	2.0312	3.6705	0.5298

SOURCE: expression

condi	ident	expre	N	MEAN	SD	SE
		h	144	2.0833	2.9417	0.2451
		s	144	1.3194	1.8212	0.1518

SOURCE: condition expression

condi	ident	expre	N	MEAN	SD	SE
r		h	48	1.6146	1.9631	0.2833
r		s	48	1.5104	1.7670	0.2550
c		h	48	1.4583	1.9862	0.2867
c		s	48	1.3542	1.9267	0.2781
o		h	48	3.1771	4.0849	0.5896
o		s	48	1.0938	1.7795	0.2568

SOURCE: identity expression

condi	ident	expre	N	MEAN	SD	SE
	A	h	72	2.2917	2.8381	0.3345
	A	s	72	1.2153	1.6780	0.1978
	B	h	72	1.8750	3.0475	0.3591
	B	s	72	1.4236	1.9603	0.2310

SOURCE: condition identity expression

condi	ident	expre	N	MEAN	SD	SE
r	A	h	24	1.7708	2.2697	0.4633
r	A	s	24	1.4583	1.7932	0.3660
r	B	h	24	1.4583	1.6347	0.3337
r	B	s	24	1.5625	1.7773	0.3628
c	A	h	24	1.7708	2.3865	0.4871
c	A	s	24	1.0417	1.6347	0.3337
c	B	h	24	1.1458	1.4706	0.3002
c	B	s	24	1.6667	2.1703	0.4430
o	A	h	24	3.3333	3.5098	0.7164
o	A	s	24	1.1458	1.6450	0.3358
o	B	h	24	3.0208	4.6613	0.9515

o B s 24 1.0417 1.9388 0.3958

FACTOR:	subs	condition	identity	expression	errors
LEVELS:	24	3	2	2	288
TYPE :	RANDOM	WITHIN	WITHIN	WITHIN	DATA

SOURCE	SS	df	MS	F	p	
conditi	28.2986	2	14.1493	1.796	0.177	
cs/	362.3264	46	7.8767			
identit	0.7812	1	0.7812	0.183	0.673	
is/	98.1771	23	4.2686			
ci	0.5208	2	0.2604	0.091	0.913	
cis/	131.7708	46	2.8646			
express	42.0139	1	42.0139	6.412	0.019	*
es/	150.6944	23	6.5519			
ce	62.6736	2	31.3368	5.893	0.005	**
ces/	244.6181	46	5.3178			
ie	7.0312	1	7.0312	1.291	0.268	
ies/	125.2604	23	5.4461			
cie	3.6458	2	1.8229	0.631	0.536	
cies/	132.8125	46	2.8872			

Chapter 3. Exp. 2 (p. 70): error data for expression classification. Condition x identity x expression.
(r = correlated, c = control, o = orthogonal, A = Person A, B = Person B, h = happy, s = sad)

SOURCE: grand mean

condi	ident	expre	N	MEAN	SD	SE
			288	2.8299	3.4196	0.2015

SOURCE: condition

condi	ident	expre	N	MEAN	SD	SE
r			96	2.4740	3.8302	0.3909
c			96	3.0729	3.2338	0.3301
o			96	2.9427	3.1622	0.3227

SOURCE: identity

condi	ident	expre	N	MEAN	SD	SE
	A		144	3.0208	3.6794	0.3066
	B		144	2.6389	3.1398	0.2616

SOURCE: condition identity

condi	ident	expre	N	MEAN	SD	SE
r	A		48	2.6562	4.8214	0.6959
r	B		48	2.2917	2.5177	0.3634
c	A		48	2.9688	3.0360	0.4382
c	B		48	3.1771	3.4495	0.4979
o	A		48	3.4375	2.9002	0.4186
o	B		48	2.4479	3.3616	0.4852

SOURCE: expression

condi	ident	expre	N	MEAN	SD	SE
		h	144	2.6736	2.9809	0.2484
		s	144	2.9861	3.8124	0.3177

SOURCE: condition expression

condi	ident	expre	N	MEAN	SD	SE
r		h	48	2.1354	2.5780	0.3721
r		s	48	2.8125	4.7721	0.6888
c		h	48	3.1250	3.2412	0.4678
c		s	48	3.0208	3.2599	0.4705
o		h	48	2.7604	3.0614	0.4419
o		s	48	3.1250	3.2820	0.4737

SOURCE: identity expression

condi	ident	expre	N	MEAN	SD	SE
	A	h	72	2.7431	3.0593	0.3605
	A	s	72	3.2986	4.2132	0.4965
	B	h	72	2.6042	2.9202	0.3442
	B	s	72	2.6736	3.3653	0.3966

SOURCE: condition identity expression

condi	ident	expre	N	MEAN	SD	SE
r	A	h	24	1.8750	2.7829	0.5681
r	A	s	24	3.4375	6.2036	1.2663
r	B	h	24	2.3958	2.3865	0.4871
r	B	s	24	2.1875	2.6898	0.5491
c	A	h	24	3.4375	3.5974	0.7343
c	A	s	24	2.5000	2.3313	0.4759
c	B	h	24	2.8125	2.8848	0.5889
c	B	s	24	3.5417	3.9643	0.8092
o	A	h	24	2.9167	2.6237	0.5356
o	A	s	24	3.9583	3.1205	0.6370
o	B	h	24	2.6042	3.4953	0.7135

o B s 24 2.2917 3.2900 0.6716

FACTOR:	subs	condition	identity	expression	errors
LEVELS:	24	3	2	2	288
TYPE :	RANDOM	WITHIN	WITHIN	WITHIN	DATA

SOURCE	SS	df	MS	F	p
conditi	19.0538	2	9.5269	1.792	0.178
cs/	244.4878	46	5.3150		
identit	10.5035	1	10.5035	1.682	0.208
is/	143.6632	23	6.2462		
ci	17.2309	2	8.6155	1.021	0.368
cis/	387.9774	46	8.4343		
express	7.0312	1	7.0312	0.515	0.480
es/	313.8021	23	13.6436		
ce	7.4219	2	3.7109	0.441	0.646
ces/	387.3698	46	8.4211		
ie	4.2535	1	4.2535	0.559	0.462
ies/	174.9132	23	7.6049		
cie	42.2309	2	21.1155	2.250	0.117
cies/	431.7274	46	9.3854		

Chapter 3. Exp. 2 (p. 70): correct RTs. Task x condition.
(i = identity, x = expression, r = correlated, c = control, o = orthogonal)

SOURCE: grand mean

task	condi	N	MEAN	SD	SE
		144	578.3707	76.6553	6.3879

SOURCE: task

task	condi	N	MEAN	SD	SE
i		72	572.5104	74.6583	8.7986
x		72	584.2309	78.6850	9.2731

SOURCE: condition

task	condi	N	MEAN	SD	SE
	r	48	567.0260	73.1114	10.5527
	c	48	568.1797	67.1101	9.6865
	o	48	599.9062	85.5451	12.3474

SOURCE: task condition

task	condi	N	MEAN	SD	SE
i	r	24	563.6562	75.2118	15.3525
i	c	24	561.7083	63.8617	13.0357
i	o	24	592.1667	82.8516	16.9120
x	r	24	570.3958	72.4047	14.7795
x	c	24	574.6510	70.9762	14.4880
x	o	24	607.6458	89.2452	18.2171

FACTOR:	subs	task	condition	data
LEVELS:	48	2	3	144
TYPE :	RANDOM	BETWEEN	WITHIN	DATA

SOURCE	SS	df	MS	F	p	
task	4945.3126	1	4945.3126	0.342	0.561	
s/t	664974.2316	46	14455.9616			
conditi	33424.2203	2	16712.1101	11.268	0.000	***
cs/t	136444.3589	92	1483.0909			
tc	485.1708	2	242.5854	0.164	0.849	
cs/t	136444.3589	92	1483.0909			

Chapter 3. Exp. 2 (p. 71): correct RTs for identity classification. Condition x identity x expression.
(r = correlated, c = control, o = orthogonal, A = Person A, B = Person B, h = happy, s = sad)

SOURCE: grand mean

condi	ident	expre	N	MEAN	SD	SE
			288	572.5104	84.3515	4.9705

SOURCE: condition

condi	ident	expre	N	MEAN	SD	SE
r			96	563.6562	85.3367	8.7096
c			96	561.7083	75.6227	7.7182
o			96	592.1667	88.9190	9.0753

SOURCE: identity

condi	ident	expre	N	MEAN	SD	SE
	A		144	566.3229	81.8509	6.8209
	B		144	578.6979	86.6223	7.2185

SOURCE: condition identity

condi	ident	expre	N	MEAN	SD	SE
r	A		48	557.2396	81.2328	11.7249
r	B		48	570.0729	89.6481	12.9396
c	A		48	552.5417	72.7244	10.4969
c	B		48	570.8750	78.0948	11.2720
o	A		48	589.1875	87.6586	12.6524
o	B		48	595.1458	90.9902	13.1333

SOURCE: expression

condi	ident	expre	N	MEAN	SD	SE
		h	144	583.2049	87.8103	7.3175
		s	144	561.8160	79.6185	6.6349

SOURCE: condition expression

condi	ident	expre	N	MEAN	SD	SE
r		h	48	561.3229	78.6119	11.3467
r		s	48	565.9896	92.3509	13.3297
c		h	48	576.9688	80.5133	11.6211
c		s	48	546.4479	67.8321	9.7907
o		h	48	611.3229	97.2710	14.0399
o		s	48	573.0104	75.9619	10.9642

SOURCE: identity expression

condi	ident	expre	N	MEAN	SD	SE
	A	h	72	587.0764	86.0615	10.1424
	A	s	72	545.5694	72.2037	8.5093
	B	h	72	579.3333	89.9606	10.6020
	B	s	72	578.0625	83.7783	9.8734

SOURCE: condition identity expression

condi	ident	expre	N	MEAN	SD	SE
r	A	h	24	576.8542	81.9631	16.7306
r	A	s	24	537.6250	77.2242	15.7633
r	B	h	24	545.7917	73.5323	15.0097
r	B	s	24	594.3542	98.9221	20.1924
c	A	h	24	571.4583	76.1259	15.5391
c	A	s	24	533.6250	65.3122	13.3318
c	B	h	24	582.4792	85.9542	17.5453
c	B	s	24	559.2708	69.2359	14.1327
o	A	h	24	612.9167	96.3865	19.6748
o	A	s	24	565.4583	72.3650	14.7714
o	B	h	24	609.7292	100.1948	20.4522

o B s 24 580.5625 80.2220 16.3753

FACTOR:	subs	condition	identity	expression	data
LEVELS:	24	3	2	2	288
TYPE :	RANDOM	WITHIN	WITHIN	WITHIN	DATA

SOURCE	SS	df	MS	F	p	
conditi	55819.1458	2	27909.5729	4.942	0.011	*
cs/	259801.7292	46	5647.8637			
identit	11026.1250	1	11026.1250	3.619	0.070	
is/	70080.8333	23	3046.9928			
ci	1845.2500	2	922.6250	0.980	0.383	
cis/	43323.0417	46	941.8053			
express	32938.8889	1	32938.8889	16.357	0.001	***
es/	46316.3194	23	2013.7530			
ce	25168.6319	2	12584.3160	7.187	0.002	**
ces/	80547.6597	46	1751.0361			
ie	29141.0035	1	29141.0035	16.104	0.001	***
ies/	41619.6215	23	1809.5488			
cie	20394.1111	2	10197.0556	8.276	0.001	***
cies/	56677.2639	46	1232.1144			

Chapter 3. Exp. 2 (p. 72): correct RTs for expression classification. Condition x identity x expression.
(r = correlated, c = control, o = orthogonal, A = Person A, B = Person B, h = happy, s = sad)

SOURCE: grand mean

condi	ident	expre	N	MEAN	SD	SE
			288	584.0747	88.8426	5.2351

SOURCE: condition

condi	ident	expre	N	MEAN	SD	SE
r			96	570.3958	85.5715	8.7336
c			96	574.1823	81.1205	8.2793
o			96	607.6458	95.3560	9.7322

SOURCE: identity

condi	ident	expre	N	MEAN	SD	SE
	A		144	595.1632	90.8561	7.5713
	B		144	572.9861	85.6665	7.1389

SOURCE: condition identity

condi	ident	expre	N	MEAN	SD	SE
r	A		48	576.3958	93.2441	13.4586
r	B		48	564.3958	77.6708	11.2108
c	A		48	595.3021	78.7405	11.3652
c	B		48	553.0625	78.6763	11.3559
o	A		48	613.7917	97.5044	14.0735
o	B		48	601.5000	93.7802	13.5360

SOURCE: expression

condi	ident	expre	N	MEAN	SD	SE
		h	144	570.8299	84.2469	7.0206
		s	144	597.3194	91.5990	7.6332

SOURCE: condition expression

condi	ident	expre	N	MEAN	SD	SE
r		h	48	556.2396	80.3659	11.5998
r		s	48	584.5521	89.0660	12.8556
c		h	48	561.8646	76.5165	11.0442
c		s	48	586.5000	84.4773	12.1932
o		h	48	594.3854	91.7335	13.2406
o		s	48	620.9062	98.0040	14.1457

SOURCE: identity expression

condi	ident	expre	N	MEAN	SD	SE
	A	h	72	569.2986	84.2399	9.9278
	A	s	72	621.0278	90.4034	10.6541
	B	h	72	572.3611	84.8170	9.9958
	B	s	72	573.6111	87.0985	10.2647

SOURCE: condition identity expression

condi	ident	expre	N	MEAN	SD	SE
r	A	h	24	545.1667	81.4744	16.6309
r	A	s	24	607.6250	95.3601	19.4653
r	B	h	24	567.3125	79.3991	16.2073
r	B	s	24	561.4792	77.4973	15.8191
c	A	h	24	576.0625	77.4927	15.8181
c	A	s	24	614.5417	76.7598	15.6685
c	B	h	24	547.6667	74.4197	15.1909
c	B	s	24	558.4583	83.9643	17.1391
o	A	h	24	586.6667	91.0648	18.5885
o	A	s	24	640.9167	97.9758	19.9992
o	B	h	24	602.1042	93.6953	19.1255

o B s 24 600.8958 95.8763 19.5707

FACTOR:	subs	condition	identity	expression	data
LEVELS:	24	3	2	2	288
TYPE :	RANDOM	WITHIN	WITHIN	WITHIN	DATA

SOURCE	SS	df	MS	F	p	
conditi	80694.6684	2	40347.3342	6.521	0.003	**
cs/	284626.9566	46	6187.5425			
identit	35411.2578	1	35411.2578	16.874	0.000	***
is/	48267.0964	23	2098.5694			
ci	14491.1615	2	7245.5807	4.666	0.014	*
cis/	71429.2969	46	1552.8108			
express	50522.2578	1	50522.2578	16.011	0.001	***
es/	72575.9297	23	3155.4752			
ce	162.2865	2	81.1432	0.081	0.922	
ces/	46073.8385	46	1001.6052			
ie	45866.6328	1	45866.6328	20.546	0.000	***
ies/	51344.2214	23	2232.3575			
cie	5169.2240	2	2584.6120	1.707	0.193	
cies/	69645.7344	46	1514.0377			

Chapter 3. Exp. 3 (p. 83): correct RTs. Task x condition.
(i = identity, x = expression, r = correlated, c = control, o = orthogonal)

SOURCE: grand mean

task	condi	N	MEAN	SD	SE
		144	583.2008	74.0895	6.1741

SOURCE: task

task	condi	N	MEAN	SD	SE
i		72	593.2106	68.4484	8.0667
x		72	573.1910	78.5328	9.2552

SOURCE: condition

task	condi	N	MEAN	SD	SE
	r	48	559.5043	68.8318	9.9350
	c	48	587.1667	72.2850	10.4334
	o	48	602.9314	75.8372	10.9462

SOURCE: task condition

task	condi	N	MEAN	SD	SE
i	r	24	569.4271	52.6600	10.7492
i	c	24	601.8125	73.6227	15.0282
i	o	24	608.3924	73.2232	14.9466
x	r	24	549.5816	81.8722	16.7121
x	c	24	572.5208	69.3504	14.1561
x	o	24	597.4705	79.5535	16.2388

FACTOR:	subs	task	condition	data
LEVELS:	48	2	3	144
TYPE :	RANDOM	BETWEEN	WITHIN	DATA

SOURCE	SS	df	MS	F	p	
task	14428.3403	1	14428.3403	1.105	0.299	
s/t	600437.2031	46	13052.9827			
conditi	46394.2965	2	23197.1482	17.539	0.000	***
cs/t	121677.6653	92	1322.5833			
tc	2025.2405	2	1012.6203	0.766	0.468	
cs/t	121677.6653	92	1322.5833			

Chapter 3. Exp. 3 (p. 84): correct RTs for identity classification. Condition x identity x expression.
(r = correlated, c = control, o = orthogonal, B = Ben, M = Mike, h = happy, s = surprised)

SOURCE: grand mean

condi	ident	expre	N	MEAN	SD	SE
			288	593.2106	78.7117	4.6381

SOURCE: condition

condi	ident	expre	N	MEAN	SD	SE
r			96	569.4271	64.7862	6.6122
c			96	601.8125	83.7284	8.5455
o			96	608.3924	81.4250	8.3104

SOURCE: identity

condi	ident	expre	N	MEAN	SD	SE
	B		144	586.9086	74.6154	6.2179
	M		144	599.5127	82.3829	6.8652

SOURCE: condition identity

condi	ident	expre	N	MEAN	SD	SE
r	B		48	563.5799	63.1173	9.1102
r	M		48	575.2743	66.5596	9.6070
c	B		48	595.6667	81.1448	11.7122
c	M		48	607.9583	86.6511	12.5070
o	B		48	601.4792	74.2970	10.7238
o	M		48	615.3056	88.2239	12.7340

SOURCE: expression

condi	ident	expre	N	MEAN	SD	SE
		h	144	584.4687	76.5296	6.3775
		s	144	601.9525	80.1479	6.6790

SOURCE: condition expression

condi	ident	expre	N	MEAN	SD	SE
r		h	48	566.1736	63.5150	9.1676
r		s	48	572.6806	66.5434	9.6047
c		h	48	593.4826	81.5499	11.7707
c		s	48	610.1424	85.8949	12.3979
o		h	48	593.7500	81.3771	11.7458
o		s	48	623.0347	79.6302	11.4936

SOURCE: identity expression

condi	ident	expre	N	MEAN	SD	SE
	B	h	72	577.3449	71.3045	8.4033
	B	s	72	596.4722	77.0940	9.0856
	M	h	72	591.5926	81.2944	9.5806
	M	s	72	607.4329	83.2674	9.8132

SOURCE: condition identity expression

condi	ident	expre	N	MEAN	SD	SE
r	B	h	24	562.3542	66.3255	13.5386
r	B	s	24	564.8056	61.1440	12.4810
r	M	h	24	569.9931	61.7591	12.6065
r	M	s	24	580.5556	71.9762	14.6921
c	B	h	24	584.0347	75.4691	15.4051
c	B	s	24	607.2986	86.4712	17.6509
c	M	h	24	602.9305	87.7954	17.9212
c	M	s	24	612.9861	87.0776	17.7746
o	B	h	24	585.6458	72.4387	14.7865
o	B	s	24	617.3125	74.2262	15.1514
o	M	h	24	601.8542	90.2660	18.4255

o M s 24 628.7569 85.9055 17.5354

FACTOR:	subs	condition	identity	expression	data
LEVELS:	24	3	2	2	288
TYPE :	RANDOM	WITHIN	WITHIN	WITHIN	DATA

SOURCE	SS	df	MS	F	p	
conditi	83532.8681	2	41766.4340	8.108	0.001	***
cs/	236950.2050	46	5151.0914			
identit	11438.2839	1	11438.2839	2.455	0.131	
is/	107160.2976	23	4659.1434			
ci	58.0581	2	29.0290	0.036	0.965	
cis/	37218.8757	46	809.1060			
express	22009.1907	1	22009.1907	8.983	0.006	**
es/	56352.2124	23	2450.0962			
ce	6250.3748	2	3125.1874	1.731	0.188	
ces/	83054.3993	46	1805.5304			
ie	194.4833	1	194.4833	0.074	0.788	
ies/	60458.6166	23	2628.6355			
cie	1383.1854	2	691.5927	0.514	0.602	
cies/	61944.0106	46	1346.6089			

Chapter 3. Exp. 3 (p. 84): correct RTs for identity classification for control and orthogonal conditions only. Condition x identity x expression.
(c = control, o = orthogonal, B = Ben, M = Mike, h = happy, s = surprised)

SOURCE: grand mean

condi	ident	expre	N	MEAN	SD	SE
			192	605.1024	82.4342	5.9492

SOURCE: condition

condi	ident	expre	N	MEAN	SD	SE
c			96	601.8125	83.7284	8.5455
o			96	608.3924	81.4250	8.3104

SOURCE: identity

condi	ident	expre	N	MEAN	SD	SE
	B		96	598.5729	77.4408	7.9038
	M		96	611.6319	87.0580	8.8853

SOURCE: condition identity

condi	ident	expre	N	MEAN	SD	SE
c	B		48	595.6667	81.1448	11.7122
c	M		48	607.9583	86.6511	12.5070
o	B		48	601.4792	74.2970	10.7238
o	M		48	615.3056	88.2239	12.7340

SOURCE: expression

condi	ident	expre	N	MEAN	SD	SE
		h	96	593.6163	81.0337	8.2705
		s	96	616.5885	82.6392	8.4343

SOURCE: condition expression

condi	ident	expre	N	MEAN	SD	SE
c		h	48	593.4826	81.5499	11.7707
c		s	48	610.1424	85.8949	12.3979
o		h	48	593.7500	81.3771	11.7458
o		s	48	623.0347	79.6302	11.4936

SOURCE: identity expression

condi	ident	expre	N	MEAN	SD	SE
	B	h	48	584.8403	73.1828	10.5630
	B	s	48	612.3056	79.8802	11.5297
	M	h	48	602.3924	88.0886	12.7145
	M	s	48	620.8715	85.9387	12.4042

SOURCE: condition identity expression

condi	ident	expre	N	MEAN	SD	SE
c	B	h	24	584.0347	75.4691	15.4051
c	B	s	24	607.2986	86.4712	17.6509
c	M	h	24	602.9305	87.7954	17.9212
c	M	s	24	612.9861	87.0776	17.7746
o	B	h	24	585.6458	72.4387	14.7865
o	B	s	24	617.3125	74.2262	15.1514
o	M	h	24	601.8542	90.2660	18.4255
o	M	s	24	628.7569	85.9055	17.5354

