Anger recognition is independent of spatial attention

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If a facial expression of emotion is preattentively recognized it should be recognized independently of the direction of attention. In the present experiment an outline face was located each side of a fixation point. Either both faces were coloured gray or one was coloured gray and one blue, and either both had a neutral expression or one had a neutral expression and one an angry expression. RT to the presence of a blue face in a display was slower when the blue face was neutral and the gray face was angry than when both blue and gray faces were neutral. The irrelevant angry expression captured attention, indicating preattentive processing. There were no effects in a condition in which a happy face was substituted for the angry one.

The idea that humans are biologically prepared for recognizing facial expressions of emotion is supported by a range of findings, from neuropsychological studies (Bowers, Bauer, Coslett, & Heilman, 1985; Humphreys, Donnelly, & Riddoch, 1993; Ley & Bryden, 1979), developmental studies (Serrano, Iglesiasis, & Loeches, 1992; Sorce, Emde, Campos, & Klinnert, (1985), psychophysical experiments (Etcoff & Magee, 1992), cross-cultural studies (Ekman, 1972, 1992; Izard, 1971), and neurophysiological investigations of other primates (Heywood & Cowey, 1992; Rolls, 1992). Collectively, this evidence converges on the ecological view that emotional expressions are evolved social affordances (McArthur & Baron, 1983).

Perhaps we are similarly prepared for the automatic analysis of expressions? Certainly it would have been advantageous for the species had our forebears been able to respond immediately to the presence of anger and threat, particularly when their attention was focused elsewhere, and disadvantageous to have had to spend time inferring the meaning of such a signal. Although he didn't use the terms, Darwin was of the mind that some expressions are recognized automatically and implicitly: "As most of the movements of expression must have been gradually acquired, afterwards becoming instinctive, there seems to be some degree of *a priori* probability that their recognition would likewise have become instinctive". Darwin was impressed that "so many shades of expression are instantly recognized without any conscious process of analysis on our part" (Darwin, 1872/1904, pp. 380-382).

Although automaticity now occupies a central position in models of emotion processing (Ekman, 1992; Lazarus, 1991; LeDoux, 1994; Öhman, 1993), comparatively few studies have attacked the question of whether we are predisposed towards the instant recognition of expressions. The studies that have been reported can be divided into two groups, according to whether they have sought evidence of unconscious processing or evidence of independence of spatial attention.

Using a mix of psychophysiological and classical conditioning procedures, Öhman and his colleagues have found evidence of the automatic processing of anger. The general technique has been to aversively condition subjects to the presentation of a happy or an angry face, and then in extinction trials to measure the strength of skin conductance and resistance to extinction when the faces are shown backward-masked. Overwhelmingly, larger responses and greater resistance to extinction have been found with angry faces than with happy ones. Anger analysis has been automatic in the sense that the subject was unaware of the expression on the face (e.g., Esteves, Dimberg, & Öhman 1994; Esteves, Parra, Dimberg, & Öhman, 1994; Öhman, Dimberg, & Esteves, 1989).

These findings have implications for an understanding of how behaviours such as phobias (Öhman, 1993) and misattributions and stereotypes (Bargh, 1992a, 1992b) depend on the observer's unawareness of the instigating stimuli. But they have less relevance to the question of whether we are hard-wired for the automatic recognition of threat and anger. This is because the experiments have failed to demonstrate independence of attention. Indeed, when the direction of attention has been manipulated, skin conductance response differences between masked happy and angry faces disappears (Esteves, Dimberg, & Öhman, 1994, Experiment 3).

Independence of attention distinguishes automatic processes from preattentive ones (Bargh,1992b; Logan, 1992; Treisman, Vieira, & Hayes,1992). Whereas involuntariness, uncontrollability, and unawareness characterize both sorts of process, independence of attention uniquely characterizes preattentive ones. And it is because preattentive processes are innate or acquired early in life, and their function is to "meet the needs the preliminary stage of visual coding, segregating the field into bounded areas that could be potential objects, monitoring for salient objects and events that might require attention" (Treisman et al., 1992, p. 342), that it is necessary to show that expressions can be recognized preattentively in order that anything conclusive may be said about biological preparedness for the instant recognition of facial expressions.

Experimental Findings

Hansen and Hansen (1988, Experiment 3) had subjects search displays of four and nine faces and respond according to whether all faces were the same or one was different from the rest. A happy face took longer to find among eight angry faces than it did among three angry faces; the display had to be searched in a serial face-by-face fashion, with attention focused on each face in turn. But an angry face was detected as rapidly among three happy faces as among eight happy faces; the display was searched in a spatially parallel manner, with the discrepant angry face "popping-out".

Hansen and Hansen's face-in-the-crowd effect has been widely cited as evidence of the preattentive analysis of anger and threat (e.g., Ambady & Rosenthal, 1992; Baron, 1992; Deaux, Dane, & Wrightsman, 1993). Yet there have been inconsistent findings (Hampton, Purcell, Bersine, Hansen, & Hansen, 1989), and failures to replicate (Nothdurft, 1993; Stewart, Purcell, & Skov, 1993). It seems likely that the original effect was caused by an artefact in the photos, in the form of a darker chin on the angry face than on the happy face distractors (Purcell, Stewart, & Skov, 1993). In another study, sad and happy faces were found to pop-out, from among happy, sad, and neutral-expression distractors (White, 1995). But pop-out was also found when the faces were shown inverted, suggesting that in the case of the upright face results, expression was not the critical factor (inversion interferes with the holistic encoding of faces and with the implicit representation of expression in a face).

More recently, Hansen and Hansen concluded that "it is quite clear now that angry faces do not pop-out of happy crowds as the result of the preattentive, parallel detection of angry faces" (1994, p. 227). In their 1994 study they used a different paradigm, measuring latency of saccadic movement to faces that were shown away from the locus