FACTOR:	subs	condition	identity	expression	data
LEVELS:	24	2	2	2	192
TYPE :	RANDOM	WITHIN	WITHIN	WITHIN	DATA

SOURCE	SS	df	MS	F	p

conditi	2078.1380	1	2078.1380	0.463	0.503
cs/	103166.4667	23	4485.4986		
identit	8185.8342	1	8185.8342	2.250	0.147
is/	83695.8582	23	3638.9504		
ci	28.2649	1	28.2649	0.028	0.868
cis/	22873.2851	23	994.4907		
express	25330.7116	1	25330.7116	7.719	0.011 *
es/	75472.3274	23	3281.4055		
ce	1912.6863	1	1912.6863	1.036	0.319
ces/	42472.2869	23	1846.6212		
ie	969.0028	1	969.0028	0.815	0.376
ies/	27332.0345	23	1188.3493		
cie	213.9255	1	213.9255	0.319	0.578
cies/	15420.4895	23	670.4561		

Chapter 3. Exp. 3 (p. 85): correct RTs for expression classification. Condition x identity x expression.
(r = correlated, c = control, o = orthogonal, B = Ben, M = Mike, h = happy, s = surprised)

SOURCE: grand mean

condi	ident	expre	N	MEAN	SD	SE
			288	573.1910	87.0724	5.1308

SOURCE: condition

condi	ident	expre	N	MEAN	SD	SE
r			96	549.5816	87.8327	8.9644
c			96	572.5208	81.4385	8.3118
o			96	597.4705	86.0129	8.7787

SOURCE: identity

condi	ident	expre	N	MEAN	SD	SE
	B		144	561.1956	82.1081	6.8423
	M		144	585.1863	90.4694	7.5391

SOURCE: condition identity

condi	ident	expre	N	MEAN	SD	SE
r	B		48	548.5833	80.8398	11.6682
r	M		48	550.5799	95.1641	13.7358
c	B		48	547.1562	74.4167	10.7411
c	M		48	597.8854	80.9543	11.6848
o	B		48	587.8472	85.7322	12.3744
o	M		48	607.0938	86.1085	12.4287

SOURCE: expression

condi	ident	expre	N	MEAN	SD	SE
		h	144	570.3426	80.1158	6.6763
		s	144	576.0394	93.7089	7.8091

SOURCE: condition expression

condi	ident	expre	N	MEAN	SD	SE
r		h	48	547.3021	80.4035	11.6052
r		s	48	551.8611	95.4881	13.7825
c		h	48	575.9688	83.9166	12.1123
c		s	48	569.0729	79.6196	11.4921
o		h	48	587.7569	71.6786	10.3459
o		s	48	607.1840	98.0984	14.1593

SOURCE: identity expression

condi	ident	expre	N	MEAN	SD	SE
	B	h	72	567.5579	76.8875	9.0613
	B	s	72	554.8333	87.0899	10.2636
	M	h	72	573.1273	83.6664	9.8602
	M	s	72	597.2454	95.8629	11.2976

SOURCE: condition identity expression

condi	ident	expre	N	MEAN	SD	SE
r	B	h	24	556.5556	73.6884	15.0416
r	B	s	24	540.6111	88.2703	18.0181
r	M	h	24	538.0486	87.1885	17.7973
r	M	s	24	563.1111	102.8426	20.9927
c	B	h	24	559.6042	85.1161	17.3742
c	B	s	24	534.7083	61.2238	12.4973
c	M	h	24	592.3333	81.1575	16.5662
c	M	s	24	603.4375	82.1052	16.7597
o	B	h	24	586.5139	70.7610	14.4440
o	B	s	24	589.1806	100.0438	20.4213
o	M	h	24	589.0000	74.0856	15.1227

o M s 24 625.1875 94.7618 19.3432

FACTOR:	subs	condition	identity	expression	data
LEVELS:	24	3	2	2	288
TYPE :	RANDOM	WITHIN	WITHIN	WITHIN	DATA

SOURCE	SS	df	MS	F	p	
conditi	110145.2703	2	55072.6351	10.143	0.000	***
cs/	249760.4666	46	5429.5754			
identit	41440.0103	1	41440.0103	27.062	0.000	***
is/	35219.5209	23	1531.2835			
ci	29308.7106	2	14654.3553	11.891	0.000	***
cis/	56688.1820	46	1232.3518			
express	2336.6208	1	2336.6208	0.574	0.456	
es/	93610.1032	23	4070.0045			
ce	8361.3545	2	4180.6773	3.978	0.025	*
ces/	48343.6266	46	1050.9484			
ie	24432.7803	1	24432.7803	26.121	0.000	***
ies/	21513.2605	23	935.3592			
cie	174.5155	2	87.2577	0.064	0.938	
cies/	62949.8362	46	1368.4747			

Chapter 3. Exp. 3 (p.85): correct RTs for expression classification for control and orthogonal conditions only. Condition x identity x expression.
(c = control, o = orthogonal, B = Ben, M = Mike, h = happy, s = surprised)

SOURCE: grand mean

condi	ident	expre	N	MEAN	SD	SE
			192	584.9957	84.4685	6.0960

SOURCE: condition

condi	ident	expre	N	MEAN	SD	SE
c			96	572.5208	81.4385	8.3118
o			96	597.4705	86.0129	8.7787

SOURCE: identity

condi	ident	expre	N	MEAN	SD	SE
	B		96	567.5017	82.4281	8.4128
	M		96	602.4896	83.2589	8.4976

SOURCE: condition identity

condi	ident	expre	N	MEAN	SD	SE
c	B		48	547.1562	74.4167	10.7411
c	M		48	597.8854	80.9543	11.6848
o	B		48	587.8472	85.7322	12.3744
o	M		48	607.0938	86.1085	12.4287

SOURCE: expression

condi	ident	expre	N	MEAN	SD	SE
		h	96	581.8628	77.8519	7.9457
		s	96	588.1285	90.9077	9.2782

SOURCE: condition expression

condi	ident	expre	N	MEAN	SD	SE
c		h	48	575.9688	83.9166	12.1123
c		s	48	569.0729	79.6196	11.4921
o		h	48	587.7569	71.6786	10.3459
o		s	48	607.1840	98.0984	14.1593

SOURCE: identity expression

condi	ident	expre	N	MEAN	SD	SE
	B	h	48	573.0590	78.6160	11.3472
	B	s	48	561.9444	86.5436	12.4915
	M	h	48	590.6667	76.8895	11.0980
	M	s	48	614.3125	88.3972	12.7590

SOURCE: condition identity expression

condi	ident	expre	N	MEAN	SD	SE
c	B	h	24	559.6042	85.1161	17.3742
c	B	s	24	534.7083	61.2238	12.4973
c	M	h	24	592.3333	81.1575	16.5662
c	M	s	24	603.4375	82.1052	16.7597
o	B	h	24	586.5139	70.7610	14.4440
o	B	s	24	589.1806	100.0438	20.4213
o	M	h	24	589.0000	74.0856	15.1227
o	M	s	24	625.1875	94.7618	19.3432

FACTOR:	subs	condition	identity	expression	data
LEVELS:	24	2	2	2	192
TYPE :	RANDOM	WITHIN	WITHIN	WITHIN	DATA

SOURCE	SS	df	MS	F	p

conditi	29879.2911	1	29879.2911	4.901	0.037 *
cs/	140209.5024	23	6096.0653		
identit	58759.1762	1	58759.1762	38.870	0.000 ***
is/	34769.0297	23	1511.6969		
ci	11893.8775	1	11893.8775	7.856	0.010 *
cis/	34821.7726	23	1513.9901		
express	1884.3869	1	1884.3869	0.581	0.454
es/	74559.2532	23	3241.7067		
ce	8314.7549	1	8314.7549	6.426	0.019 *
ces/	29761.3039	23	1293.9697		
ie	14499.4393	1	14499.4393	16.605	0.000 ***
ies/	20084.1339	23	873.2232		
cie	18.4390	1	18.4390	0.023	0.882
cies/	18808.5216	23	817.7618		

Chapter 3. Exp. 4 (p. 91): correct RTs. Task x condition.
(i = identity, x = expression, r = correlated, c = control, o = orthogonal)

SOURCE: grand mean

task	condi	N	MEAN	SD	SE
		144	549.7622	79.8083	6.6507

SOURCE: task

task	condi	N	MEAN	SD	SE
i		72	532.6632	71.7674	8.4579
x		72	566.8611	84.1718	9.9197

SOURCE: condition

task	condi	N	MEAN	SD	SE
	r	48	536.7682	76.1238	10.9875
	c	48	548.5703	77.1161	11.1308
	o	48	563.9479	85.1939	12.2967

SOURCE: task condition

task	condi	N	MEAN	SD	SE
i	r	24	522.2604	63.3546	12.9322
i	c	24	532.7135	80.4764	16.4272
i	o	24	543.0156	72.0036	14.6977
x	r	24	551.2760	85.9567	17.5458
x	c	24	564.4271	71.7715	14.6503
x	o	24	584.8802	93.4484	19.0751

FACTOR:	subs	task	condition	data
LEVELS:	48	2	3	144
TYPE :	RANDOM	BETWEEN	WITHIN	DATA

SOURCE	SS	df	MS	F	p	
task	42101.9102	1	42101.9102	2.768	0.103	
s/t	699692.5477	46	15210.7076			
conditi	17831.9247	2	8915.9623	5.465	0.006	**
cs/t	150091.1111	92	1631.4251			
tc	1101.6725	2	550.8363	0.338	0.714	
cs/t	150091.1111	92	1631.4251			

Chapter 3. Exp. 4 (p. 92): correct RTs for identity classification. Condition x identity x expression.
(r = correlated, c = control, o = orthogonal, s = sad, su = surprised)

SOURCE: grand mean

condi	ident	expre	N	MEAN	SD	SE
			288	532.6632	81.7882	4.8194

SOURCE: condition

condi	ident	expre	N	MEAN	SD	SE
r			96	522.2604	75.1945	7.6745
c			96	532.7135	89.9874	9.1843
o			96	543.0156	78.9884	8.0617

SOURCE: identity

condi	ident	expre	N	MEAN	SD	SE
	Jim		144	526.0312	82.8432	6.9036
	Paul		144	539.2951	80.4601	6.7050

SOURCE: condition identity

condi	ident	expre	N	MEAN	SD	SE
r	Jim		48	512.4896	70.8093	10.2204
r	Paul		48	532.0312	78.8655	11.3833
c	Jim		48	526.7396	95.6444	13.8051
c	Paul		48	538.6875	84.5400	12.2023
o	Jim		48	538.8646	79.7699	11.5138
o	Paul		48	547.1667	78.8203	11.3767

SOURCE: expression

condi	ident	expre	N	MEAN	SD	SE
		s	144	531.4479	83.4599	6.9550
		su	144	533.8785	80.3548	6.6962

SOURCE: condition expression

condi	ident	expre	N	MEAN	SD	SE
r		s	48	518.2396	74.3615	10.7332
r		su	48	526.2812	76.5904	11.0549
c		s	48	538.3750	100.3608	14.4858
c		su	48	527.0521	78.9304	11.3926
o		s	48	537.7292	72.9635	10.5314
o		su	48	548.3021	85.0313	12.2732

SOURCE: identity expression

condi	ident	expre	N	MEAN	SD	SE
	Jim	s	72	519.8889	83.5972	9.8520
	Jim	su	72	532.1736	82.2049	9.6879
	Paul	s	72	543.0069	82.2783	9.6966
	Paul	su	72	535.5833	79.0011	9.3104

SOURCE: condition identity expression

condi	ident	expre	N	MEAN	SD	SE
r	Jim	s	24	497.5417	66.8356	13.6428
r	Jim	su	24	527.4375	72.8877	14.8781
r	Paul	s	24	538.9375	77.0624	15.7303
r	Paul	su	24	525.1250	81.6811	16.6731
c	Jim	s	24	529.5208	104.4985	21.3307
c	Jim	su	24	523.9583	88.0758	17.9784
c	Paul	s	24	547.2292	97.4625	19.8944
c	Paul	su	24	530.1458	70.3816	14.3666
o	Jim	s	24	532.6042	73.4820	14.9995
o	Jim	su	24	545.1250	86.7280	17.7033
o	Paul	s	24	542.8542	73.6504	15.0338
o	Paul	su	24	551.4792	85.0424	17.3592

FACTOR:	subs	condition	identity	expression	data
LEVELS:	24	3	2	2	288
TYPE :	RANDOM	WITHIN	WITHIN	WITHIN	DATA

SOURCE	SS	df	MS	F	p	
conditi	20677.7413	2	10338.8707	1.810	0.175	
cs/	262769.4670	46	5712.3797			
identit	12667.0139	1	12667.0139	3.515	0.074	
is/	82876.3611	23	3603.3200			
ci	1578.2830	2	789.1415	0.536	0.588	
cis/	67674.5920	46	1471.1868			
express	425.3472	1	425.3472	0.180	0.676	
es/	54479.0278	23	2368.6534			
ce	6886.5747	2	3443.2873	1.800	0.177	
ces/	88010.3003	46	1913.2674			
ie	6991.5313	1	6991.5313	5.012	0.035	*
ies/	32083.0104	23	1394.9135			
cie	5358.4219	2	2679.2109	1.257	0.294	
cies/	98044.7865	46	2131.4084			

Chapter 3. Exp. 4 (pp. 92-93): correct RTs for expression classification. Condition x identity x expression.
(r = correlated, c = control, o = orthogonal, s = sad, su = surprised)

SOURCE: grand mean

condi	ident	expre	N	MEAN	SD	SE
			288	566.8611	91.8291	5.4111

SOURCE: condition

condi	ident	expre	N	MEAN	SD	SE
r			96	551.2760	95.3102	9.7276
c			96	564.4271	79.5685	8.1209
o			96	584.8802	97.3679	9.9376

SOURCE: identity

condi	ident	expre	N	MEAN	SD	SE
	Jim		144	561.8090	90.0948	7.5079
	Paul		144	571.9132	93.5715	7.7976

SOURCE: condition identity

condi	ident	expre	N	MEAN	SD	SE
r	Jim		48	548.5208	94.5577	13.6482
r	Paul		48	554.0312	96.9778	13.9975
c	Jim		48	550.6250	68.6693	9.9116
c	Paul		48	578.2292	87.7065	12.6593
o	Jim		48	586.2812	100.5997	14.5203
o	Paul		48	583.4792	95.0706	13.7223

SOURCE: expression

condi	ident	expre	N	MEAN	SD	SE
		s	144	573.3611	91.7386	7.6449
		su	144	560.3611	91.7772	7.6481

SOURCE: condition expression

condi	ident	expre	N	MEAN	SD	SE
r		s	48	560.0000	94.9857	13.7100
r		su	48	542.5521	95.8312	13.8320
c		s	48	563.9583	80.2131	11.5778
c		su	48	564.8958	79.7647	11.5130
o		s	48	596.1250	96.6839	13.9551
o		su	48	573.6354	97.7584	14.1102

SOURCE: identity expression

condi	ident	expre	N	MEAN	SD	SE
	Jim	s	72	567.7014	92.0637	10.8498
	Jim	su	72	555.9167	88.3309	10.4099
	Paul	s	72	579.0208	91.7049	10.8075
	Paul	su	72	564.8056	95.5109	11.2561

SOURCE: condition identity expression

condi	ident	expre	N	MEAN	SD	SE
r	Jim	s	24	556.2917	98.7166	20.1505
r	Jim	su	24	540.7500	91.6519	18.7084
r	Paul	s	24	563.7083	93.0762	18.9991
r	Paul	su	24	544.3542	101.7825	20.7763
c	Jim	s	24	550.3750	70.4657	14.3838
c	Jim	su	24	550.8750	68.3405	13.9499
c	Paul	s	24	577.5417	88.3038	18.0249
c	Paul	su	24	578.9167	88.9987	18.1668
o	Jim	s	24	596.4375	100.7125	20.5579
o	Jim	su	24	576.1250	101.5990	20.7388
o	Paul	s	24	595.8125	94.6507	19.3205
o	Paul	su	24	571.1458	95.8834	19.5721

FACTOR:	subs	condition	identity	expression	data
LEVELS:	24	3	2	2	288
TYPE :	RANDOM	WITHIN	WITHIN	WITHIN	DATA

SOURCE	SS	df	MS	F	p	
conditi	55056.6476	2	27528.3238	3.751	0.031	*
cs/	337594.9774	46	7339.0212			
identit	7350.7812	1	7350.7812	5.895	0.023	*
is/	28678.5104	23	1246.8918			
ci	11854.1719	2	5927.0859	4.263	0.020	*
cis/	63955.2865	46	1390.3323			
express	12168.0000	1	12168.0000	4.402	0.047	*
es/	63578.5417	23	2764.2844			
ce	7298.1615	2	3649.0807	2.722	0.076	
ces/	61665.2969	46	1340.5499			
ie	106.3368	1	106.3368	0.045	0.834	
ies/	54613.9549	23	2374.5198			
cie	99.2205	2	49.6102	0.024	0.977	
cies/	96670.2378	46	2101.5269			

Chapter 3. Exp. 4 (p. 93): correct RTs for expression classification for control and orthogonal conditions only. Condition x identity x expression.
(c = control, o = orthogonal, s = sad, su = surprised)

SOURCE: grand mean

condi	ident	expre	N	MEAN	SD	SE
			192	574.6536	89.2725	6.4427

SOURCE: condition

condi	ident	expre	N	MEAN	SD	SE
c			96	564.4271	79.5685	8.1209
o			96	584.8802	97.3679	9.9376

SOURCE: identity

condi	ident	expre	N	MEAN	SD	SE
	Jim		96	568.4531	87.5271	8.9332
	Paul		96	580.8542	91.0183	9.2895

SOURCE: condition identity

condi	ident	expre	N	MEAN	SD	SE
c	Jim		48	550.6250	68.6693	9.9116
c	Paul		48	578.2292	87.7065	12.6593
o	Jim		48	586.2812	100.5997	14.5203
o	Paul		48	583.4792	95.0706	13.7223

SOURCE: expression

condi	ident	expre	N	MEAN	SD	SE
		s	96	580.0417	89.8292	9.1682
		su	96	569.2656	88.8542	9.0686

SOURCE: condition expression

condi	ident	expre	N	MEAN	SD	SE
c		s	48	563.9583	80.2131	11.5778
c		su	48	564.8958	79.7647	11.5130
o		s	48	596.1250	96.6839	13.9551
o		su	48	573.6354	97.7584	14.1102

SOURCE: identity expression

condi	ident	expre	N	MEAN	SD	SE
	Jim	s	48	573.4062	89.0798	12.8576
	Jim	su	48	563.5000	86.6006	12.4997
	Paul	s	48	586.6771	91.0227	13.1380
	Paul	su	48	575.0312	91.5999	13.2213

SOURCE: condition identity expression

condi	ident	expre	N	MEAN	SD	SE
c	Jim	s	24	550.3750	70.4657	14.3838
c	Jim	su	24	550.8750	68.3405	13.9499
c	Paul	s	24	577.5417	88.3038	18.0249
c	Paul	su	24	578.9167	88.9987	18.1668
o	Jim	s	24	596.4375	100.7125	20.5579
o	Jim	su	24	576.1250	101.5990	20.7388
o	Paul	s	24	595.8125	94.6507	19.3205
o	Paul	su	24	571.1458	95.8834	19.5721

FACTOR:	subs	condition	identity	expression	data
LEVELS:	24	2	2	2	192
TYPE :	RANDOM	WITHIN	WITHIN	WITHIN	DATA

SOURCE	SS	df	MS	F	p
conditi	20079.8555	1	20079.8555	2.574	0.122

cs/	179444.6758	23	7801.9424		
identit	7381.7201	1	7381.7201	3.968	0.058
is/	42789.8112	23	1860.4266		
ci	11094.4805	1	11094.4805	9.766	0.005 **
cis/	26128.4258	23	1136.0185		
express	5573.9076	1	5573.9076	4.263	0.050
es/	30072.7487	23	1307.5108		
ce	6585.9388	1	6585.9388	4.016	0.057
ces/	37716.0924	23	1639.8301		
ie	36.3138	1	36.3138	0.029	0.867
ies/	29034.7174	23	1262.3790		
cie	82.0326	1	82.0326	0.067	0.799
cies/	28305.8737	23	1230.6902		

Chapter 4. Exp. 5 (p. 110): lid-to-brow distance. Sex x expression x ratio.
(f = female stimulus face, m = male stimulus face, a = angry, su = surprised, min = minimum ratio, max = maximum ratio)

SOURCE: grand mean

sex	expre	ratio	N	MEAN	SD	SE
			40	1.2153	0.6696	0.1059

SOURCE: sex

sex	expre	ratio	N	MEAN	SD	SE
f			20	1.3633	0.6475	0.1448
m			20	1.0673	0.6746	0.1508

SOURCE: expression

sex	expre	ratio	N	MEAN	SD	SE
	a		20	0.7428	0.4231	0.0946
	su		20	1.6878	0.5209	0.1165

SOURCE: sex expression

sex	expre	ratio	N	MEAN	SD	SE
f	a		10	0.9052	0.4592	0.1452
f	su		10	1.8215	0.4559	0.1442
m	a		10	0.5804	0.3293	0.1041
m	su		10	1.5542	0.5704	0.1804

SOURCE: ratio

sex	expre	ratio	N	MEAN	SD	SE
		min	20	0.8857	0.5539	0.1238
		max	20	1.5450	0.6204	0.1387

SOURCE: sex ratio

sex	expre	ratio	N	MEAN	SD	SE
f		min	10	1.0393	0.5590	0.1768
f		max	10	1.6874	0.5825	0.1842
m		min	10	0.7321	0.5317	0.1681
m		max	10	1.4025	0.6544	0.2069

SOURCE: expression ratio

sex	expre	ratio	N	MEAN	SD	SE
	a	min	10	0.4473	0.2914	0.0922
	a	max	10	1.0383	0.3145	0.0995
	su	min	10	1.3241	0.3682	0.1164
	su	max	10	2.0516	0.3785	0.1197

SOURCE: sex expression ratio

sex	expre	ratio	N	MEAN	SD	SE
f	a	min	5	0.5794	0.3498	0.1564
f	a	max	5	1.2310	0.2944	0.1317
f	su	min	5	1.4992	0.2277	0.1019
f	su	max	5	2.1438	0.3950	0.1767
m	a	min	5	0.3152	0.1584	0.0708
m	a	max	5	0.8456	0.2075	0.0928
m	su	min	5	1.1490	0.4201	0.1879
m	su	max	5	1.9594	0.3809	0.1703

FACTOR:	items	sex	expression	ratio	data
LEVELS:	10	2	2	2	40
TYPE :	RANDOM	BETWEEN	WITHIN	WITHIN	DATA

SOURCE	SS	df	MS	F	p
sex	0.8765	1	0.8765	2.739	0.137

i/s	2.5601	8	0.3200		
express	8.9312	1	8.9312	173.803	0.000 ***
ei/s	0.4111	8	0.0514		
se	0.0083	1	0.0083	0.161	0.699
ei/s	0.4111	8	0.0514		
ratio	4.3461	1	4.3461	179.513	0.000 ***
ri/s	0.1937	8	0.0242		
sr	0.0012	1	0.0012	0.051	0.826
ri/s	0.1937	8	0.0242		
er	0.0466	1	0.0466	6.005	0.040 *
eri/s	0.0621	8	0.0078		
ser	0.0515	1	0.0515	6.637	0.033 *
eri/s	0.0621	8	0.0078		

Chapter 4. Exp. 5 (p. 111): ratings data. Expression x stimulus sex.
(a = angry, su = surprised, f = female stimulus face, m = male stimulus face)

SOURCE: grand mean

expre	sex	N	MEAN	SD	SE
		96	8.6208	2.5762	0.2629

SOURCE: expression

expre	sex	N	MEAN	SD	SE
a		48	9.6875	2.3964	0.3459
su		48	7.5542	2.3127	0.3338

SOURCE: sex

expre	sex	N	MEAN	SD	SE
	f	48	6.9542	1.9843	0.2864
	m	48	10.2875	1.9504	0.2815

SOURCE: expression sex

expre	sex	N	MEAN	SD	SE
a	f	24	7.9083	1.9551	0.3991
a	m	24	11.4667	1.1431	0.2333
su	f	24	6.0000	1.5243	0.3111
su	m	24	9.1083	1.8882	0.3854

FACTOR:	subs	expression	sex	data
LEVELS:	24	2	2	96
TYPE :	RANDOM	WITHIN	WITHIN	DATA

SOURCE	SS	df	MS	F	p
express	109.2267	1	109.2267	92.451	0.000 ***
es/	27.1733	23	1.1814		
sex	266.6667	1	266.6667	46.843	0.000 ***
ss/	130.9333	23	5.6928		
es	1.2150	1	1.2150	1.798	0.193
ess/	15.5450	23	0.6759		

Chapter 4. Exp. 6 (p.115): correct RTs. Task x condition.
(ds = sex classification, x = expression classification, r = correlated, c = control, o = orthogonal)

SOURCE: grand mean

task	cond	N	MEAN	SD	SE
		72	600.5299	140.7496	16.5875

SOURCE: task

task	cond	N	MEAN	SD	SE
ds		36	522.1875	86.6333	14.4389
x		36	678.8722	141.6186	23.6031

SOURCE: cond

task	cond	N	MEAN	SD	SE
	r	24	564.7000	132.1068	26.9662
	c	24	614.6125	149.3073	30.4772
	o	24	622.2771	139.1729	28.4086

SOURCE: task cond

task	cond	N	MEAN	SD	SE
ds	r	12	510.1333	76.3964	22.0537
ds	c	12	528.3167	86.4549	24.9574
ds	o	12	528.1125	101.6462	29.3427
x	r	12	619.2667	155.4290	44.8685
x	c	12	700.9083	151.2930	43.6745
x	o	12	716.4417	104.0238	30.0291

FACTOR:	subs	task	cond	data
LEVELS:	24	2	3	72
TYPE :	RANDOM	BETWEEN	WITHIN	DATA

SOURCE	SS	df	MS	F	p	
task	441901.8622	1	441901.8622	12.554	0.002	**
s/t	774412.0921	22	35200.5496			
cond	46920.9901	2	23460.4950	8.446	0.001	***
cs/t	122214.6056	44	2777.6047			
tc	21093.2191	2	10546.6096	3.797	0.030	*
cs/t	122214.6056	44	2777.6047			

Chapter 4. Exp. 6 (p. 116): correct RTs for sex classification. Condition x stimulus sex x expression.
(r = correlated, c = control, o = orthogonal, f = female stimulus face, m = male stimulus face, a = angry, su = surprised)

SOURCE: grand mean

cond	sex	expre	N	MEAN	SD	SE
			144	522.1875	90.3614	7.5301

SOURCE: cond

cond	sex	expre	N	MEAN	SD	SE
r			48	510.1333	80.6035	11.6341
c			48	528.3167	88.3425	12.7511
o			48	528.1125	101.5828	14.6622

SOURCE: sex

cond	sex	expre	N	MEAN	SD	SE
	f		72	519.5667	80.3387	9.4680
	m		72	524.8083	99.8856	11.7716

SOURCE: cond sex

cond	sex	expre	N	MEAN	SD	SE
r	f		24	503.7667	73.3466	14.9718
r	m		24	516.5000	88.3855	18.0416
c	f		24	529.9167	81.8815	16.7140
c	m		24	526.7167	96.1155	19.6195
o	f		24	525.0167	86.2356	17.6028
o	m		24	531.2083	116.7485	23.8312

SOURCE: expression

cond	sex	expre	N	MEAN	SD	SE
		a	72	518.9333	91.4080	10.7725
		su	72	525.4417	89.8247	10.5859

SOURCE: cond expression

cond	sex	expre	N	MEAN	SD	SE
r		a	24	507.8667	83.0325	16.9489
r		su	24	512.4000	79.8198	16.2931
c		a	24	518.4250	83.3429	17.0123
c		su	24	538.2083	93.7970	19.1462
o		a	24	530.5083	108.0949	22.0648
o		su	24	525.7167	96.9036	19.7804

SOURCE: sex expression

cond	sex	expre	N	MEAN	SD	SE
	f	a	36	517.5444	79.1068	13.1845
	f	su	36	521.5889	82.6239	13.7706
	m	a	36	520.3222	103.3813	17.2302
	m	su	36	529.2944	97.5204	16.2534

SOURCE: cond sex expression

cond	sex	expre	N	MEAN	SD	SE
r	f	a	12	511.0333	78.4824	22.6559
r	f	su	12	496.5000	70.5252	20.3589
r	m	a	12	504.7000	90.7425	26.1951
r	m	su	12	528.3000	88.2961	25.4889
c	f	a	12	516.9667	75.9577	21.9271
c	f	su	12	542.8667	88.7873	25.6307
c	m	a	12	519.8833	93.5378	27.0020
c	m	su	12	533.5500	102.2987	29.5311
o	f	a	12	524.6333	88.7748	25.6271
o	f	su	12	525.4000	87.5667	25.2783
o	m	a	12	536.3833	128.3548	37.0528

o m su 12 526.0333 109.3899 31.5782

FACTOR:	subs	cond	sex	expression	data
LEVELS:	12	3	2	2	144
TYPE :	RANDOM	WITHIN	WITHIN	WITHIN	DATA

SOURCE	SS	df	MS	F	p
cond	10462.8133	2	5231.4067	1.226	0.313
cs/	93873.2600	22	4266.9664		
sex	989.1010	1	989.1010	0.388	0.546
ss/	28070.4285	11	2551.8571		
cs	1539.4729	2	769.7365	0.626	0.544
css/	27060.1452	22	1230.0066		
express	1524.9023	1	1524.9023	1.204	0.296
es/	13928.7823	11	1266.2529		
ce	3693.7944	2	1846.8972	2.593	0.097
ces/	15668.7467	22	712.2158		
se	218.5472	1	218.5472	0.343	0.570
ses/	7009.1244	11	637.1931		
cse	4963.6085	2	2481.8042	4.472	0.023 *
cses/	12207.9473	22	554.9067		

Chapter 4. Exp. 6 (p. 116): correct RTs to items for sex classifications. Stimulus sex x expression x condition.
f = female stimulus face, m = male stimulus face, a = angry, su = surprised, r = correlated, c = control, o = orthogonal.

SOURCE: grand mean

sex	expre	cond	N	MEAN	SD	SE
			60	522.1806	23.5761	3.0437

SOURCE: sex

sex	expre	cond	N	MEAN	SD	SE
f			30	519.5417	23.1787	4.2318
m			30	524.8194	24.0659	4.3938

SOURCE: expression

sex	expre	cond	N	MEAN	SD	SE
	a		30	518.9194	19.7935	3.6138
	su		30	525.4417	26.7777	4.8889

SOURCE: sex expression

sex	expre	cond	N	MEAN	SD	SE
f	a		15	517.4944	17.5126	4.5217
f	su		15	521.5889	28.2349	7.2902
m	a		15	520.3444	22.3719	5.7764
m	su		15	529.2944	25.6181	6.6146

SOURCE: cond

sex	expre	cond	N	MEAN	SD	SE
		r	20	510.1542	23.6302	5.2839
		c	20	528.3125	20.0418	4.4815
		o	20	528.0750	23.1849	5.1843

SOURCE: sex cond

sex	expre	cond	N	MEAN	SD	SE
f		r	10	503.7667	20.1124	6.3601
f		c	10	529.9167	20.9683	6.6308
f		o	10	524.9417	21.4119	6.7710
m		r	10	516.5417	26.1465	8.2683
m		c	10	526.7083	20.0647	6.3450
m		o	10	531.2083	25.5836	8.0902

SOURCE: expression cond

sex	expre	cond	N	MEAN	SD	SE
	a	r	10	507.9083	15.5559	4.9192
	a	c	10	518.4167	14.4311	4.5635
	a	o	10	530.4333	23.0188	7.2792
	su	r	10	512.4000	30.4240	9.6209
	su	c	10	538.2083	20.5452	6.4970
	su	o	10	525.7167	24.3430	7.6979

SOURCE: sex expression cond

sex	expre	cond	N	MEAN	SD	SE
f	a	r	5	511.0333	10.5696	4.7269
f	a	c	5	516.9667	13.7821	6.1635
f	a	o	5	524.4833	25.6549	11.4732
f	su	r	5	496.5000	25.8150	11.5448
f	su	c	5	542.8667	19.4950	8.7184
f	su	o	5	525.4000	19.3096	8.6355
m	a	r	5	504.7833	20.2074	9.0370
m	a	c	5	519.8667	16.5341	7.3943
m	a	o	5	536.3833	21.1073	9.4395
m	su	r	5	528.3000	28.0037	12.5236
m	su	c	5	533.5500	22.7031	10.1532

m su o 5 526.0333 30.9871 13.8579

FACTOR:	items	sex	expression	cond	data
LEVELS:	10	2	2	3	60
TYPE :	RANDOM	BETWEEN	WITHIN	WITHIN	DATA

SOURCE	SS	df	MS	F	p
sex	417.8249	1	417.8249	0.309	0.593
i/s	10801.4755	8	1350.1844		
express	638.0905	1	638.0905	1.611	0.240
ei/s	3168.0150	8	396.0019		
se	88.4115	1	88.4115	0.223	0.649
ei/s	3168.0150	8	396.0019		
cond	4339.5844	2	2169.7922	8.050	0.004 **
ci/s	4312.6356	16	269.5397		
sc	646.0009	2	323.0005	1.198	0.327
ci/s	4312.6356	16	269.5397		
ec	1532.5718	2	766.2859	2.563	0.108
eci/s	4782.8241	16	298.9265		
sec	2066.5703	2	1033.2852	3.457	0.057
eci/s	4782.8241	16	298.9265		

Chapter 4. Exp. 6 (p. 116): correct RTs for expression classification. Condition x sex x expression.
(r = correlated, c = control, o = orthogonal, f = female stimulus face, m = male stimulus face, a = angry, su = surprised)

SOURCE: grand mean

cond	sex	expre	N	MEAN	SD	SE
			144	678.8722	153.5846	12.7987

SOURCE: cond

cond	sex	expre	N	MEAN	SD	SE
r			48	619.2667	166.8131	24.0774
c			48	700.9083	161.7513	23.3468
o			48	716.4417	110.5102	15.9508

SOURCE: sex

cond	sex	expre	N	MEAN	SD	SE
	f		72	678.3722	160.2253	18.8827
	m		72	679.3722	147.7702	17.4149

SOURCE: cond sex

cond	sex	expre	N	MEAN	SD	SE
r	f		24	620.3583	177.9216	36.3181
r	m		24	618.1750	158.7593	32.4066
c	f		24	701.6750	172.2665	35.1638
c	m		24	700.1417	154.2321	31.4825
o	f		24	713.0833	112.1658	22.8957
o	m		24	719.8000	111.1364	22.6856

SOURCE: expression

cond	sex	expre	N	MEAN	SD	SE
		a	72	675.3306	161.4155	19.0230
		su	72	682.4139	146.3841	17.2515

SOURCE: cond expression

cond	sex	expre	N	MEAN	SD	SE
r		a	24	617.2167	174.2235	35.5632
r		su	24	621.3167	162.7897	33.2293
c		a	24	697.2167	168.1656	34.3267
c		su	24	704.6000	158.6077	32.3757
o		a	24	711.5583	128.0765	26.1435
o		su	24	721.3250	92.2098	18.8222

SOURCE: sex expression

cond	sex	expre	N	MEAN	SD	SE
	f	a	36	669.9111	161.4536	26.9089
	f	su	36	686.8333	160.8206	26.8034
	m	a	36	680.7500	163.4829	27.2471
	m	su	36	677.9944	132.5345	22.0891

SOURCE: cond sex expression

cond	sex	expre	N	MEAN	SD	SE
r	f	a	12	615.3500	161.1877	46.5309
r	f	su	12	625.3667	200.3841	57.8459
r	m	a	12	619.0833	193.5924	55.8853
r	m	su	12	617.2667	123.3715	35.6143
c	f	a	12	696.1833	183.3444	52.9270
c	f	su	12	707.1667	168.4290	48.6213
c	m	a	12	698.2500	159.7271	46.1092
c	m	su	12	702.0333	155.6182	44.9231
o	f	a	12	698.2000	135.9084	39.2334
o	f	su	12	727.9667	85.7419	24.7516
o	m	a	12	724.9167	124.2497	35.8678

o m su 12 714.6833 101.6383 29.3405

FACTOR:	subs	cond	sex	expression	data
LEVELS:	12	3	2	2	144
TYPE :	RANDOM	WITHIN	WITHIN	WITHIN	DATA

SOURCE	SS	df	MS	F	p	
cond	261594.0346	2	130797.0173	7.285	0.004	**
cs/	394985.1660	22	17953.8712			
sex	35.9999	1	35.9999	0.007	0.937	
ss/	59978.6140	11	5452.6013			
cs	590.7815	2	295.3907	0.062	0.940	
css/	104672.8321	22	4757.8560			
express	1806.2498	1	1806.2498	0.145	0.711	
es/	137178.4766	11	12470.7706			
ce	194.2875	2	97.1437	0.036	0.965	
ces/	59958.0329	22	2725.3651			
se	3484.9368	1	3484.9368	0.423	0.529	
ses/	90554.5250	11	8232.2295			
cse	1890.6685	2	945.3342	0.198	0.822	
cses/	104954.4303	22	4770.6559			

Chapter 4. Exp. 6 (p. 116): correct RTs to items for expression classification. Condition x sex x expression.
(r = correlated, c = control, o = orthogonal, f = female stimulus face, m = male stimulus face, a = angry, su = surprised)

SOURCE: grand mean

sex	expre	cond	N	MEAN	SD	SE
			60	678.8722	67.1448	8.6684

SOURCE: sex

sex	expre	cond	N	MEAN	SD	SE
f			30	678.3722	57.7062	10.5357
m			30	679.3722	76.4316	13.9544

SOURCE: expression

sex	expre	cond	N	MEAN	SD	SE
	a		30	675.3306	74.2889	13.5632
	su		30	682.4139	60.2289	10.9962

SOURCE: sex expression

sex	expre	cond	N	MEAN	SD	SE
f	a		15	669.9111	56.6613	14.6299
f	su		15	686.8333	59.4471	15.3492
m	a		15	680.7500	90.3241	23.3216
m	su		15	677.9944	62.7561	16.2036

SOURCE: cond

sex	expre	cond	N	MEAN	SD	SE
		r	20	619.2667	41.6813	9.3202
		c	20	700.9083	58.0053	12.9704
		o	20	716.4417	56.2244	12.5722

SOURCE: sex cond

sex	expre	cond	N	MEAN	SD	SE
f		r	10	620.3583	31.2270	9.8749
f		c	10	701.6750	45.9241	14.5225
f		o	10	713.0833	44.3194	14.0150
m		r	10	618.1750	51.8645	16.4010
m		c	10	700.1417	70.6593	22.3444
m		o	10	719.8000	68.4422	21.6433

SOURCE: expression cond

sex	expre	cond	N	MEAN	SD	SE
	a	r	10	617.2167	53.4371	16.8983
	a	c	10	697.2167	67.7642	21.4289
	a	o	10	711.5583	67.7675	21.4300
	su	r	10	621.3167	28.3344	8.9601
	su	c	10	704.6000	49.8077	15.7506
	su	o	10	721.3250	45.0353	14.2414

SOURCE: sex expression cond

sex	expre	cond	N	MEAN	SD	SE
f	a	r	5	615.3500	30.6648	13.7137
f	a	c	5	696.1833	52.4543	23.4583
f	a	o	5	698.2000	44.2798	19.8025
f	su	r	5	625.3667	34.5108	15.4337
f	su	c	5	707.1667	43.8001	19.5880
f	su	o	5	727.9667	43.6460	19.5191
m	a	r	5	619.0833	73.9992	33.0935
m	a	c	5	698.2500	87.0507	38.9303
m	a	o	5	724.9167	89.0290	39.8150
m	su	r	5	617.2667	23.9662	10.7180
m	su	c	5	702.0333	60.3894	27.0070

m su o 5 714.6833 50.4790 22.5749

FACTOR:	items	sex	expression	cond	data
LEVELS:	10	2	2	3	60
TYPE :	RANDOM	BETWEEN	WITHIN	WITHIN	DATA

SOURCE	SS	df	MS	F	p	
sex	15.0002	1	15.0002	0.001	0.973	
i/s	96859.3220	8	12107.4152			
express	752.6042	1	752.6042	0.143	0.715	
ei/s	42155.6962	8	5269.4620			
se	1452.0580	1	1452.0580	0.276	0.614	
ei/s	42155.6962	8	5269.4620			
cond	108997.5039	2	54498.7519	95.815	0.000	***
ci/s	9100.6514	16	568.7907			
sc	246.1584	2	123.0792	0.216	0.808	
ci/s	9100.6514	16	568.7907			
ec	80.9525	2	40.4762	0.117	0.891	
eci/s	5549.1164	16	346.8198			
sec	787.7798	2	393.8899	1.136	0.346	
eci/s	5549.1164	16	346.8198			

Chapter 4. Exp. 7 (p. 170): correct RTs. Task x condition.
(gend = sex classification, expr = expression classification, r = correlated, c = control, o = orthogonal)

SOURCE: grand mean

task	cond	N	MEAN	SD	SE
		72	733.9264	120.5654	14.2088

SOURCE: task

task	cond	N	MEAN	SD	SE
gend		36	759.0042	117.1786	19.5298
expr		36	708.8486	120.2614	20.0436

SOURCE: cond

task	cond	N	MEAN	SD	SE
	r	24	713.2167	121.0973	24.7189
	c	24	747.7917	129.4105	26.4158
	o	24	740.7708	112.9752	23.0610

SOURCE: task cond

task	cond	N	MEAN	SD	SE
gend	r	12	748.2000	124.4850	35.9357
gend	c	12	759.1750	126.2788	36.4536
gend	o	12	769.6375	109.5234	31.6167
expr	r	12	678.2333	111.7834	32.2691
expr	c	12	736.4083	137.0677	39.5680
expr	o	12	711.9042	113.4621	32.7537

FACTOR:	subs	task	cond	data
LEVELS:	24	2	3	72
TYPE :	RANDOM	BETWEEN	WITHIN	DATA

SOURCE	SS	df	MS	F	p
task	45280.4405	1	45280.4405	1.319	0.263
s/t	755071.4515	22	34321.4296		
cond	16031.6314	2	8015.8157	1.692	0.196
cs/t	208473.3795	44	4738.0314		
tc	7200.3252	2	3600.1626	0.760	0.474
cs/t	208473.3795	44	4738.0314		

Chapter 4. Exp. 7 (p.121): correct RTs for sex classification. Condition x stimulus sex x expression.
(r = correlated, c = control, o = orthogonal, f = female stimulus face, m = male stimulus face, a = angry, su = surprised)

SOURCE: grand mean

cond	sex	expre	N	MEAN	SD	SE
			144	759.0403	133.3574	11.1131

SOURCE: cond

cond	sex	expre	N	MEAN	SD	SE
r			48	748.4354	143.0193	20.6431
c			48	759.0479	138.7927	20.0330
o			48	769.6375	119.0037	17.1767

SOURCE: sex

cond	sex	expre	N	MEAN	SD	SE
	f		72	752.5361	125.6449	14.8074
	m		72	765.5444	141.2318	16.6443

SOURCE: cond sex

cond	sex	expre	N	MEAN	SD	SE
r	f		24	742.4333	157.7860	32.2079
r	m		24	754.4375	129.7180	26.4786
c	f		24	756.3583	116.5232	23.7852
c	m		24	761.7375	160.5355	32.7692
o	f		24	758.8167	100.4776	20.5099
o	m		24	780.4583	136.3795	27.8384

SOURCE: expression

cond	sex	expre	N	MEAN	SD	SE
		a	72	754.8444	126.6974	14.9314
		su	72	763.2361	140.4669	16.5542

SOURCE: cond expression

cond	sex	expre	N	MEAN	SD	SE
r		a	24	746.9083	138.7209	28.3163
r		su	24	749.9625	150.1666	30.6526
c		a	24	752.1250	137.1240	27.9903
c		su	24	765.9708	143.0432	29.1986
o		a	24	765.5000	106.3678	21.7122
o		su	24	773.7750	132.6259	27.0722

SOURCE: sex expression

cond	sex	expre	N	MEAN	SD	SE
	f	a	36	753.4500	118.6480	19.7747
	f	su	36	751.6222	133.9600	22.3267
	m	a	36	756.2389	135.9476	22.6579
	m	su	36	774.8500	147.6579	24.6097

SOURCE: cond sex expression

cond	sex	expre	N	MEAN	SD	SE
r	f	a	12	747.9000	129.8197	37.4757
r	f	su	12	736.9667	187.4507	54.1124
r	m	a	12	745.9167	152.9087	44.1410
r	m	su	12	762.9583	107.9062	31.1498
c	f	a	12	751.4500	130.2527	37.6007
c	f	su	12	761.2667	106.6363	30.7832
c	m	a	12	752.8000	149.4945	43.1553
c	m	su	12	770.6750	177.0968	51.1234
o	f	a	12	761.0000	104.2711	30.1005
o	f	su	12	756.6333	101.1257	29.1925
o	m	a	12	770.0000	112.8722	32.5834

o m su 12 790.9167 160.9684 46.4676

FACTOR:	subs	cond	sex	expression	data
LEVELS:	12	3	2	2	144
TYPE :	RANDOM	WITHIN	WITHIN	WITHIN	DATA

SOURCE	SS	df	MS	F	p
cond	10788.6872	2	5394.3436	0.192	0.827
cs/	617867.6966	22	28084.8953		
sex	6091.7974	1	6091.7974	0.291	0.601
ss/	230658.3333	11	20968.9394		
cs	1604.9646	2	802.4823	0.211	0.811
css/	83566.0145	22	3798.4552		
express	2535.1211	1	2535.1211	1.033	0.331
es/	27005.1250	11	2455.0114		
ce	699.0054	2	349.5027	0.100	0.905
ces/	76757.9920	22	3488.9996		
se	3759.7304	1	3759.7304	0.403	0.538
ses/	102558.9508	11	9323.5410		
cse	700.6197	2	350.3098	0.088	0.916
cses/	87342.2223	22	3970.1010		

Chapter 4. Exp. 7 (p. 122): correct RTs to items for sex classifications. Stimulus sex x expression x condition.
f = female stimulus face, m = male stimulus face, a = angry, su = surprised, r = correlated, c = control, o = orthogonal.

SOURCE: grand mean

sex	expre	cond	N	MEAN	SD	SE
			60	759.0042	79.1245	10.2149

SOURCE: sex

sex	expre	cond	N	MEAN	SD	SE
f			30	752.5333	78.9054	14.4061
m			30	765.4750	80.1533	14.6339

SOURCE: expression

sex	expre	cond	N	MEAN	SD	SE
	a		30	754.8417	81.7591	14.9271
	su		30	763.1667	77.5683	14.1620

SOURCE: sex expression

sex	expre	cond	N	MEAN	SD	SE
f	a		15	753.4444	75.0042	19.3660
f	su		15	751.6222	85.2610	22.0143
m	a		15	756.2389	90.6464	23.4048
m	su		15	774.7111	70.0603	18.0895

SOURCE: cond

sex	expre	cond	N	MEAN	SD	SE
		r	20	748.2000	84.7754	18.9564
		c	20	759.1750	79.7035	17.8223
		o	20	769.6375	75.2304	16.8220

SOURCE: sex cond

sex	expre	cond	N	MEAN	SD	SE
f		r	10	742.4250	83.0367	26.2585
f		c	10	756.3583	83.4822	26.3994
f		o	10	758.8167	77.6127	24.5433
m		r	10	753.9750	90.5708	28.6410
m		c	10	761.9917	80.1514	25.3461
m		o	10	780.4583	75.2605	23.7995

SOURCE: expression cond

sex	expre	cond	N	MEAN	SD	SE
	a	r	10	746.9000	92.9779	29.4022
	a	c	10	752.1250	83.2672	26.3314
	a	o	10	765.5000	75.8702	23.9923
	su	r	10	749.5000	80.7689	25.5414
	su	c	10	766.2250	79.7952	25.2335
	su	o	10	773.7750	78.4458	24.8067

SOURCE: sex expression cond

sex	expre	cond	N	MEAN	SD	SE
f	a	r	5	747.8833	87.2752	39.0307
f	a	c	5	751.4500	82.8097	37.0336
f	a	o	5	761.0000	71.4164	31.9384
f	su	r	5	736.9667	88.4449	39.5538
f	su	c	5	761.2667	93.6119	41.8645
f	su	o	5	756.6333	91.8759	41.0881
m	a	r	5	745.9167	108.7733	48.6449
m	a	c	5	752.8000	93.4968	41.8130
m	a	o	5	770.0000	88.3217	39.4987
m	su	r	5	762.0333	80.3923	35.9525
m	su	c	5	771.1833	74.1735	33.1714

m su o 5 790.9167 68.3386 30.5620

FACTOR:	items	sex	expression	cond	DATA
LEVELS:	10	2	2	3	60
TYPE :	RANDOM	BETWEEN	WITHIN	WITHIN	DATA

SOURCE	SS	df	MS	F	p
sex	2512.3010	1	2512.3010	0.074	0.793
i/s	272789.8327	8	34098.7291		
express	1039.5844	1	1039.5844	0.140	0.718
ei/s	59534.5339	8	7441.8167		
se	1544.4926	1	1544.4926	0.208	0.661
ei/s	59534.5339	8	7441.8167		
cond	4596.5395	2	2298.2698	2.855	0.087
ci/s	12877.8716	16	804.8670		
sc	655.1923	2	327.5962	0.407	0.672
ci/s	12877.8716	16	804.8670		
ec	330.6434	2	165.3217	0.200	0.821
eci/s	13239.2806	16	827.4550		
sec	259.8019	2	129.9009	0.157	0.856
eci/s	13239.2806	16	827.4550		

Chapter 4. Exp. 7 (p. 122): correct RTs for expression classification. Condition x sex x expression.
(r = correlated, c = control, o = orthogonal, f = female stimulus face, m = male stimulus face, a = angry, su = surprised)

SOURCE: grand mean

condi	sex	expre	N	MEAN	SD	SE
			144	708.8486	131.8752	10.9896

SOURCE: condition

condi	sex	expre	N	MEAN	SD	SE
r			48	678.2333	118.2367	17.0660
c			48	736.4083	148.4516	21.4271
o			48	711.9042	123.0974	17.7676

SOURCE: sex

condi	sex	expre	N	MEAN	SD	SE
	f		72	709.9556	133.7196	15.7590
	m		72	707.7417	130.9339	15.4307

SOURCE: condition sex

condi	sex	expre	N	MEAN	SD	SE
r	f		24	676.9833	128.4908	26.2281
r	m		24	679.4833	109.7931	22.4114
c	f		24	734.7333	138.7805	28.3285
c	m		24	738.0833	160.5243	32.7669
o	f		24	718.1500	132.5993	27.0667
o	m		24	705.6583	115.3290	23.5414

SOURCE: expression

condi	sex	expre	N	MEAN	SD	SE
		a	72	702.4917	130.2766	15.3532
		su	72	715.2056	134.0639	15.7996

SOURCE: condition expression

condi	sex	expre	N	MEAN	SD	SE
r		a	24	673.2167	115.4139	23.5588
r		su	24	683.2500	123.2671	25.1618
c		a	24	720.6917	136.6748	27.8986
c		su	24	752.1250	160.7434	32.8116
o		a	24	713.5667	137.9258	28.1540
o		su	24	710.2417	109.2497	22.3005

SOURCE: sex expression

condi	sex	expre	N	MEAN	SD	SE
	f	a	36	713.0444	130.3154	21.7192
	f	su	36	706.8667	138.8200	23.1367
	m	a	36	691.9389	131.2162	21.8694
	m	su	36	723.5444	130.5594	21.7599

SOURCE: condition sex expression

condi	sex	expre	N	MEAN	SD	SE
r	f	a	12	695.8500	119.9197	34.6178
r	f	su	12	658.1167	139.1522	40.1698
r	m	a	12	650.5833	111.1452	32.0849
r	m	su	12	708.3833	105.0208	30.3169
c	f	a	12	721.1000	127.7899	36.8898
c	f	su	12	748.3667	153.4119	44.2862
c	m	a	12	720.2833	150.7567	43.5197
c	m	su	12	755.8833	174.5274	50.3817
o	f	a	12	722.1833	151.1244	43.6258
o	f	su	12	714.1167	117.8537	34.0214
o	m	a	12	704.9500	129.5217	37.3897

o m su 12 706.3667 105.0417 30.3229

FACTOR:	subs	condition	sex	expression	DATA
LEVELS:	12	3	2	2	144
TYPE :	RANDOM	WITHIN	WITHIN	WITHIN	DATA

SOURCE	SS	df	MS	F	p	
conditi	81896.1676	2	40948.0838	4.176	0.029	*
cs/	215745.6862	22	9806.6221			
sex	176.4471	1	176.4471	0.029	0.868	
ss/	67274.9788	11	6115.9072			
cs	1905.7272	2	952.8636	0.247	0.783	
css/	84760.4124	22	3852.7460			
express	5819.1461	1	5819.1461	0.517	0.487	
es/	123903.0276	11	11263.9116			
ce	7378.1949	2	3689.0975	1.346	0.281	
ces/	60301.7329	22	2740.9879			
se	12848.2187	1	12848.2187	3.442	0.091	
ses/	41057.8471	11	3732.5316			
cse	15009.7624	2	7504.8812	3.960	0.034	*
cses/	41694.3523	22	1895.1978			

Chapter 4. Exp. 7 (p. 122): correct RTs to items for expression classification. Condition x sex x expression.
(r = correlated, c = control, o = orthogonal, f = female stimulus face, m = male stimulus face, a = angry, su = surprised)

SOURCE: grand mean

sex	expre	cond	N	MEAN	SD	SE
			60	708.7792	63.3132	8.1737

SOURCE: sex

sex	expre	cond	N	MEAN	SD	SE
f			30	709.8167	67.2284	12.2742
m			30	707.7417	60.2783	11.0053

SOURCE: expression

sex	expre	cond	N	MEAN	SD	SE
	a		30	702.4917	55.5675	10.1452
	su		30	715.0667	70.6103	12.8916

SOURCE: sex expression

sex	expre	cond	N	MEAN	SD	SE
f	a		15	713.0444	46.2115	11.9318
f	su		15	706.5889	84.8783	21.9155
m	a		15	691.9389	63.4187	16.3746
m	su		15	723.5444	54.4924	14.0699

SOURCE: cond

sex	expre	cond	N	MEAN	SD	SE
		r	20	678.2333	48.1148	10.7588
		c	20	736.4083	73.7834	16.4985
		o	20	711.6958	53.7957	12.0291

SOURCE: sex cond

sex	expre	cond	N	MEAN	SD	SE
f		r	10	676.9833	46.3229	14.6486
f		c	10	734.7333	84.0389	26.5754
f		o	10	717.7333	58.2901	18.4329
m		r	10	679.4833	52.3259	16.5469
m		c	10	738.0833	66.5139	21.0335
m		o	10	705.6583	51.2910	16.2196

SOURCE: expression cond

sex	expre	cond	N	MEAN	SD	SE
	a	r	10	673.2167	43.9135	13.8867
	a	c	10	720.6917	65.3256	20.6578
	a	o	10	713.5667	47.9272	15.1559
	su	r	10	683.2500	53.8792	17.0381
	su	c	10	752.1250	81.7099	25.8389
	su	o	10	709.8250	61.6823	19.5057

SOURCE: sex expression cond

sex	expre	cond	N	MEAN	SD	SE
f	a	r	5	695.8500	28.6790	12.8256
f	a	c	5	721.1000	61.4813	27.4953
f	a	o	5	722.1833	48.1325	21.5255
f	su	r	5	658.1167	55.8186	24.9628
f	su	c	5	748.3667	107.9170	48.2620
f	su	o	5	713.2833	72.6543	32.4920
m	a	r	5	650.5833	47.2835	21.1458
m	a	c	5	720.2833	76.2978	34.1214
m	a	o	5	704.9500	51.6326	23.0908
m	su	r	5	708.3833	42.8573	19.1664
m	su	c	5	755.8833	57.7993	25.8486

m su o 5 706.3667 57.0267 25.5031

FACTOR:	items	sex	expression	cond	DATA
LEVELS:	10	2	2	3	60
TYPE :	RANDOM	BETWEEN	WITHIN	WITHIN	DATA

SOURCE	SS	df	MS	F	p	
sex	64.5844	1	64.5844	0.005	0.946	
i/s	104594.2131	8	13074.2766			
express	2371.9594	1	2371.9594	0.316	0.590	
ei/s	60117.6063	8	7514.7008			
se	5432.4345	1	5432.4345	0.723	0.420	
ei/s	60117.6063	8	7514.7008			
cond	34098.5180	2	17049.2590	21.246	0.000	***
ci/s	12839.4324	16	802.4645			
sc	751.8071	2	375.9036	0.468	0.634	
ci/s	12839.4324	16	802.4645			
ec	3141.6549	2	1570.8275	3.644	0.050	*
eci/s	6897.5300	16	431.0956			
sec	6195.6924	2	3097.8462	7.186	0.006	**
eci/s	6897.5300	16	431.0956			

Chapter 5. Exp. 8 (p. 142): ratings data for 'interest' to angry and happy faces looking towards and away from the viewer. Expression x gaze direction.
(a = angry, h = happy, t = towards, w = away)

SOURCE: grand mean

expre	gaze	N	MEAN	SD	SE
		96	8.2630	2.4975	0.2549

SOURCE: expression

expre	gaze	N	MEAN	SD	SE
a		48	8.1146	2.8039	0.4047
h		48	8.4115	2.1681	0.3129

SOURCE: gaze

expre	gaze	N	MEAN	SD	SE
	t	48	8.2552	2.4492	0.3535
	w	48	8.2708	2.5707	0.3711

SOURCE: expression gaze

expre	gaze	N	MEAN	SD	SE
a	t	24	7.9062	2.7265	0.5565
a	w	24	8.3229	2.9224	0.5965
h	t	24	8.6042	2.1378	0.4364
h	w	24	8.2188	2.2267	0.4545

FACTOR:	subs	expression	gaze	data
LEVELS:	24	2	2	96
TYPE :	RANDOM	WITHIN	WITHIN	DATA

SOURCE	SS	df	MS	F	p
express	2.1152	1	2.1152	0.218	0.645
es/	223.5254	23	9.7185		
gaze	0.0059	1	0.0059	0.005	0.945
gs/	27.8223	23	1.2097		
eg	3.8600	1	3.8600	5.671	0.026 *
egs/	15.6556	23	0.6807		

Chapter 5. Exp. 8 (p. 143): ratings data for 'liking' to angry and happy faces looking towards and away from the viewer. Expression x gaze direction.
(a = angry, h = happy, t = towards, w = away)

SOURCE: grand mean

expre	gaze	N	MEAN	SD	SE
		96	6.5729	2.7135	0.2769

SOURCE: expression

expre	gaze	N	MEAN	SD	SE
a		48	5.0052	2.3118	0.3337
h		48	8.1406	2.1256	0.3068

SOURCE: gaze

expre	gaze	N	MEAN	SD	SE
	t	48	6.7083	2.8412	0.4101
	w	48	6.4375	2.6024	0.3756

SOURCE: expression gaze

expre	gaze	N	MEAN	SD	SE
a	t	24	5.0000	2.3556	0.4808
a	w	24	5.0104	2.3178	0.4731
h	t	24	8.4167	2.2038	0.4499
h	w	24	7.8646	2.0536	0.4192

FACTOR:	subs	expression	gaze	data
LEVELS:	24	2	2	96
TYPE :	RANDOM	WITHIN	WITHIN	DATA

SOURCE	SS	df	MS	F	p
express	235.9401	1	235.9401	33.344	0.000 ***
es/	162.7474	23	7.0760		
gaze	1.7604	1	1.7604	2.266	0.146
gs/	17.8646	23	0.7767		
eg	1.8984	1	1.8984	1.855	0.186
egs/	23.5391	23	1.0234		

Chapter 5. Exp. 9 (p. 146): error data. Task x condition.
(g = gaze direction classification, x = expression classification, r = correlated, c = control, o = orthogonal)

SOURCE: grand mean

task	condi	N	MEAN	SD	SE
		144	2.5174	1.8786	0.1565

SOURCE: task

task	condi	N	MEAN	SD	SE
g		72	2.7170	1.9657	0.2317
x		72	2.3177	1.7784	0.2096

SOURCE: condition

task	condi	N	MEAN	SD	SE
	r	48	2.3568	1.8061	0.2607
	c	48	2.4219	2.0451	0.2952
	o	48	2.7734	1.7860	0.2578

SOURCE: task condition

task	condi	N	MEAN	SD	SE
g	r	24	2.1354	1.5738	0.3212
g	c	24	2.8125	2.2945	0.4684
g	o	24	3.2031	1.8913	0.3861
x	r	24	2.5781	2.0216	0.4126
x	c	24	2.0312	1.7215	0.3514
x	o	24	2.3438	1.5988	0.3263

FACTOR:	subs	task	condition	errors
LEVELS:	48	2	3	144
TYPE :	RANDOM	BETWEEN	WITHIN	DATA

SOURCE	SS	df	MS	F	p	
task	5.7400	1	5.7400	0.826	0.368	
s/t	319.4770	46	6.9452			
conditi	4.8231	2	2.4116	1.371	0.259	
cs/t	161.8056	92	1.7588			
tc	12.7984	2	6.3992	3.638	0.030	*
cs/t	161.8056	92	1.7588			

Chapter 5. Exp. 9 (p. 147): correct RTs. Task x condition.
(g = gaze direction classification, x = expression classification, r = correlated, c = control, o = orthogonal)

SOURCE: grand mean

task	condi	N	MEAN	SD	SE
		144	676.2674	117.2916	9.7743

SOURCE: task

task	condi	N	MEAN	SD	SE
g		72	663.9549	132.6565	15.6337
x		72	688.5799	99.0111	11.6686

SOURCE: condition

task	condi	N	MEAN	SD	SE
	r	48	666.0781	126.4211	18.2473
	c	48	678.2135	116.6546	16.8376
	o	48	684.5104	109.9431	15.8689

SOURCE: task condition

task	condi	N	MEAN	SD	SE
g	r	24	645.4922	144.5192	29.4999
g	c	24	666.6094	133.3695	27.2239
g	o	24	679.7630	122.5822	25.0220
x	r	24	686.6641	104.3516	21.3007
x	c	24	689.8177	98.6904	20.1451
x	o	24	689.2578	98.1177	20.0282

FACTOR:	subs	task	condition	data
LEVELS:	48	2	3	144
TYPE :	RANDOM	BETWEEN	WITHIN	DATA

SOURCE	SS	df	MS	F	p
task	21830.0625	1	21830.0625	0.598	0.443
s/t	1677925.7352	46	36476.6464		
conditi	8426.6936	2	4213.3468	1.532	0.222
cs/t	253057.2381	92	2750.6222		
tc	6056.7507	2	3028.3753	1.101	0.337
cs/t	253057.2381	92	2750.6222		

Chapter 5. Exp. 9 (p. 148): correct RTs for gaze direction classification. Condition x gaze direction x expression.
(r = correlated, c = control, o = orthogonal, t = towards, w = away, a = angry, h = happy)

SOURCE: grand mean

condi	expre	gaze	N	MEAN	SD	SE
			288	663.9549	140.5377	8.2813

SOURCE: condition

condi	expre	gaze	N	MEAN	SD	SE
r			96	645.4922	152.7173	15.5866
c			96	666.6094	137.5816	14.0419
o			96	679.7630	129.6650	13.2339

SOURCE: expression

condi	expre	gaze	N	MEAN	SD	SE
	a		144	669.8924	142.2925	11.8577
	h		144	658.0174	139.0024	11.5835

SOURCE: condition expression

condi	expre	gaze	N	MEAN	SD	SE
r	a		48	650.5677	154.6223	22.3178
r	h		48	640.4167	152.2521	21.9757
c	a		48	674.3698	146.3931	21.1300
c	h		48	658.8490	129.2523	18.6560
o	a		48	684.7396	125.0483	18.0492
o	h		48	674.7865	135.2629	19.5235

SOURCE: gaze

condi	expre	gaze	N	MEAN	SD	SE
		t	144	642.3715	133.0341	11.0862
		w	144	685.5382	144.9260	12.0772

SOURCE: condition gaze

condi	expre	gaze	N	MEAN	SD	SE
r		t	48	614.9375	140.9139	20.3392
r		w	48	676.0469	159.3039	22.9935
c		t	48	652.7396	133.3246	19.2437
c		w	48	680.4792	141.7454	20.4592
o		t	48	659.4375	122.6349	17.7008
o		w	48	700.0885	134.5384	19.4189

SOURCE: expression gaze

condi	expre	gaze	N	MEAN	SD	SE
	a	t	72	661.1944	137.8710	16.2483
	a	w	72	678.5903	147.0294	17.3276
	h	t	72	623.5486	126.1683	14.8691
	h	w	72	692.4861	143.4830	16.9096

SOURCE: condition expression gaze

condi	expre	gaze	N	MEAN	SD	SE
r	a	t	24	638.6667	150.1382	30.6468
r	a	w	24	662.4688	161.3027	32.9258
r	h	t	24	591.2083	129.8469	26.5049
r	h	w	24	689.6250	159.5480	32.5676
c	a	t	24	665.8958	150.6245	30.7461
c	a	w	24	682.8438	144.7621	29.5494
c	h	t	24	639.5833	115.2161	23.5184
c	h	w	24	678.1146	141.7368	28.9319
o	a	t	24	679.0208	112.0924	22.8808
o	a	w	24	690.4583	139.0003	28.3733
o	h	t	24	639.8542	131.7857	26.9006

o h w 24 709.7188 132.1874 26.9826

FACTOR:	subs	condition	expression	gaze	data
LEVELS:	24	3	2	2	288
TYPE :	RANDOM	WITHIN	WITHIN	WITHIN	DATA

SOURCE	SS	df	MS	F	p	
conditi	57390.2088	2	28695.1044	3.263	0.047	*
cs/	404581.2391	46	8795.2443			
express	10153.1250	1	10153.1250	5.042	0.035	*
es/	46314.6979	23	2013.6825			
ce	478.9857	2	239.4928	0.144	0.866	
ces/	76621.6914	46	1665.6889			
gaze	134162.0000	1	134162.0000	16.374	0.001	***
gs/	188451.9896	23	8193.5648			
cg	13590.3372	2	6795.1686	4.847	0.012	*
cgs/	64489.2982	46	1401.9413			
eg	47817.7812	1	47817.7812	54.818	0.000	***
egs/	20062.7500	23	872.2935			
ceg	8863.6211	2	4431.8105	3.413	0.041	*
cegs/	59731.7852	46	1298.5171			

Chapter 5. Exp. 9 (p. 148): correct RTs to items for gaze direction classification. Condition x expression x gaze direction.
(r = correlated, c = control, o = orthogonal, a = angry, h = happy, t = towards, w = away)

SOURCE: grand mean

condi	expre	gaze	N	MEAN	SD	SE
			48	663.9549	39.7723	5.7406

SOURCE: condition

condi	expre	gaze	N	MEAN	SD	SE
r			16	645.4922	45.0631	11.2658
c			16	666.6094	31.6104	7.9026
o			16	679.7630	35.9005	8.9751

SOURCE: expression

condi	expre	gaze	N	MEAN	SD	SE
	a		24	669.8924	31.5698	6.4442
	h		24	658.0174	46.4997	9.4917

SOURCE: condition expression

condi	expre	gaze	N	MEAN	SD	SE
r	a		8	650.5677	27.3815	9.6808
r	h		8	640.4167	59.5218	21.0441
c	a		8	674.3698	31.7634	11.2301
c	h		8	658.8490	31.5375	11.1502
o	a		8	684.7396	28.5383	10.0898
o	h		8	674.7865	43.4830	15.3736

SOURCE: gaze

condi	expre	gaze	N	MEAN	SD	SE
		t	24	642.3715	35.7482	7.2971
		w	24	685.5382	31.3420	6.3977

SOURCE: condition gaze

condi	expre	gaze	N	MEAN	SD	SE
r		t	8	614.9375	32.8681	11.6206
r		w	8	676.0469	33.7231	11.9229
c		t	8	652.7396	27.4685	9.7116
c		w	8	680.4792	30.7727	10.8798
o		t	8	659.4375	32.3767	11.4469
o		w	8	700.0885	27.7357	9.8061

SOURCE: expression gaze

condi	expre	gaze	N	MEAN	SD	SE
	a	t	12	661.1944	31.2736	9.0279
	a	w	12	678.5903	30.6727	8.8545
	h	t	12	623.5486	30.3478	8.7606
	h	w	12	692.4861	31.7460	9.1643

SOURCE: condition expression gaze

condi	expre	gaze	N	MEAN	SD	SE
r	a	t	4	638.6667	25.7242	12.8621
r	a	w	4	662.4688	26.6453	13.3227
r	h	t	4	591.2083	18.9067	9.4533
r	h	w	4	689.6250	38.1045	19.0523
c	a	t	4	665.8958	29.9508	14.9754
c	a	w	4	682.8438	35.5752	17.7876
c	h	t	4	639.5833	20.0480	10.0240
c	h	w	4	678.1146	30.4806	15.2403
o	a	t	4	679.0208	29.9584	14.9792
o	a	w	4	690.4583	30.2594	15.1297

o	h	t	4	639.8542	22.9287	11.4644
o	h	w	4	709.7188	25.1401	12.5701

FACTOR:	items	condition	expression	gaze	data
LEVELS:	4	3	2	2	48
TYPE :	RANDOM	WITHIN	WITHIN	WITHIN	DATA

SOURCE	SS	df	MS	F	p	
conditi	9565.0345	2	4782.5172	37.443	0.000	***
ci/	766.3632	6	127.7272			
express	1692.1868	1	1692.1868	1.524	0.305	
ei/	3330.8198	3	1110.2733			
ce	79.8309	2	39.9154	0.131	0.880	
cei/	1825.9648	6	304.3275			
gaze	22360.3307	1	22360.3307	22.397	0.018	*
gi/	2995.0534	3	998.3511			
cg	2265.0556	2	1132.5278	3.467	0.100	
cgi/	1960.1121	6	326.6854			
eg	7969.6255	1	7969.6255	5.719	0.097	
egi/	4180.6090	3	1393.5363			
ceg	1477.2709	2	738.6354	22.977	0.002	**
cegi/	192.8821	6	32.1470			

Chapter 5. Exp. 9 (p. 149): correct RTs for expression classification. Condition x expression x gaze direction.
(r = correlated, c = control, o = orthogonal, a = angry, h = happy, t = towards, w = away,)

SOURCE: grand mean

condi	expre	gaze	N	MEAN	SD	SE
			288	688.5799	111.1910	6.5520

SOURCE: condition

condi	expre	gaze	N	MEAN	SD	SE
r			96	686.6641	122.8075	12.5340
c			96	689.8177	108.0829	11.0312
o			96	689.2578	102.8653	10.4987

SOURCE: expression

condi	expre	gaze	N	MEAN	SD	SE
	a		144	699.2031	112.4359	9.3697
	h		144	677.9566	109.2896	9.1075

SOURCE: condition expression

condi	expre	gaze	N	MEAN	SD	SE
r	a		48	693.6250	119.2319	17.2096
r	h		48	679.7031	127.1576	18.3536
c	a		48	705.1615	112.5654	16.2474
c	h		48	674.4740	102.2768	14.7624
o	a		48	698.8229	107.2756	15.4839
o	h		48	679.6927	98.4518	14.2103

SOURCE: gaze

condi	expre	gaze	N	MEAN	SD	SE
		t	144	687.7257	114.8366	9.5697
		w	144	689.4340	107.8166	8.9847

SOURCE: condition gaze

condi	expre	gaze	N	MEAN	SD	SE
r		t	48	677.3542	115.1577	16.6216
r		w	48	695.9740	130.5601	18.8447
c		t	48	695.0885	125.7226	18.1465
c		w	48	684.5469	88.0310	12.7062
o		t	48	690.7344	104.3149	15.0566
o		w	48	687.7812	102.4775	14.7914

SOURCE: expression gaze

condi	expre	gaze	N	MEAN	SD	SE
	a	t	72	708.0764	119.5077	14.0841
	a	w	72	690.3299	104.9759	12.3715
	h	t	72	667.3750	106.9514	12.6043
	h	w	72	688.5382	111.3148	13.1186

SOURCE: condition expression gaze

condi	expre	gaze	N	MEAN	SD	SE
r	a	t	24	700.7188	115.9582	23.6699
r	a	w	24	686.5312	124.4960	25.4126
r	h	t	24	653.9896	111.8641	22.8342
r	h	w	24	705.4167	138.3750	28.2457
c	a	t	24	713.5000	134.8278	27.5216
c	a	w	24	696.8229	87.0011	17.7590
c	h	t	24	676.6771	115.8171	23.6411
c	h	w	24	672.2708	89.1749	18.2028
o	a	t	24	710.0104	111.2307	22.7049
o	a	w	24	687.6354	104.3217	21.2946
o	h	t	24	671.4583	95.3342	19.4600

o h w 24 687.9271 102.8437 20.9929

FACTOR:	subs	condition	expression	gaze	data
LEVELS:	24	3	2	2	288
TYPE :	RANDOM	WITHIN	WITHIN	WITHIN	DATA

SOURCE	SS	df	MS	F	p
conditi	543.5681	2	271.7841	0.021	0.980
cs/	607647.7131	46	13209.7329		
express	32501.8759	1	32501.8759	4.048	0.056
es/	184684.7908	23	8029.7735		
ce	3534.2713	2	1767.1356	1.051	0.358
ces/	77343.5933	46	1681.3825		
gaze	210.1250	1	210.1250	0.077	0.784
gs/	62780.9375	23	2729.6060		
cg	10986.9388	2	5493.4694	2.213	0.121
cgs/	114208.5299	46	2482.7941		
eg	27251.3967	1	27251.3967	5.788	0.025 *
egs/	108295.8741	23	4708.5163		
ceg	8536.7062	2	4268.3531	1.467	0.241
cegs/	133864.5543	46	2910.0990		

Chapter 5. Exp. 10 (p. 152): correct RTs to inverted faces. Task x condition.
(g = gaze direction classification, x = expression classification, r = correlated, c = control, o = orthogonal)

SOURCE: grand mean

task	condi	N	MEAN	SD	SE
		144	745.9913	119.2589	9.9382

SOURCE: task

task	condi	N	MEAN	SD	SE
x		72	722.5009	109.8972	12.9515
g		72	769.4818	124.2946	14.6483

SOURCE: condition

task	condi	N	MEAN	SD	SE
	r	48	734.7513	116.8809	16.8703
	c	48	749.7773	115.8190	16.7170
	o	48	753.4453	126.4820	18.2561

SOURCE: task condition

task	condi	N	MEAN	SD	SE
x	r	24	716.0234	112.3534	22.9340
x	c	24	731.9115	117.7594	24.0375
x	o	24	719.5677	103.1828	21.0621
g	r	24	753.4792	120.6690	24.6314
g	c	24	767.6432	113.4807	23.1642
g	o	24	787.3229	140.1752	28.6131

FACTOR:	subs	task	condition	data
LEVELS:	48	2	3	144
TYPE :	RANDOM	BETWEEN	WITHIN	DATA

SOURCE	SS	df	MS	F	p
task	79459.3881	1	79459.3881	2.333	0.134
s/t	1567038.5255	46	34066.0549		
conditi	9419.2312	2	4709.6156	1.171	0.315
cs/t	370141.1968	92	4023.2739		
tc	7786.1241	2	3893.0620	0.968	0.384
cs/t	370141.1968	92	4023.2739		

Chapter 5. Exp. 10 (p. 154): correct RTs to inverted faces for gaze direction classification. Condition x gaze direction x expression.
(r = correlated, c = control, o = orthogonal, t = towards, w = away, a = angry, h = happy)

SOURCE: grand mean

condi	expre	gaze	N	MEAN	SD	SE
			288	769.4818	141.3217	8.3275

SOURCE: condition

condi	expre	gaze	N	MEAN	SD	SE
r			96	753.4792	138.6299	14.1489
c			96	767.6432	133.3493	13.6099
o			96	787.3229	150.8371	15.3947

SOURCE: expression

condi	expre	gaze	N	MEAN	SD	SE
	a		144	748.2899	132.7830	11.0653
	h		144	790.6736	146.7907	12.2326

SOURCE: condition expression

condi	expre	gaze	N	MEAN	SD	SE
r	a		48	740.9323	124.6984	17.9987
r	h		48	766.0260	151.5722	21.8776
c	a		48	741.6198	130.0168	18.7663
c	h		48	793.6667	132.8714	19.1783
o	a		48	762.3177	144.5287	20.8609
o	h		48	812.3281	154.3440	22.2776

SOURCE: gaze

condi	expre	gaze	N	MEAN	SD	SE
		t	144	765.3733	139.2992	11.6083
		w	144	773.5903	143.6839	11.9737

SOURCE: condition gaze

condi	expre	gaze	N	MEAN	SD	SE
r		t	48	749.6510	130.6358	18.8557
r		w	48	757.3073	147.4779	21.2866
c		t	48	765.6979	133.6830	19.2955
c		w	48	769.5885	134.4007	19.3991
o		t	48	780.7708	153.6457	22.1768
o		w	48	793.8750	149.3085	21.5508

SOURCE: expression gaze

condi	expre	gaze	N	MEAN	SD	SE
	a	t	72	752.1007	136.9499	16.1397
	a	w	72	744.4792	129.3301	15.2417
	h	t	72	778.6458	141.3128	16.6539
	h	w	72	802.7014	152.1047	17.9257

SOURCE: condition expression gaze

condi	expre	gaze	N	MEAN	SD	SE
r	a	t	24	753.3646	129.0961	26.3516
r	a	w	24	728.5000	121.6022	24.8219
r	h	t	24	745.9375	134.8289	27.5218
r	h	w	24	786.1146	167.1111	34.1114
c	a	t	24	740.8021	139.9333	28.5638
c	a	w	24	742.4375	122.3150	24.9674
c	h	t	24	790.5938	125.0778	25.5314
c	h	w	24	796.7396	142.8743	29.1641
o	a	t	24	762.1354	146.3203	29.8675
o	a	w	24	762.5000	145.8615	29.7738

o	h	t	24	799.4062	161.5735	32.9811
o	h	w	24	825.2500	149.0818	30.4312

FACTOR:	subs	condition	expression	gaze	data
LEVELS:	24	3	2	2	288
TYPE :	RANDOM	WITHIN	WITHIN	WITHIN	DATA

SOURCE	SS	df	MS	F	p	
conditi	55465.9258	2	27732.9629	1.446	0.246	
cs/	882470.6992	46	19184.1456			
express	129339.0992	1	129339.0992	13.319	0.001	**
es/	223350.4373	23	9710.8886			
ce	10811.6671	2	5405.8336	1.232	0.301	
ces/	201773.3746	46	4386.3777			
gaze	4861.3908	1	4861.3908	0.355	0.557	
gs/	314933.9373	23	13692.7799			
cg	1029.9926	2	514.9963	0.180	0.836	
cgs/	131592.2574	46	2860.7012			
eg	18061.8770	1	18061.8770	2.768	0.110	
egs/	150083.1595	23	6525.3548			
ceg	11337.8242	2	5668.9121	1.772	0.181	
cegs/	147182.0924	46	3199.6107			

Chapter 5. Exp. 10 (p. 154): correct RTs to inverted faces for expression classification. Condition x expression x gaze direction.
(r = correlated, c = control, o = orthogonal, a = angry, h = happy, t = towards, w = away)

SOURCE: grand mean

condi	expre	gaze	N	MEAN	SD	SE
			288	722.5009	120.9833	7.1290

SOURCE: condition

condi	expre	gaze	N	MEAN	SD	SE
r			96	716.0234	123.4905	12.6037
c			96	731.9115	129.4456	13.2115
o			96	719.5677	109.8745	11.2140

SOURCE: expression

condi	expre	gaze	N	MEAN	SD	SE
	a		144	705.2188	111.4240	9.2853
	h		144	739.7830	127.9042	10.6587

SOURCE: condition expression

condi	expre	gaze	N	MEAN	SD	SE
r	a		48	702.1042	113.0008	16.3103
r	h		48	729.9427	132.8885	19.1808
c	a		48	712.4167	122.5640	17.6906
c	h		48	751.4062	134.4271	19.4029
o	a		48	701.1354	99.5150	14.3638
o	h		48	738.0000	117.4924	16.9586

SOURCE: gaze

condi	expre	gaze	N	MEAN	SD	SE
		t	144	722.3490	116.6172	9.7181
		w	144	722.6528	125.6052	10.4671

SOURCE: condition gaze

condi	expre	gaze	N	MEAN	SD	SE
r		t	48	722.6302	132.8310	19.1725
r		w	48	709.4167	114.4160	16.5145
c		t	48	732.1719	117.1989	16.9162
c		w	48	731.6510	141.8913	20.4802
o		t	48	712.2448	98.9692	14.2850
o		w	48	726.8906	120.4044	17.3789

SOURCE: expression gaze

condi	expre	gaze	N	MEAN	SD	SE
	a	t	72	709.7882	106.5991	12.5628
	a	w	72	700.6493	116.6180	13.7436
	h	t	72	734.9097	125.3290	14.7702
	h	w	72	744.6562	131.1253	15.4533

SOURCE: condition expression gaze

condi	expre	gaze	N	MEAN	SD	SE
r	a	t	24	710.2708	118.6356	24.2164
r	a	w	24	693.9375	108.9951	22.2485
r	h	t	24	734.9896	147.1804	30.0431
r	h	w	24	724.8958	119.8801	24.4704
c	a	t	24	718.0938	111.7766	22.8163
c	a	w	24	706.7396	134.6690	27.4892
c	h	t	24	746.2500	123.1289	25.1336
c	h	w	24	756.5625	147.3457	30.0768
o	a	t	24	701.0000	91.4165	18.6603
o	a	w	24	701.2708	108.9956	22.2486

o	h	t	24	723.4896	106.7465	21.7895
o	h	w	24	752.5104	127.9643	26.1206

FACTOR:	subs	condition	expression	gaze	data
LEVELS:	24	3	2	2	288
TYPE :	RANDOM	WITHIN	WITHIN	WITHIN	DATA

SOURCE	SS	df	MS	F	p	
conditi	13355.4952	2	6677.7476	0.514	0.602	
cs/	598094.0881	46	13002.0454			
express	86017.4221	1	86017.4221	9.637	0.005	**
es/	205283.4894	23	8925.3691			
ce	1682.6463	2	841.3231	0.253	0.777	
ces/	152796.0204	46	3321.6526			
gaze	6.6461	1	6.6461	0.003	0.956	
gs/	48928.8487	23	2127.3412			
cg	9338.2192	2	4669.1096	1.619	0.209	
cgs/	132694.1141	46	2884.6547			
eg	6419.8613	1	6419.8613	4.889	0.037	*
egs/	30204.8001	23	1313.2522			
ceg	1589.7747	2	794.8874	0.381	0.685	
cegs/	95866.0169	46	2084.0438			

Chapter 5. Exps. 9 and 10 compared (p. 156): correct RTs.
Task x orientation x expression x gaze direction.
(g = gaze direction, x = expression, up = upright, in = inverted, a = angry, h = happy, t = towards, w = away)

SOURCE: grand mean

task	orien	expre	gaze	N	MEAN	SD	SE
				384	711.1293	121.1537	6.1826

SOURCE: task

task	orien	expre	gaze	N	MEAN	SD	SE
g				192	716.7183	137.7745	9.9430
x				192	705.5404	101.9250	7.3558

SOURCE: orientation

task	orien	expre	gaze	N	MEAN	SD	SE
	up			192	676.2674	115.6340	8.3452
	in			192	745.9913	116.6989	8.4220

SOURCE: task orientation

task	orien	expre	gaze	N	MEAN	SD	SE
g	up			96	663.9549	132.2245	13.4951
g	in			96	769.4818	122.6928	12.5223
x	up			96	688.5799	95.3597	9.7326
x	in			96	722.5009	105.8863	10.8070

SOURCE: expression

task	orien	expre	gaze	N	MEAN	SD	SE
		a		192	705.6510	115.4844	8.3344
		h		192	716.6076	126.6346	9.1391

SOURCE: task expression

task	orien	expre	gaze	N	MEAN	SD	SE
g		a		96	709.0911	130.7444	13.3440
g		h		96	724.3455	144.7472	14.7732
x		a		96	702.2109	98.4666	10.0497
x		h		96	708.8698	105.6820	10.7861

SOURCE: orientation expression

task	orien	expre	gaze	N	MEAN	SD	SE
	up	a		96	684.5477	116.8770	11.9287
	up	h		96	667.9870	114.3870	11.6746
	in	a		96	726.7543	110.6950	11.2978
	in	h		96	765.2283	119.9139	12.2387

SOURCE: task orientation expression

task	orien	expre	gaze	N	MEAN	SD	SE
g	up	a		48	669.8924	132.9925	19.1958
g	up	h		48	658.0174	132.5882	19.1375
g	in	a		48	748.2899	117.1598	16.9106
g	in	h		48	790.6736	125.6328	18.1335
x	up	a		48	699.2031	97.3930	14.0575
x	up	h		48	677.9566	93.0835	13.4354
x	in	a		48	705.2188	100.4677	14.5013
x	in	h		48	739.7830	109.3552	15.7841

SOURCE: gaze

task	orien	expre	gaze	N	MEAN	SD	SE
			t	192	704.4549	118.9969	8.5879
			w	192	717.8038	123.2212	8.8927

SOURCE: task gaze

task	orien	expre	gaze	N	MEAN	SD	SE

g		t	96	703.8724	134.4194	13.7191
g		w	96	729.5642	140.5750	14.3474
x		t	96	705.0373	101.9820	10.4085
x		w	96	706.0434	102.4008	10.4512

SOURCE: orientation gaze

task	orien	expre	gaze	N	MEAN	SD	SE
	up		t	96	665.0486	113.6972	11.6042
	up		w	96	687.4861	117.0545	11.9468
	in		t	96	743.8611	111.3739	11.3670
	in		w	96	748.1215	122.3410	12.4864

SOURCE: task orientation gaze

task	orien	expre	gaze	N	MEAN	SD	SE
g	up		t	48	642.3715	122.5156	17.6836
g	up		w	48	685.5382	139.2016	20.0920
g	in		t	48	765.3733	117.4132	16.9471
g	in		w	48	773.5903	128.8681	18.6005
x	up		t	48	687.7257	100.3430	14.4833
x	up		w	48	689.4340	91.1605	13.1579
x	in		t	48	722.3490	101.6912	14.6779
x	in		w	48	722.6528	111.0010	16.0216

SOURCE: expression gaze

task	orien	expre	gaze	N	MEAN	SD	SE
		a	t	96	707.7899	114.9105	11.7280
		a	w	96	703.5122	116.6191	11.9024
		h	t	96	701.1198	123.4613	12.6007
		h	w	96	732.0955	128.5067	13.1157

SOURCE: task expression gaze

task	orien	expre	gaze	N	MEAN	SD	SE
g		a	t	48	706.6476	128.9571	18.6134
g		a	w	48	711.5347	133.8273	19.3163
g		h	t	48	701.0972	140.9820	20.3490
g		h	w	48	747.5937	146.1828	21.0997
x		a	t	48	708.9323	100.2855	14.4750
x		a	w	48	695.4896	97.2017	14.0299
x		h	t	48	701.1424	104.5647	15.0926
x		h	w	48	716.5972	107.3278	15.4914

SOURCE: orientation expression gaze

task	orien	expre	gaze	N	MEAN	SD	SE
	up	a	t	48	684.6354	117.9666	17.0270
	up	a	w	48	684.4601	117.0255	16.8912
	up	h	t	48	645.4618	106.9085	15.4309
	up	h	w	48	690.5122	118.2430	17.0669
	in	a	t	48	730.9444	108.0675	15.5982
	in	a	w	48	722.5642	114.2498	16.4905
	in	h	t	48	756.7778	114.2489	16.4904
	in	h	w	48	773.6788	125.9601	18.1808

SOURCE: task orientation expression gaze

task	orien	expre	gaze	N	MEAN	SD	SE
g	up	a	t	24	661.1944	126.3043	25.7818
g	up	a	w	24	678.5903	141.5357	28.8908
g	up	h	t	24	623.5486	118.2393	24.1355
g	up	h	w	24	692.4861	139.5118	28.4777
g	in	a	t	24	752.1007	117.1261	23.9083
g	in	a	w	24	744.4792	119.5859	24.4104
g	in	h	t	24	778.6458	118.6800	24.2255
g	in	h	w	24	802.7014	133.6660	27.2845
x	up	a	t	24	708.0764	106.4790	21.7349
x	up	a	w	24	690.3299	88.7756	18.1212

x	up	h	t	24	667.3750	91.5047	18.6783
x	up	h	w	24	688.5382	95.3887	19.4711
x	in	a	t	24	709.7882	95.9809	19.5920
x	in	a	w	24	700.6493	106.6324	21.7662
x	in	h	t	24	734.9097	107.6578	21.9756
x	in	h	w	24	744.6562	113.1250	23.0916

FACTOR:	subs	task	orientatio	expression	gaze	data
LEVELS:	96	2	2	2	2	384
TYPE :	RANDOM	BETWEEN	BETWEEN	WITHIN	WITHIN	DATA

SOURCE	SS	df	MS	F	p	
task	11994.8654	1	11994.8654	0.255	0.615	
s/to	4326618.9028	92	47028.4663			
orienta	466697.3023	1	466697.3023	9.924	0.002	**
s/to	4326618.9028	92	47028.4663			
to	123057.7260	1	123057.7260	2.617	0.109	
s/to	4326618.9028	92	47028.4663			
express	11524.5050	1	11524.5050	4.822	0.031	*
es/to	219877.7938	92	2389.9760			
te	1773.1775	1	1773.1775	0.742	0.391	
es/to	219877.7938	92	2389.9760			
oe	72691.7001	1	72691.7001	30.415	0.000	***
es/to	219877.7938	92	2389.9760			
toe	14.4538	1	14.4538	0.006	0.938	
es/to	219877.7938	92	2389.9760			
gaze	17106.6885	1	17106.6885	7.676	0.007	**
gs/to	205031.9028	92	2228.6076			
tg	14625.2833	1	14625.2833	6.563	0.012	*
gs/to	205031.9028	92	2228.6076			
og	7929.7576	1	7929.7576	3.558	0.062	
gs/to	205031.9028	92	2228.6076			
tog	6751.6598	1	6751.6598	3.030	0.085	
gs/to	205031.9028	92	2228.6076			
eg	29827.3728	1	29827.3728	26.672	0.000	***
egs/to	102882.1925	92	1118.2847			
teg	969.5387	1	969.5387	0.867	0.354	
egs/to	102882.1925	92	1118.2847			
oeg	2386.6872	1	2386.6872	2.134	0.147	
egs/to	102882.1925	92	1118.2847			
toeg	0.0383	1	0.0383	0.000	0.995	
egs/to	102882.1925	92	1118.2847			

Chapter 5. Exp. 9 (p. 159): correct RTs for gaze direction classification for individual stimuli. Expression x gaze direction x face.
(a = angry, h = happy, t = towards, w = away, A = 17, B = 22, C = 32, D = 7)

SOURCE: grand mean

expre	gaze	face	N	MEAN	SD	SE
			384	663.9549	140.1672	7.1529

SOURCE: expression

expre	gaze	face	N	MEAN	SD	SE
a			192	669.8924	140.0691	10.1086
h			192	658.0174	140.3792	10.1310

SOURCE: gaze

expre	gaze	face	N	MEAN	SD	SE
	t		192	642.3715	127.8504	9.2268
	w		192	685.5382	148.7086	10.7321

SOURCE: expression gaze

expre	gaze	face	N	MEAN	SD	SE
a	t		96	661.1944	132.3555	13.5085
a	w		96	678.5903	147.5612	15.0604
h	t		96	623.5486	120.9524	12.3446
h	w		96	692.4861	150.2976	15.3397

SOURCE: face

expre	gaze	face	N	MEAN	SD	SE
		A	96	635.5243	133.4657	13.6218
		B	96	678.2986	146.2147	14.9230
		C	96	674.6840	142.0803	14.5010
		D	96	667.3125	136.6626	13.9481

SOURCE: expression face

expre	gaze	face	N	MEAN	SD	SE
a		A	48	638.2361	133.0013	19.1971
a		B	48	681.1944	150.3238	21.6974
a		C	48	672.8403	134.6888	19.4406
a		D	48	687.2986	140.8184	20.3254
h		A	48	632.8125	135.2805	19.5261
h		B	48	675.4028	143.5200	20.7153
h		C	48	676.5278	150.5162	21.7251
h		D	48	647.3264	130.7861	18.8773

SOURCE: gaze face

expre	gaze	face	N	MEAN	SD	SE
	t	A	48	613.6458	127.7726	18.4424
	t	B	48	645.4514	129.5483	18.6987
	t	C	48	653.5972	122.2443	17.6444
	t	D	48	656.7917	131.0745	18.9190
	w	A	48	657.4028	136.7539	19.7387
	w	B	48	711.1458	155.6464	22.4656
	w	C	48	695.7708	157.9597	22.7995
	w	D	48	677.8333	142.6327	20.5873

SOURCE: expression gaze face

expre	gaze	face	N	MEAN	SD	SE
a	t	A	24	628.7778	130.1848	26.5739
a	t	B	24	649.7222	128.3373	26.1967
a	t	C	24	679.1111	134.4847	27.4516
a	t	D	24	687.1667	136.3066	27.8235
a	w	A	24	647.6944	137.8877	28.1462

a	w	B	24	712.6667	166.2510	33.9358
a	w	C	24	666.5694	137.4870	28.0644
a	w	D	24	687.4306	148.1292	30.2367
h	t	A	24	598.5139	126.2361	25.7678
h	t	B	24	641.1806	133.3668	27.2234
h	t	C	24	628.0833	105.3204	21.4984
h	t	D	24	626.4167	120.8430	24.6670
h	w	A	24	667.1111	137.8647	28.1415
h	w	B	24	709.6250	147.8536	30.1805
h	w	C	24	724.9722	174.0836	35.5347
h	w	D	24	668.2361	139.4210	28.4592

FACTOR:	subs	expression	gaze	face	data
LEVELS:	24	2	2	4	384
TYPE :	RANDOM	WITHIN	WITHIN	WITHIN	DATA

SOURCE	SS	df	MS	F	p	
express	13537.4971	1	13537.4971	5.042	0.035	*
es/	61752.9193	23	2684.9095			
gaze	178882.6930	1	178882.6930	16.374	0.001	***
gs/	251269.3466	23	10924.7542			
eg	63757.0417	1	63757.0417	54.818	0.000	***
egs/	26750.3379	23	1163.0582			
face	109481.1242	3	36493.7081	23.238	0.000	***
fs/	108360.3827	69	1570.4403			
ef	26646.5514	3	8882.1838	3.265	0.026	*
efs/	187702.5355	69	2720.3266			
gf	23960.4189	3	7986.8063	4.343	0.007	**
gfs/	126899.7498	69	1839.1268			
egf	33444.8642	3	11148.2881	2.907	0.041	*
egfs/	264575.5829	69	3834.4287			

Chapter 5. Exp. 10 (p. 159): correct RTs for inverted faces for gaze direction classification for individual stimuli. Expression x gaze direction x face.
(a = angry, h = happy, t = towards, w = away, A = 17, B = 22, C = 32, D = 7)

SOURCE: grand mean

expre	gaze	face	N	MEAN	SD	SE
			384	769.4818	142.9537	7.2951

SOURCE: expression

expre	gaze	face	N	MEAN	SD	SE
a			192	748.2899	129.0314	9.3120
h			192	790.6736	153.0572	11.0460

SOURCE: gaze

expre	gaze	face	N	MEAN	SD	SE
	t		192	765.3733	138.6790	10.0083
	w		192	773.5903	147.3523	10.6342

SOURCE: expression gaze

expre	gaze	face	N	MEAN	SD	SE
a	t		96	752.1007	126.9259	12.9543
a	w		96	744.4792	131.6584	13.4373
h	t		96	778.6458	148.9966	15.2069
h	w		96	802.7014	156.8670	16.0102

SOURCE: face

expre	gaze	face	N	MEAN	SD	SE
		A	96	720.8472	113.7048	11.6049
		B	96	823.6493	169.4348	17.2929
		C	96	772.4514	132.2887	13.5017
		D	96	760.9792	133.4689	13.6221

SOURCE: expression face

expre	gaze	face	N	MEAN	SD	SE
a		A	48	730.1667	118.3069	17.0761
a		B	48	766.4931	136.9570	19.7680
a		C	48	755.9861	129.8393	18.7407
a		D	48	740.5139	131.3435	18.9578
h		A	48	711.5278	109.3559	15.7842
h		B	48	880.8056	180.5471	26.0597
h		C	48	788.9167	134.0186	19.3439
h		D	48	781.4444	133.7920	19.3112

SOURCE: gaze face

expre	gaze	face	N	MEAN	SD	SE
	t	A	48	702.8264	98.0586	14.1535
	t	B	48	824.1458	169.8895	24.5214
	t	C	48	773.2153	127.3265	18.3780
	t	D	48	761.3056	125.9459	18.1787
	w	A	48	738.8681	125.9120	18.1738
	w	B	48	823.1528	170.7753	24.6493
	w	C	48	771.6875	138.4187	19.9790
	w	D	48	760.6528	141.9307	20.4859

SOURCE: expression gaze face

expre	gaze	face	N	MEAN	SD	SE
a	t	A	24	712.5139	107.2323	21.8887
a	t	B	24	753.9306	131.8694	26.9177
a	t	C	24	770.4583	124.7994	25.4746
a	t	D	24	771.5000	140.3418	28.6471
a	w	A	24	747.8194	128.2671	26.1824

a	w	B	24	779.0556	143.5656	29.3052
a	w	C	24	741.5139	135.7845	27.7169
a	w	D	24	709.5278	116.4161	23.7633
h	t	A	24	693.1389	89.1875	18.2053
h	t	B	24	894.3611	176.9213	36.1139
h	t	C	24	775.9722	132.4318	27.0325
h	t	D	24	751.1111	111.8110	22.8233
h	w	A	24	729.9167	125.6076	25.6395
h	w	B	24	867.2500	186.8880	38.1484
h	w	C	24	801.8611	137.1678	27.9993
h	w	D	24	811.7778	148.8520	30.3843

FACTOR:	subs	expression	gaze	face	data
LEVELS:	24	2	2	4	384
TYPE :	RANDOM	WITHIN	WITHIN	WITHIN	DATA

SOURCE	SS	df	MS	F	p	
express	172452.1409	1	172452.1409	13.319	0.001	**
es/	297800.5768	23	12947.8512			
gaze	6481.8541	1	6481.8541	0.355	0.557	
gs/	419911.9558	23	18257.0416			
eg	24082.4968	1	24082.4968	2.768	0.110	
egs/	200110.8781	23	8700.4730			
face	516533.2184	3	172177.7395	54.285	-0.000	***
fs/	218847.9813	69	3171.7099			
ef	215735.5545	3	71911.8515	11.565	0.000	***
efs/	429040.6315	69	6217.9802			
gf	24784.1052	3	8261.3684	2.749	0.049	*
gfs/	207387.9543	69	3005.6225			
egf	100584.1090	3	33528.0363	5.877	0.001	**
egfs/	393646.7759	69	5705.0257			

Chapter 5. Exp. 9 (p. 159): correct RTs for expression classification for individual stimuli. Expression x gaze direction x face.
(a = angry, h = happy, t = towards, w = away, A = 17, B = 22, C = 32, D = 7)

SOURCE: grand mean

expre	gaze	face	N	MEAN	SD	SE
			384	688.5799	110.0170	5.6143

SOURCE: expression

expre	gaze	face	N	MEAN	SD	SE
a			192	699.2031	110.1576	7.9499
h			192	677.9566	109.1295	7.8757

SOURCE: gaze

expre	gaze	face	N	MEAN	SD	SE
	t		192	687.7257	115.3471	8.3245
	w		192	689.4340	104.7111	7.5569

SOURCE: expression gaze

expre	gaze	face	N	MEAN	SD	SE
a	t		96	708.0764	122.1599	12.4679
a	w		96	690.3299	96.5140	9.8504
h	t		96	667.3750	104.8326	10.6994
h	w		96	688.5382	112.8171	11.5143

SOURCE: face

expre	gaze	face	N	MEAN	SD	SE
		A	96	672.3021	119.4485	12.1912
		B	96	683.7812	98.1916	10.0216
		C	96	689.7708	108.2624	11.0495
		D	96	708.4653	111.6908	11.3994

SOURCE: expression face

expre	gaze	face	N	MEAN	SD	SE
a		A	48	726.6319	123.5981	17.8398
a		B	48	682.6736	97.2582	14.0380
a		C	48	677.0000	102.3334	14.7706
a		D	48	710.5069	111.4639	16.0884
h		A	48	617.9722	86.7979	12.5282
h		B	48	684.8889	100.1333	14.4530
h		C	48	702.5417	113.5148	16.3844
h		D	48	706.4236	113.0591	16.3187

SOURCE: gaze face

expre	gaze	face	N	MEAN	SD	SE
	t	A	48	681.1389	134.8753	19.4676
	t	B	48	681.6389	99.5904	14.3746
	t	C	48	684.1806	113.8659	16.4351
	t	D	48	703.9444	112.3849	16.2214
	w	A	48	663.4653	102.4138	14.7822
	w	B	48	685.9236	97.7789	14.1132
	w	C	48	695.3611	103.2549	14.9036
	w	D	48	712.9861	111.9955	16.1652

SOURCE: expression gaze face

expre	gaze	face	N	MEAN	SD	SE
a	t	A	24	759.0556	137.4965	28.0664
a	t	B	24	688.5139	101.4196	20.7022
a	t	C	24	675.5278	114.3780	23.3473
a	t	D	24	709.2083	123.0737	25.1223
a	w	A	24	694.2083	100.5877	20.5324

a	w	B	24	676.8333	94.7231	19.3353
a	w	C	24	678.4722	91.1741	18.6108
a	w	D	24	711.8056	101.1828	20.6539
h	t	A	24	603.2222	74.8225	15.2731
h	t	B	24	674.7639	99.4140	20.2928
h	t	C	24	692.8333	115.1349	23.5018
h	t	D	24	698.6806	102.9802	21.0207
h	w	A	24	632.7222	96.6585	19.7303
h	w	B	24	695.0139	101.9421	20.8088
h	w	C	24	712.2500	113.4844	23.1649
h	w	D	24	714.1667	124.0582	25.3233

FACTOR:	subs	expression	gaze	face	data
LEVELS:	24	2	2	4	384
TYPE :	RANDOM	WITHIN	WITHIN	WITHIN	DATA

SOURCE	SS	df	MS	F	p	
express	43335.8308	1	43335.8308	4.048	0.056	
es/	246246.3922	23	10706.3649			
gaze	280.1664	1	280.1664	0.077	0.784	
gs/	83707.9104	23	3639.4744			
eg	36335.1982	1	36335.1982	5.788	0.025	*
egs/	144394.4980	23	6278.0217			
face	65744.7325	3	21914.9108	5.713	0.001	**
fs/	264673.1302	69	3835.8425			
ef	256205.6137	3	85401.8712	22.755	0.000	***
efs/	258961.4867	69	3753.0650			
gf	12619.1657	3	4206.3886	2.431	0.072	
gfs/	119372.1145	69	1730.0306			
egf	25815.2999	3	8605.1000	3.358	0.024	*
egfs/	176815.4395	69	2562.5426			

Chapter 5. Exp. 10 (p. 159): correct RTs for inverted faces for expression classification for individual stimuli. Expression x gaze direction x face.
(a = angry, h = happy, t = towards, w = away, A = 17, B = 22, C = 32, D = 7)

SOURCE: grand mean

expre	gaze	face	N	MEAN	SD	SE
			384	722.5009	118.7309	6.0590

SOURCE: expression

expre	gaze	face	N	MEAN	SD	SE
a			192	705.2188	111.4967	8.0466
h			192	739.7830	123.4337	8.9081

SOURCE: gaze

expre	gaze	face	N	MEAN	SD	SE
	t		192	722.3490	115.5212	8.3370
	w		192	722.6528	122.1584	8.8160

SOURCE: expression gaze

expre	gaze	face	N	MEAN	SD	SE
a	t		96	709.7882	107.5974	10.9816
a	w		96	700.6493	115.6482	11.8033
h	t		96	734.9097	122.2076	12.4728
h	w		96	744.6563	125.0977	12.7677

SOURCE: face

expre	gaze	face	N	MEAN	SD	SE
		A	96	701.5521	115.7659	11.8153
		B	96	720.3819	112.0434	11.4354
		C	96	717.9410	118.7406	12.1189
		D	96	750.1285	124.6521	12.7222

SOURCE: expression face

expre	gaze	face	N	MEAN	SD	SE
a		A	48	720.3472	120.8892	17.4488
a		B	48	685.7361	102.3742	14.7764
a		C	48	678.7014	101.0804	14.5897
a		D	48	736.0903	113.5554	16.3903
h		A	48	682.7569	108.4108	15.6478
h		B	48	755.0278	111.5452	16.1002
h		C	48	757.1806	123.0301	17.7579
h		D	48	764.1667	134.5716	19.4237

SOURCE: gaze face

expre	gaze	face	N	MEAN	SD	SE
	t	A	48	705.6250	119.7778	17.2884
	t	B	48	718.1806	101.3198	14.6243
	t	C	48	721.9514	116.2011	16.7722
	t	D	48	743.6389	123.8984	17.8832
	w	A	48	697.4792	112.7299	16.2712
	w	B	48	722.5833	122.8778	17.7359
	w	C	48	713.9306	122.3237	17.6559
	w	D	48	756.6181	126.3727	18.2403

SOURCE: expression gaze face

expre	gaze	face	N	MEAN	SD	SE
a	t	A	24	744.0694	127.6037	26.0470
a	t	B	24	687.0833	80.7555	16.4841
a	t	C	24	685.6667	100.0378	20.4201
a	t	D	24	722.3333	111.6762	22.7958
a	w	A	24	696.6250	111.3851	22.7364

a	w	B	24	684.3889	122.0302	24.9093
a	w	C	24	671.7361	103.7781	21.1836
a	w	D	24	749.8472	116.1197	23.7028
h	t	A	24	667.1806	99.7498	20.3613
h	t	B	24	749.2778	111.5263	22.7652
h	t	C	24	758.2361	121.8083	24.8640
h	t	D	24	764.9444	133.9782	27.3482
h	w	A	24	698.3333	116.4493	23.7701
h	w	B	24	760.7778	113.6597	23.2007
h	w	C	24	756.1250	126.8515	25.8935
h	w	D	24	763.3889	138.0398	28.1773

FACTOR:	subs	expression	gaze	face	data
LEVELS:	24	2	2	4	384
TYPE :	RANDOM	WITHIN	WITHIN	WITHIN	DATA

SOURCE	SS	df	MS	F	p	
express	114689.9039	1	114689.9039	9.637	0.005	**
es/	273711.3426	23	11900.4932			
gaze	8.8613	1	8.8613	0.003	0.956	
gs/	65238.4625	23	2836.4549			
eg	8559.8180	1	8559.8180	4.889	0.037	*
egs/	40273.0652	23	1751.0028			
face	117832.1694	3	39277.3898	9.263	0.000	***
fs/	292567.5923	69	4240.1100			
ef	201189.1211	3	67063.0404	15.012	0.000	***
efs/	308246.4403	69	4467.3397			
gf	7635.8992	3	2545.2997	2.032	0.117	
gfs/	86414.9193	69	1252.3901			
egf	35622.5969	3	11874.1990	9.192	0.000	***
egfs/	89129.6501	69	1291.7341			

Chapter 5. Exp. 11 (p. 164): correct RTs to the face looking at the viewer. Type of eyes x type of mouth.
(ea = angry eyes, eh = happy eyes, ma = angry mouth, mh = happy mouth)

SOURCE: grand mean

eyes	mouth	N	MEAN	SD	SE
		80	933.8875	231.1794	25.8466

SOURCE: eyes

eyes	mouth	N	MEAN	SD	SE
ea		40	924.6750	239.8789	37.9282
eh		40	943.1000	224.8160	35.5465

SOURCE: mouth

eyes	mouth	N	MEAN	SD	SE
	ma	40	948.3000	233.5262	36.9237
	mh	40	919.4750	230.8628	36.5026

SOURCE: eyes mouth

eyes	mouth	N	MEAN	SD	SE
ea	ma	20	934.2000	241.8272	54.0742
ea	mh	20	915.1500	243.8050	54.5165
eh	ma	20	962.4000	230.3047	51.4977
eh	mh	20	923.8000	223.4282	49.9601

FACTOR:	subs	eyes	mouth	data
LEVELS:	20	2	2	80
TYPE :	RANDOM	WITHIN	WITHIN	DATA

SOURCE	SS	df	MS	F	p
eyes	6789.6125	1	6789.6125	1.709	0.207
es/	75497.1375	19	3973.5336		
mouth	16617.6125	1	16617.6125	13.006	0.002 **
ms/	24276.1375	19	1277.6914		
em	1911.0125	1	1911.0125	0.874	0.362
ems/	41549.7375	19	2186.8283		

Chapter 7. Exp. 12 (p. 189): estimates of 10 s intervals. Participant sex x stimulus sex x expression.
(Psex = participant sex, f = Female participant, m = Male participant, Ssex = stimulus sex, m = male stimulus face, f = female stimulus face, a = angry, h = happy)

SOURCE: grand mean

Psex	Ssex	expre	N	MEAN	SD	SE
			128	12.6799	3.6652	0.3240

SOURCE: Psex

Psex	Ssex	expre	N	MEAN	SD	SE
f			64	12.1612	2.9213	0.3652
m			64	13.1986	4.2427	0.5303

SOURCE: Ssex

Psex	Ssex	expre	N	MEAN	SD	SE
	m		64	12.7133	3.5866	0.4483
	f		64	12.6466	3.7703	0.4713

SOURCE: Psex Ssex

Psex	Ssex	expre	N	MEAN	SD	SE
f	m		32	12.1119	2.7090	0.4789
f	f		32	12.2106	3.1623	0.5590
m	m		32	13.3147	4.2494	0.7512
m	f		32	13.0825	4.3008	0.7603

SOURCE: expression

Psex	Ssex	expre	N	MEAN	SD	SE
		a	64	12.6280	3.6926	0.4616
		h	64	12.7319	3.6661	0.4583

SOURCE: Psex expression

Psex	Ssex	expre	N	MEAN	SD	SE
f		a	32	11.9772	2.8307	0.5004
f		h	32	12.3453	3.0431	0.5379
m		a	32	13.2788	4.3386	0.7670
m		h	32	13.1184	4.2125	0.7447

SOURCE: Ssex expression

Psex	Ssex	expre	N	MEAN	SD	SE
	m	a	32	12.6894	3.6124	0.6386
	m	h	32	12.7372	3.6183	0.6396
	f	a	32	12.5666	3.8280	0.6767
	f	h	32	12.7266	3.7712	0.6667

SOURCE: Psex Ssex expression

Psex	Ssex	expre	N	MEAN	SD	SE
f	m	a	16	11.9687	2.5696	0.6424
f	m	h	16	12.2550	2.9189	0.7297
f	f	a	16	11.9856	3.1555	0.7889
f	f	h	16	12.4356	3.2559	0.8140
m	m	a	16	13.4100	4.3884	1.0971
m	m	h	16	13.2194	4.2474	1.0618
m	f	a	16	13.1475	4.4280	1.1070
m	f	h	16	13.0175	4.3140	1.0785

FACTOR:	subs	Psex	Ssex	expression	data
LEVELS:	32	2	2	2	128
TYPE :	RANDOM	BETWEEN	WITHIN	WITHIN	DATA

SOURCE	SS	df	MS	F	p

Psex	34.4346	1	34.4346	0.635	0.432
s/P	1627.6665	30	54.2555		
Ssex	0.1424	1	0.1424	0.261	0.613
Ss/P	16.3499	30	0.5450		
PS	0.8762	1	0.8762	1.608	0.215
Ss/P	16.3499	30	0.5450		
express	0.3455	1	0.3455	0.688	0.413
es/P	15.0561	30	0.5019		
Pe	2.2340	1	2.2340	4.451	0.043 *
es/P	15.0561	30	0.5019		
Se	0.1007	1	0.1007	0.340	0.564
Ses/P	8.8874	30	0.2962		
PSe	0.0213	1	0.0213	0.072	0.791
Ses/P	8.8874	30	0.2962		

Chapter 7. Exp. 13 (pp. 194-195): 'longer' judgements to male faces. Expression of the first stimulus x level x expression of the second stimulus.
(a = first stimulus angry, h = first stimulus happy, secA = second stimulus angry, secH = second stimulus happy, 100 = 100 ms exposure duration of the first stimulus, 80 = 80 ms exposure duration of the first stimulus, etc.)

SOURCE: grand mean

first	level	secon	N	MEAN	SD	SE
			1000	2.3160	1.4164	0.0448

SOURCE: first

first	level	secon	N	MEAN	SD	SE
a			500	2.3400	1.4158	0.0633
h			500	2.2920	1.4180	0.0634

SOURCE: level

first	level	secon	N	MEAN	SD	SE
	100		200	3.2200	1.1911	0.0842
	80		200	2.9750	1.2698	0.0898
	60		200	2.6050	1.0885	0.0770
	40		200	1.6850	1.2096	0.0855
	20		200	1.0950	1.0732	0.0759

SOURCE: first level

first	level	secon	N	MEAN	SD	SE
a	100		100	3.2200	1.1598	0.1160
a	80		100	3.0500	1.2421	0.1242
a	60		100	2.5200	1.0869	0.1087
a	40		100	1.7200	1.3033	0.1303
a	20		100	1.1900	1.1344	0.1134
h	100		100	3.2200	1.2275	0.1227
h	80		100	2.9000	1.2988	0.1299
h	60		100	2.6900	1.0889	0.1089
h	40		100	1.6500	1.1135	0.1114
h	20		100	1.0000	1.0050	0.1005

SOURCE: second

first	level	secon	N	MEAN	SD	SE
		secA	500	2.2520	1.3639	0.0610
		secH	500	2.3800	1.4656	0.0655

SOURCE: first second

first	level	secon	N	MEAN	SD	SE
a		secA	250	2.3160	1.3885	0.0878
a		secH	250	2.3640	1.4449	0.0914
h		secA	250	2.1880	1.3386	0.0847
h		secH	250	2.3960	1.4886	0.0941

SOURCE: level second

first	level	secon	N	MEAN	SD	SE
	100	secA	100	3.0700	1.1569	0.1157
	100	secH	100	3.3700	1.2115	0.1212
	80	secA	100	2.8900	1.2382	0.1238
	80	secH	100	3.0600	1.3013	0.1301
	60	secA	100	2.5000	1.0299	0.1030
	60	secH	100	2.7100	1.1397	0.1140
	40	secA	100	1.6200	1.2616	0.1262
	40	secH	100	1.7500	1.1580	0.1158
	20	secA	100	1.1800	1.0672	0.1067
	20	secH	100	1.0100	1.0777	0.1078

SOURCE: first level second

first	level	secon	N	MEAN	SD	SE
a	100	secA	50	3.1400	1.1250	0.1591
a	100	secH	50	3.3000	1.1995	0.1696
a	80	secA	50	3.0000	1.2936	0.1829
a	80	secH	50	3.1000	1.1995	0.1696
a	60	secA	50	2.4600	0.9521	0.1346
a	60	secH	50	2.5800	1.2137	0.1716
a	40	secA	50	1.7000	1.3590	0.1922
a	40	secH	50	1.7400	1.2586	0.1780
a	20	secA	50	1.2800	1.1959	0.1691
a	20	secH	50	1.1000	1.0738	0.1519
h	100	secA	50	3.0000	1.1952	0.1690
h	100	secH	50	3.4400	1.2316	0.1742
h	80	secA	50	2.7800	1.1830	0.1673
h	80	secH	50	3.0200	1.4068	0.1990
h	60	secA	50	2.5400	1.1104	0.1570
h	60	secH	50	2.8400	1.0568	0.1494
h	40	secA	50	1.5400	1.1643	0.1647
h	40	secH	50	1.7600	1.0606	0.1500
h	20	secA	50	1.0800	0.9223	0.1304
h	20	secH	50	0.9200	1.0850	0.1534

FACTOR:	subs	first	level	second	data
LEVELS:	50	2	5	2	1000
TYPE :	RANDOM	WITHIN	WITHIN	WITHIN	DATA

SOURCE	SS	df	MS	F	p
first	0.5760	1	0.5760	0.449	0.506
fs/	62.8240	49	1.2821		
level	644.8040	4	161.2010	81.223	0.000 ***
ls/	388.9960	196	1.9847		
fl	4.0440	4	1.0110	1.045	0.385
fls/	189.5560	196	0.9671		
second	4.0960	1	4.0960	4.121	0.048 *
ss/	48.7040	49	0.9940		
fs	1.6000	1	1.6000	1.446	0.235
fss/	54.2000	49	1.1061		
ls	6.3440	4	1.5860	1.447	0.220
lss/	214.8560	196	1.0962		
fls	0.4400	4	0.1100	0.107	0.980
flss/	201.7600	196	1.0294		

Chapter 7. Exp. 13 (p. 195): 'longer' judgements to male faces. Participant sex x expression of the first stimulus (one) x expression of the second stimulus (Two).
(m = Male participant, f = Female participant, a = first stimulus angry, h = first stimulus happy, secA = second stimulus angry, secH = second stimulus happy)

SOURCE: grand mean

Psex	One	Two	N	MEAN	SD	SE
			200	2.3160	0.5959	0.0421

SOURCE: Psex

Psex	One	Two	N	MEAN	SD	SE
m			100	2.2840	0.5342	0.0534
f			100	2.3480	0.6530	0.0653

SOURCE: One

Psex	One	Two	N	MEAN	SD	SE
	a		100	2.3400	0.6199	0.0620
	h		100	2.2920	0.5731	0.0573

SOURCE: Psex One

Psex	One	Two	N	MEAN	SD	SE
m	a		50	2.3240	0.5964	0.0843
m	h		50	2.2440	0.4665	0.0660
f	a		50	2.3560	0.6481	0.0917
f	h		50	2.3400	0.6642	0.0939

SOURCE: Two

Psex	One	Two	N	MEAN	SD	SE
		secA	100	2.2520	0.6041	0.0604
		secH	100	2.3800	0.5836	0.0584

SOURCE: Psex Two

Psex	One	Two	N	MEAN	SD	SE
m		secA	50	2.2360	0.5340	0.0755
m		secH	50	2.3320	0.5355	0.0757
f		secA	50	2.2680	0.6720	0.0950
f		secH	50	2.4280	0.6299	0.0891

SOURCE: One Two

Psex	One	Two	N	MEAN	SD	SE
	a	secA	50	2.3160	0.6377	0.0902
	a	secH	50	2.3640	0.6070	0.0858
	h	secA	50	2.1880	0.5677	0.0803
	h	secH	50	2.3960	0.5649	0.0799

SOURCE: Psex One Two

Psex	One	Two	N	MEAN	SD	SE
m	a	secA	25	2.2400	0.6000	0.1200
m	a	secH	25	2.4080	0.5930	0.1186
m	h	secA	25	2.2320	0.4715	0.0943
m	h	secH	25	2.2560	0.4709	0.0942
f	a	secA	25	2.3920	0.6770	0.1354
f	a	secH	25	2.3200	0.6298	0.1260
f	h	secA	25	2.1440	0.6571	0.1314
f	h	secH	25	2.5360	0.6238	0.1248

FACTOR:	subs	Psex	One	Two	data
LEVELS:	50	2	2	2	200
TYPE :	RANDOM	BETWEEN	WITHIN	WITHIN	DATA

SOURCE	SS	df	MS	F	p

Psex	0.2048	1	0.2048	0.273	0.604
s/P	36.0640	48	0.7513		
One	0.1152	1	0.1152	0.442	0.509
Os/P	12.5136	48	0.2607		
PO	0.0512	1	0.0512	0.196	0.660
Os/P	12.5136	48	0.2607		
Two	0.8192	1	0.8192	4.058	0.050 *
Ts/P	9.6896	48	0.2019		
PT	0.0512	1	0.0512	0.254	0.617
Ts/P	9.6896	48	0.2019		
OT	0.3200	1	0.3200	1.586	0.214
OTs/P	9.6848	48	0.2018		
POT	1.1552	1	1.1552	5.725	0.021 *
OTs/P	9.6848	48	0.2018		

Chapter 7. Exp. 14 (pp. 198-199): 'longer' judgements to female faces made by a mixed (sex) group of participants. Expression of the first stimulus x level x expression of the second stimulus.
(a = first stimulus angry, h = first stimulus happy, secA = second stimulus angry, secH = second stimulus happy, 170 = 170 ms exposure duration of the first stimulus, 140 = 140 ms exposure duration of the first stimulus, etc.)

SOURCE: grand mean

first	level	secon	N	MEAN	SD	SE
			500	2.6600	1.6413	0.0734

SOURCE: first

first	level	secon	N	MEAN	SD	SE
a			250	2.5480	1.6156	0.1022
h			250	2.7720	1.6622	0.1051

SOURCE: level

first	level	secon	N	MEAN	SD	SE
	170		100	4.0500	1.1225	0.1123
	140		100	3.6000	1.2713	0.1271
	110		100	2.8200	1.2663	0.1266
	80		100	1.7600	1.2722	0.1272
	50		100	1.0700	1.1124	0.1112

SOURCE: first level

first	level	secon	N	MEAN	SD	SE
a	170		50	3.9600	1.0872	0.1538
a	140		50	3.4800	1.2329	0.1744
a	110		50	2.5200	1.2329	0.1744
a	80		50	1.7000	1.4178	0.2005
a	50		50	1.0800	1.0850	0.1534
h	170		50	4.1400	1.1608	0.1642
h	140		50	3.7200	1.3099	0.1853
h	110		50	3.1200	1.2395	0.1753
h	80		50	1.8200	1.1192	0.1583
h	50		50	1.0600	1.1502	0.1627

SOURCE: second

first	level	secon	N	MEAN	SD	SE
		secA	250	2.8400	1.5952	0.1009
		secH	250	2.4800	1.6700	0.1056

SOURCE: first second

first	level	secon	N	MEAN	SD	SE
a		secA	125	2.8800	1.5943	0.1426
a		secH	125	2.2160	1.5739	0.1408
h		secA	125	2.8000	1.6014	0.1432
h		secH	125	2.7440	1.7269	0.1545

SOURCE: level second

first	level	secon	N	MEAN	SD	SE
	170	secA	50	4.2000	0.9476	0.1340
	170	secH	50	3.9000	1.2657	0.1790
	140	secA	50	3.7200	1.1436	0.1617
	140	secH	50	3.4800	1.3886	0.1964
	110	secA	50	3.0200	1.3323	0.1884
	110	secH	50	2.6200	1.1761	0.1663
	80	secA	50	1.9200	1.2262	0.1734
	80	secH	50	1.6000	1.3093	0.1852
	50	secA	50	1.3400	1.2554	0.1775
	50	secH	50	0.8000	0.8806	0.1245

SOURCE: first level second

first	level	secon	N	MEAN	SD	SE
a	170	secA	25	4.2800	0.8907	0.1781
a	170	secH	25	3.6400	1.1860	0.2372
a	140	secA	25	3.7600	0.9256	0.1851
a	140	secH	25	3.2000	1.4434	0.2887
a	110	secA	25	2.9600	1.4283	0.2857
a	110	secH	25	2.0800	0.8124	0.1625
a	80	secA	25	2.0400	1.4572	0.2914
a	80	secH	25	1.3600	1.3191	0.2638
a	50	secA	25	1.3600	1.1504	0.2301
a	50	secH	25	0.8000	0.9574	0.1915
h	170	secA	25	4.1200	1.0132	0.2026
h	170	secH	25	4.1600	1.3128	0.2626
h	140	secA	25	3.6800	1.3454	0.2691
h	140	secH	25	3.7600	1.3000	0.2600
h	110	secA	25	3.0800	1.2557	0.2511
h	110	secH	25	3.1600	1.2477	0.2495
h	80	secA	25	1.8000	0.9574	0.1915
h	80	secH	25	1.8400	1.2806	0.2561
h	50	secA	25	1.3200	1.3760	0.2752
h	50	secH	25	0.8000	0.8165	0.1633

FACTOR:	subs	first	level	second	data
LEVELS:	25	2	5	2	500
TYPE :	RANDOM	WITHIN	WITHIN	WITHIN	DATA

SOURCE	SS	df	MS	F	p
first	6.2720	1	6.2720	1.907	0.180
fs/	78.9280	24	3.2887		
level	617.9400	4	154.4850	74.691	0.000 ***
ls/	198.5600	96	2.0683		
fl	5.3480	4	1.3370	1.157	0.335
fls/	110.9520	96	1.1557		
second	16.2000	1	16.2000	9.529	0.005 **
ss/	40.8000	24	1.7000		
fs	11.5520	1	11.5520	12.029	0.002 **
fss/	23.0480	24	0.9603		
ls	1.3400	4	0.3350	0.361	0.836
lss/	89.1600	96	0.9287		
fls	2.9080	4	0.7270	0.862	0.490
flss/	80.9920	96	0.8437		

Chapter 7. Exp. 15 (p. 202): longer judgements to the first stimulus of each pair at variable levels of this stimulus. 1 = 50 ms, 2 = 80 ms, 3 = 110 ms, 4 = 140 ms, 5 = 170 ms. Maximum score = 4.

SOURCE: grand mean

level	N	MEAN	SD	SE
	125	1.9770	0.8141	0.0728

SOURCE: level

level	N	MEAN	SD	SE
1	25	0.9800	0.5156	0.1031
2	25	1.5075	0.3010	0.0602
3	25	2.1250	0.4300	0.0860
4	25	2.5600	0.5492	0.1098
5	25	2.7125	0.6134	0.1227

FACTOR:	subs	level	data
LEVELS:	25	5	125
TYPE :	RANDOM	WITHIN	DATA

SOURCE	SS	df	MS	F	p
level	52.9298	4	13.2325	70.518	0.000 ***
ls/	18.0139	96	0.1876		

Chapter 7. Exp. 15 (p. 202): longer judgements to the first stimulus face.
Expression of the first stimulus face (One) x sex of the first face (Primary) x expression of the second stimulus (Two) x sex of the second face (Secondary).

SOURCE: grand mean

One	Prima	Two	Secon	N	MEAN	SD	SE
				400	1.9770	0.6324	0.0316

SOURCE: One

One	Prima	Two	Secon	N	MEAN	SD	SE
A				200	1.9980	0.6546	0.0463
H				200	1.9560	0.6102	0.0431

SOURCE: Primary

One	Prima	Two	Secon	N	MEAN	SD	SE
	F			200	1.9840	0.6171	0.0436
	M			200	1.9700	0.6487	0.0459

SOURCE: One Primary

One	Prima	Two	Secon	N	MEAN	SD	SE
A	F			100	1.9860	0.6577	0.0658
A	M			100	2.0100	0.6547	0.0655
H	F			100	1.9820	0.5771	0.0577
H	M			100	1.9300	0.6435	0.0643

SOURCE: Two

One	Prima	Two	Secon	N	MEAN	SD	SE
		a		200	1.9980	0.6312	0.0446
		h		200	1.9560	0.6344	0.0449

SOURCE: One Two

One	Prima	Two	Secon	N	MEAN	SD	SE
A		a		100	2.0380	0.6193	0.0619
A		h		100	1.9580	0.6889	0.0689
H		a		100	1.9580	0.6434	0.0643
H		h		100	1.9540	0.5783	0.0578

SOURCE: Primary Two

One	Prima	Two	Secon	N	MEAN	SD	SE
	F	a		100	2.0340	0.6274	0.0627
	F	h		100	1.9340	0.6057	0.0606
	M	a		100	1.9620	0.6361	0.0636
	M	h		100	1.9780	0.6642	0.0664

SOURCE: One Primary Two

One	Prima	Two	Secon	N	MEAN	SD	SE
A	F	a		50	2.0480	0.6421	0.0908
A	F	h		50	1.9240	0.6736	0.0953
A	M	a		50	2.0280	0.6021	0.0851
A	M	h		50	1.9920	0.7091	0.1003
H	F	a		50	2.0200	0.6184	0.0875
H	F	h		50	1.9440	0.5361	0.0758
H	M	a		50	1.8960	0.6679	0.0945
H	M	h		50	1.9640	0.6229	0.0881

SOURCE: Secondary

One	Prima	Two	Secon	N	MEAN	SD	SE
			f	200	1.9850	0.6466	0.0457
			m	200	1.9690	0.6193	0.0438

SOURCE: One Secondary

One	Prima	Two	Secon	N	MEAN	SD	SE
A			f	100	2.0100	0.6977	0.0698
A			m	100	1.9860	0.6118	0.0612
H			f	100	1.9600	0.5936	0.0594
H			m	100	1.9520	0.6293	0.0629

SOURCE: Primary Secondary

One	Prima	Two	Secon	N	MEAN	SD	SE
	F		f	100	2.0000	0.6426	0.0643
	F		m	100	1.9680	0.5934	0.0593
	M		f	100	1.9700	0.6534	0.0653
	M		m	100	1.9700	0.6472	0.0647

SOURCE: One Primary Secondary

One	Prima	Two	Secon	N	MEAN	SD	SE
A	F		f	50	1.9960	0.7062	0.0999
A	F		m	50	1.9760	0.6123	0.0866
A	M		f	50	2.0240	0.6959	0.0984
A	M		m	50	1.9960	0.6174	0.0873
H	F		f	50	2.0040	0.5792	0.0819
H	F		m	50	1.9600	0.5799	0.0820
H	M		f	50	1.9160	0.6102	0.0863
H	M		m	50	1.9440	0.6810	0.0963

SOURCE: Two Secondary

One	Prima	Two	Secon	N	MEAN	SD	SE
		a	f	100	2.1060	0.6359	0.0636
		a	m	100	1.8900	0.6106	0.0611
		h	f	100	1.8640	0.6375	0.0637
		h	m	100	2.0480	0.6209	0.0621

SOURCE: One Two Secondary

One	Prima	Two	Secon	N	MEAN	SD	SE
A		a	f	50	2.1160	0.6441	0.0911
A		a	m	50	1.9600	0.5897	0.0834
A		h	f	50	1.9040	0.7387	0.1045
A		h	m	50	2.0120	0.6381	0.0902
H		a	f	50	2.0960	0.6341	0.0897
H		a	m	50	1.8200	0.6289	0.0889
H		h	f	50	1.8240	0.5216	0.0738
H		h	m	50	2.0840	0.6076	0.0859

SOURCE: Primary Two Secondary

One	Prima	Two	Secon	N	MEAN	SD	SE
	F	a	f	50	2.1680	0.6329	0.0895
	F	a	m	50	1.9000	0.5983	0.0846
	F	h	f	50	1.8320	0.6133	0.0867
	F	h	m	50	2.0360	0.5865	0.0829
	M	a	f	50	2.0440	0.6392	0.0904
	M	a	m	50	1.8800	0.6286	0.0889
	M	h	f	50	1.8960	0.6655	0.0941
	M	h	m	50	2.0600	0.6593	0.0932

SOURCE: One Primary Two Secondary

One	Prima	Two	Secon	N	MEAN	SD	SE
A	F	a	f	25	2.1840	0.6606	0.1321
A	F	a	m	25	1.9120	0.6058	0.1212
A	F	h	f	25	1.8080	0.7129	0.1426
A	F	h	m	25	2.0400	0.6245	0.1249
A	M	a	f	25	2.0480	0.6332	0.1266
A	M	a	m	25	2.0080	0.5816	0.1163
A	M	h	f	25	2.0000	0.7659	0.1532
A	M	h	m	25	1.9840	0.6631	0.1326
H	F	a	f	25	2.1520	0.6172	0.1234

H	F	a	m	25	1.8880	0.6030	0.1206
H	F	h	f	25	1.8560	0.5083	0.1017
H	F	h	m	25	2.0320	0.5588	0.1118
H	M	a	f	25	2.0400	0.6583	0.1317
H	M	a	m	25	1.7520	0.6590	0.1318
H	M	h	f	25	1.7920	0.5431	0.1086
H	M	h	m	25	2.1360	0.6601	0.1320

FACTOR:	subs	One	Primary	Two	Secondary
data					
LEVELS:	25	2	2	2	2
400					
TYPE :	RANDOM	WITHIN	WITHIN	WITHIN	WITHIN
DATA					

SOURCE	SS	df	MS	F	p
One	0.1764	1	0.1764	0.164	0.689
Os/	25.8186	24	1.0758		
Primary	0.0196	1	0.0196	0.065	0.800
Ps/	7.1854	24	0.2994		
OP	0.1444	1	0.1444	0.577	0.455
OPs/	6.0106	24	0.2504		
Two	0.1764	1	0.1764	0.194	0.664
Ts/	21.8486	24	0.9104		
OT	0.1444	1	0.1444	0.475	0.497
OTs/	7.2906	24	0.3038		
PT	0.3364	1	0.3364	1.631	0.214
PTs/	4.9486	24	0.2062		
OPT	0.0196	1	0.0196	0.125	0.726
OPTs/	3.7554	24	0.1565		
Seconda	0.0256	1	0.0256	0.099	0.756
Ss/	6.1994	24	0.2583		
OS	0.0064	1	0.0064	0.037	0.849
OSs/	4.1286	24	0.1720		
PS	0.0256	1	0.0256	0.127	0.725
PSs/	4.8394	24	0.2016		
OPS	0.0400	1	0.0400	0.362	0.553
OPSs/	2.6550	24	0.1106		
TS	4.0000	1	4.0000	13.744	0.001 **
TSs/	6.9850	24	0.2910		
OTS	0.4624	1	0.4624	2.492	0.127
OTSs/	4.4526	24	0.1855		
PTS	0.1296	1	0.1296	0.564	0.460
PTSs/	5.5154	24	0.2298		
OPTS	0.7056	1	0.7056	3.074	0.092
OPTSs/	5.5094	24	0.2296		

Chapter 8. Exp. 16 (p. 214): correct guesses to the majority stimulus. Group x interval.
(ah = group in which the majority stimulus is an angry face, ha = majority stimulus is a happy face, do = majority stimulus is a field of dashes; v1 = interval 1, v2 = interval 2 etc.; Maximum score = 7, **NB. Analysis carried out on raw data with interval means converted to % correct for Figure 52)**

SOURCE: grand mean

group	inter	N	MEAN	SD	SE
		540	4.3963	1.3925	0.0599

SOURCE: group

group	inter	N	MEAN	SD	SE
ah		180	4.3000	1.3532	0.1009
ha		180	4.8500	1.3962	0.1041
do		180	4.0389	1.3090	0.0976

SOURCE: interval

group	inter	N	MEAN	SD	SE
	v1	36	3.8889	1.3475	0.2246
	v2	36	3.6111	1.4198	0.2366
	v3	36	4.1944	1.3271	0.2212
	v4	36	4.2500	1.4015	0.2336
	v5	36	4.5000	1.2306	0.2051
	v6	36	3.9722	1.2068	0.2011
	v7	36	4.3889	1.3995	0.2333
	v8	36	4.0833	1.4218	0.2370
	v9	36	4.7500	1.2507	0.2085
	v10	36	4.6667	1.3939	0.2323
	v11	36	4.8056	1.2147	0.2024
	v12	36	4.4167	1.5743	0.2624
	v13	36	4.5833	1.2277	0.2046
	v14	36	5.2778	1.3008	0.2168
	v15	36	4.5556	1.4822	0.2470

SOURCE: group interval

group	inter	N	MEAN	SD	SE
ah	v1	12	3.0000	1.0445	0.3015
ah	v2	12	3.9167	1.1645	0.3362
ah	v3	12	3.6667	1.1547	0.3333
ah	v4	12	4.1667	1.1934	0.3445
ah	v5	12	4.6667	1.0731	0.3098
ah	v6	12	3.5000	1.1677	0.3371
ah	v7	12	4.0000	1.3484	0.3892
ah	v8	12	3.5000	1.3143	0.3794
ah	v9	12	5.0000	1.1282	0.3257
ah	v10	12	4.6667	1.2309	0.3553
ah	v11	12	5.8333	0.7177	0.2072
ah	v12	12	4.0000	1.2060	0.3482
ah	v13	12	4.6667	1.1547	0.3333
ah	v14	12	5.5833	1.2401	0.3580
ah	v15	12	4.3333	1.2309	0.3553
ha	v1	12	4.9167	1.3114	0.3786
ha	v2	12	3.9167	1.5643	0.4516
ha	v3	12	5.0000	1.4142	0.4082
ha	v4	12	4.1667	1.5859	0.4578
ha	v5	12	4.1667	1.4668	0.4234
ha	v6	12	4.5000	1.3817	0.3989
ha	v7	12	4.8333	1.5275	0.4410
ha	v8	12	5.0833	1.3790	0.3981
ha	v9	12	4.9167	1.0836	0.3128
ha	v10	12	5.0833	1.7816	0.5143

ha	v11	12	4.8333	0.7177	0.2072
ha	v12	12	5.4167	1.1645	0.3362
ha	v13	12	5.3333	1.0731	0.3098
ha	v14	12	6.0000	0.8528	0.2462
ha	v15	12	4.5833	1.5050	0.4345
do	v1	12	3.7500	0.9653	0.2787
do	v2	12	3.0000	1.4142	0.4082
do	v3	12	3.9167	1.0836	0.3128
do	v4	12	4.4167	1.5050	0.4345
do	v5	12	4.6667	1.1547	0.3333
do	v6	12	3.9167	0.9003	0.2599
do	v7	12	4.3333	1.3027	0.3761
do	v8	12	3.6667	1.0731	0.3098
do	v9	12	4.3333	1.4975	0.4323
do	v10	12	4.2500	1.0553	0.3046
do	v11	12	3.7500	1.1382	0.3286
do	v12	12	3.8333	1.8505	0.5342
do	v13	12	3.7500	0.9653	0.2787
do	v14	12	4.2500	1.1382	0.3286
do	v15	12	4.7500	1.7645	0.5094

FACTOR:	subs	group	interval	data
LEVELS:	36	3	15	540
TYPE :	RANDOM	BETWEEN	WITHIN	DATA

SOURCE	SS	df	MS	F	p	
group	61.7148	2	30.8574	7.110	0.003	**
s/g	143.2111	33	4.3397			
interva	87.4148	14	6.2439	4.407	0.000	***
is/g	654.6222	462	1.4169			
gi	98.2296	28	3.5082	2.476	0.000	***
is/g	654.6222	462	1.4169			

Chapter 8. Exp. 17, Phase 1 (pp. 222-223): correct guesses to the majority stimulus. Group x interval.
(ah = group in which the majority stimulus is an angry face, ha = majority stimulus is a happy face, fl = majority stimulus is a flat ellipse, up = majority stimulus is a vertical ellipse; v1 = interval 1, v2 = interval 2 etc.; Maximum score = 7, **NB. Analysis carried out on raw data with interval means converted to % correct for Figure 54)**

SOURCE: grand mean

group	inter	N	MEAN	SD	SE
		800	4.2088	1.3884	0.0491

SOURCE: group

group	inter	N	MEAN	SD	SE
ah		200	3.9050	1.5615	0.1104
ha		200	4.3950	1.2233	0.0865
fl		200	4.2050	1.4082	0.0996
up		200	4.3300	1.2960	0.0916

SOURCE: interval

group	inter	N	MEAN	SD	SE
	v1	80	3.3375	1.1467	0.1282
	v2	80	3.7375	1.2603	0.1409
	v3	80	3.6375	1.3710	0.1533
	v4	80	4.3125	1.2386	0.1385
	v5	80	4.6125	1.3454	0.1504
	v6	80	4.2125	1.2497	0.1397
	v7	80	4.4750	1.3685	0.1530
	v8	80	4.1250	1.2566	0.1405
	v9	80	4.8875	1.4408	0.1611
	v10	80	4.7500	1.3917	0.1556

SOURCE: group interval

group	inter	N	MEAN	SD	SE
ah	v1	20	2.8000	0.9515	0.2128
ah	v2	20	3.1000	1.3338	0.2982
ah	v3	20	3.6500	1.2258	0.2741
ah	v4	20	3.8000	1.2814	0.2865
ah	v5	20	4.0500	1.5720	0.3515
ah	v6	20	4.6500	1.3870	0.3101
ah	v7	20	4.0000	1.7770	0.3974
ah	v8	20	3.7500	1.4824	0.3315
ah	v9	20	4.7500	2.0229	0.4523
ah	v10	20	4.5000	1.4327	0.3204
ha	v1	20	3.9000	0.9679	0.2164
ha	v2	20	4.0500	1.2763	0.2854
ha	v3	20	4.0000	1.1239	0.2513
ha	v4	20	4.2000	1.0563	0.2362
ha	v5	20	4.8000	1.3992	0.3129
ha	v6	20	4.3500	1.3485	0.3015
ha	v7	20	4.7000	1.0311	0.2306
ha	v8	20	4.2500	1.2513	0.2798
ha	v9	20	4.8000	1.0563	0.2362
ha	v10	20	4.9000	1.3727	0.3069
fl	v1	20	3.4500	1.1910	0.2663
fl	v2	20	4.0500	1.3169	0.2945
fl	v3	20	3.2000	1.5079	0.3372
fl	v4	20	4.6000	1.2732	0.2847
fl	v5	20	4.5000	1.0513	0.2351
fl	v6	20	3.7000	1.1286	0.2524
fl	v7	20	4.4500	1.4681	0.3283
fl	v8	20	4.3500	1.0400	0.2325
fl	v9	20	5.1500	1.4609	0.3267

fl	v10	20	4.6000	1.6026	0.3584
up	v1	20	3.2000	1.2397	0.2772
up	v2	20	3.7500	0.9105	0.2036
up	v3	20	3.7000	1.5594	0.3487
up	v4	20	4.6500	1.2258	0.2741
up	v5	20	5.1000	1.1653	0.2606
up	v6	20	4.1500	0.9881	0.2209
up	v7	20	4.7500	1.0195	0.2280
up	v8	20	4.1500	1.2258	0.2741
up	v9	20	4.8500	1.0894	0.2436
up	v10	20	5.0000	1.1698	0.2616

FACTOR:	subs	group	interval	data
LEVELS:	80	4	10	800
TYPE :	RANDOM	BETWEEN	WITHIN	DATA

SOURCE	SS	df	MS	F	p	
group	28.3338	3	9.4446	2.313	0.083	
s/g	310.3050	76	4.0830			
interva	185.0263	9	20.5585	14.558	0.000	***
is/g	965.9450	684	1.4122			
gi	50.5288	27	1.8714	1.325	0.126	
is/g	965.9450	684	1.4122			

Chapter 8. Exp. 17, Phase 2 (pp. 223-225): recognition scores (hits). Group x expression.
(A = group ah in which the majority stimulus is an angry face, H = group ha in which the majority stimulus is a happy face; a = angry,h = happy, n = neutral. Maximum score = 10)

SOURCE: grand mean

group	expre	N	MEAN	SD	SE
		120	7.6500	2.2253	0.2031

SOURCE: group

group	expre	N	MEAN	SD	SE
A		60	7.1833	2.5278	0.3263
H		60	8.1167	1.7764	0.2293

SOURCE: expression

group	expre	N	MEAN	SD	SE
	a	40	8.9500	1.1536	0.1824
	h	40	7.9000	1.9189	0.3034
	n	40	6.1000	2.4158	0.3820

SOURCE: group expression

group	expre	N	MEAN	SD	SE
A	a	20	9.2000	0.8944	0.2000
A	h	20	7.3000	2.1546	0.4818
A	n	20	5.0500	2.3050	0.5154
H	a	20	8.7000	1.3416	0.3000
H	h	20	8.5000	1.4690	0.3285
H	n	20	7.1500	2.0844	0.4661

FACTOR:	subs	group	expression	data
LEVELS:	40	2	3	120
TYPE :	RANDOM	BETWEEN	WITHIN	DATA

SOURCE	SS	df	MS	F	p	
group	26.1333	1	26.1333	4.615	0.038	*
s/g	215.1667	38	5.6623			
express	166.2000	2	83.1000	42.983	0.000	***
es/g	146.9333	76	1.9333			
ge	34.8667	2	17.4333	9.017	0.000	***
es/g	146.9333	76	1.9333			

Chapter 8. Exp. 17, Phase 2 (p. 225): recognition scores (hits), analysis across items. Group x expression.
(A = group ah in which the majority stimulus is an angry face, H = group ha in which the majority stimulus is a happy face; a = angry,h = happy, n = neutral)

SOURCE: grand mean

group	expre	N	MEAN	SD	SE
		60	15.3000	3.3764	0.4359

SOURCE: group

group	expre	N	MEAN	SD	SE
A		30	14.3667	3.9083	0.7136
H		30	16.2333	2.4731	0.4515

SOURCE: expression

group	expre	N	MEAN	SD	SE
	a	20	17.9000	1.9167	0.4286
	h	20	15.8000	2.1909	0.4899
	n	20	12.2000	3.0711	0.6867

SOURCE: group expression

group	expre	N	MEAN	SD	SE
A	a	10	18.4000	1.4298	0.4522
A	h	10	14.6000	2.0111	0.6360
A	n	10	10.1000	2.1833	0.6904
H	a	10	17.4000	2.2706	0.7180
H	h	10	17.0000	1.6997	0.5375
H	n	10	14.3000	2.3118	0.7311

FACTOR:	items	group	expression	data
LEVELS:	10	2	3	60
TYPE :	RANDOM	WITHIN	WITHIN	DATA

SOURCE	SS	df	MS	F	p	
group	52.2667	1	52.2667	7.661	0.022	*
gi/	61.4000	9	6.8222			
express	332.4000	2	166.2000	61.981	0.000	***
ei/	48.2667	18	2.6815			
ge	69.7333	2	34.8667	13.763	0.000	***
gei/	45.6000	18	2.5333			

Chapter 8. Exp. 17, Phase 2 (p. 225): correct RTs (hits). Group x expression.

(A = group ah in which the majority stimulus is an angry face, H = group ha in which the majority stimulus is a happy face; a = angry,h = happy, n = neutral)

SOURCE: grand mean

group	expre	N	MEAN	SD	SE
		120	1000.9833	302.1486	27.5823

SOURCE: group

group	expre	N	MEAN	SD	SE
A		60	1006.1000	343.2502	44.3134
H		60	995.8667	257.4119	33.2317

SOURCE: expression

group	expre	N	MEAN	SD	SE
	a	40	899.8000	197.9964	31.3060
	h	40	1021.1000	337.2470	53.3234
	n	40	1082.0500	328.5862	51.9540

SOURCE: group expression

group	expre	N	MEAN	SD	SE
A	a	20	862.7000	206.0343	46.0707
A	h	20	1068.3000	427.2507	95.5362
A	n	20	1087.3000	328.9563	73.5569
H	a	20	936.9000	187.4050	41.9050
H	h	20	973.9000	214.9972	48.0748
H	n	20	1076.8000	336.6752	75.2829

FACTOR:	subs	group	expression	data
LEVELS:	40	2	3	120
TYPE :	RANDOM	BETWEEN	WITHIN	DATA

SOURCE	SS	df	MS	F	p	
group	3141.6333	1	3141.6333	0.016	0.901	
s/g	7684809.6667	38	202231.8333			
express	688582.0667	2	344291.0333	11.157	0.000	***
es/g	2345291.7333	76	30859.1018			
ge	142130.8667	2	71065.4333	2.303	0.107	
es/g	2345291.7333	76	30859.1018			

Chapter 8. Exp. 17, Phase 2 (p. 225): correct rejections. Group x expression.
(A = group ah in which the majority stimulus is an angry face, H = group ha in which the majority stimulus is a happy face; a = angry,h = happy, n = neutral. Maximum score = 10)

SOURCE: grand mean

group	expre	N	MEAN	SD	SE
		120	7.6000	1.5251	0.1392

SOURCE: group

group	expre	N	MEAN	SD	SE
A		60	8.0000	1.3148	0.1697
H		60	7.2000	1.6240	0.2097

SOURCE: expression

group	expre	N	MEAN	SD	SE
	a	40	7.5000	1.4850	0.2348
	h	40	7.3250	1.5752	0.2491
	n	40	7.9750	1.4761	0.2334

SOURCE: group expression

group	expre	N	MEAN	SD	SE
A	a	20	7.8500	1.2258	0.2741
A	h	20	7.7000	1.4179	0.3171
A	n	20	8.4500	1.2344	0.2760
H	a	20	7.1500	1.6631	0.3719
H	h	20	6.9500	1.6694	0.3733
H	n	20	7.5000	1.5728	0.3517

FACTOR:	subs	group	expression	data
LEVELS:	40	2	3	120
TYPE :	RANDOM	BETWEEN	WITHIN	DATA

SOURCE	SS	df	MS	F	p	
group	19.2000	1	19.2000	5.688	0.022	*
s/g	128.2667	38	3.3754			
express	9.0500	2	4.5250	2.867	0.063	
es/g	119.9333	76	1.5781			
ge	0.3500	2	0.1750	0.111	0.895	
es/g	119.9333	76	1.5781			

Chapter 8. Exp. 17, Phase 2 (p. 225): correct rejections, analysis across items. Group x expression.
(A = group ah in which the majority stimulus is an angry face, H = group ha in which the majority stimulus is a happy face; a = angry,h = happy, n = neutral)

SOURCE: grand mean

group	expre	N	MEAN	SD	SE
		60	15.2000	2.7727	0.3580

SOURCE: group

group	expre	N	MEAN	SD	SE
A		30	16.0000	2.3342	0.4262
H		30	14.4000	2.9781	0.5437

SOURCE: expression

group	expre	N	MEAN	SD	SE
	a	20	15.2500	2.9714	0.6644
	h	20	14.5000	2.5443	0.5689
	n	20	15.8500	2.7582	0.6168

SOURCE: group expression

group	expre	N	MEAN	SD	SE
A	a	10	15.9000	2.4244	0.7667
A	h	10	15.3000	2.7909	0.8825
A	n	10	16.8000	1.6193	0.5121
H	a	10	14.6000	3.4383	1.0873
H	h	10	13.7000	2.1108	0.6675
H	n	10	14.9000	3.3813	1.0693

FACTOR:	items	group	expression	data
LEVELS:	10	2	3	60
TYPE :	RANDOM	WITHIN	WITHIN	DATA

SOURCE	SS	df	MS	F	p
group	38.4000	1	38.4000	6.655	0.030 *
gi/	51.9333	9	5.7704		
express	18.3000	2	9.1500	1.864	0.184
ei/	88.3667	18	4.9093		
ge	0.9000	2	0.4500	0.131	0.878
gei/	61.7667	18	3.4315		

Chapter 8. Exp. 17, Phase 2 (p. 225): correct RTs (rejections). Group x expression.
(A = group ah in which the majority stimulus is an angry face, H = group ha in which the majority stimulus is a happy face; a = angry,h = happy, n = neutral)

SOURCE: grand mean

group	expre	N	MEAN	SD	SE
		120	1126.8000	366.7356	33.4782

SOURCE: group

group	expre	N	MEAN	SD	SE
A		60	1147.4500	414.6252	53.5279
H		60	1106.1500	313.8282	40.5151

SOURCE: expression

group	expre	N	MEAN	SD	SE
	a	40	1145.8000	376.8292	59.5819
	h	40	1154.8250	382.5332	60.4838
	n	40	1079.7750	344.3928	54.4533

SOURCE: group expression

group	expre	N	MEAN	SD	SE
A	a	20	1150.9000	409.5454	91.5771
A	h	20	1191.3000	458.7996	102.5907
A	n	20	1100.1500	388.8732	86.9547
H	a	20	1140.7000	351.6987	78.6422
H	h	20	1118.3500	295.0711	65.9799
H	n	20	1059.4000	302.2563	67.5866

FACTOR:	subs	group	expression	data
LEVELS:	40	2	3	120
TYPE :	RANDOM	BETWEEN	WITHIN	DATA

SOURCE	SS	df	MS	F	p
group	51170.7000	1	51170.7000	0.138	0.713
s/g	14139682.5000	38	372096.9079		
express	134310.0500	2	67155.0250	3.074	0.052
es/g	1660047.6000	76	21842.7316		
ge	19692.3500	2	9846.1750	0.451	0.639
es/g	1660047.6000	76	21842.7316		

APPENDIX C
Experimental procedure for Garner experiments

The table below shows counterbalancing for hand of response, order in which each condition was seen (1 = first, 2 = second, and 3 = third), and stimulus arrangement within each block of correlated and control conditions for each of the participants (1 - 24) in the identity classification group of Experiment 2 (A = Person A, B = Person B; h = happy, s = sad). For the orthogonal condition, As, Ah, Bs, and Bh were distributed over both blocks, so it was not necessary to balance for within-condition order here.

For example: P1 saw the correlated condition first, the orthogonal condition second and the control condition third. In the first block of the correlated condition P1 saw the faces of Person A sad and Person B happy and in the second block, Person A happy and Person B sad and so on. P1 pressed a key to the right of the keyboard for Person A and to the left of the keyboard for Person B. In this way, equal numbers of participants saw each possible condition order and each possible stimulus combination with equal numbers of each responding with either their right or left hand to Person A. With stimulus item changes as appropriate this procedure is relevant to the expression classification group of Experiment 2 and to each of the classificatory groups of Experiments 3, 4, 9, and 10.

Participant no.	Order presented								
Right hand to Person A	correlated			control			orthogonal		
1	1	AsBh	AhBs	3	AsBs	AhBh	2		
2	1	AhBs	AsBh	2	AhBh	AsBs	3		
3	2	AsBh	AhBs	1	AsBs	AhBh	3		
4	3	AhBs	AsBh	1	AhBh	AsBs	2		
5	2	AsBh	AhBs	3	AsBs	AhBh	1		
6	3	AhBs	AsBh	2	AhBh	AsBs	1		
Left hand to Person A									
7	1	AhBs	AsBh	3	AhBh	AsBs	2		
8	1	AsBh	AhBs	2	AsBs	AhBh	3		
9	2	AhBs	AsBh	1	AhBh	AsBs	3		
10	3	AsBh	AhBs	1	AsBs	AhBh	2		
11	2	AhBs	AsBh	3	AhBh	AsBs	1		
12	3	AsBh	AhBs	2	AsBs	AhBh	1		
Right hand to Person A									
13	1	AhBs	AsBh	3	AhBh	AsBs	2		
14	1	AsBh	AhBs	2	AsBs	AhBh	3		
15	2	AhBs	AsBh	1	AhBh	AsBs	3		
16	3	AsBh	AhBs	1	AsBs	AhBh	2		
17	2	AhBs	AsBh	3	AhBh	AsBs	1		
18	3	AsBh	AhBs	2	AsBs	AhBh	1		
Left hand to Person A									
19	1	AsBh	AhBs	3	AsBs	AhBh	2		
20	1	AhBs	AsBh	2	AhBh	AsBs	3		
21	2	AsBh	AhBs	1	AsBs	AhBh	3		
22	3	AhBs	AsBh	1	AhBh	AsBs	2		
23	2	AsBh	AhBs	3	AsBs	AhBh	1		
24	3	AhBs	AsBh	2	AhBh	AsBs	1		

APPENDIX D
Examples of stimulus faces from Table 1, p. 42

(see p. 386 for legend)

Appendix D cont.

Appendix D cont.

Both left columns above in Appendix D contain faces that have been agreed and ranked. To give the reader some idea about how subtle (or otherwise) the difference between those faces that achieved agreement and those that did not, the right column contains faces that failed to achieve criterion agreement and were not ranked. The list below contains each Face No. and their ranking (as in Table 1).

P. 384, Rows 1-6

1	Angry female:	9 (1=)	2 (5)	3
2	Angry male:	38 (1=)	22 (8=)	29
3	Disgusted female:	2 (1=)	12 (9=)	9
4	Disgusted male:	40 (1=)	27 (12=)	41
5	Fearful female:	8 (1=)	16 (8)	11
6	Fearful male:	41 (1)	32 (2=)	22

P. 385, Rows 7-12

7	Happy female:	10 (1=)	14 (16=)	-
8	Happy male:	35 (1=)	25 (18)	-
9	Neutral female:	5 (1=)	17 (8=)	20
10	Neutral male:	21 (1=)	38 (14=)	40
11	Sad female:	5 (1)	18 (2=)	7
12	Sad male:	27 (1)	33 (4=)	36

P386 (this page), Rows 13-14

13	Surprised female:	3 (1=)	17 (8=)	14
14	Surprised male:	34 (1=)	23 (16)	37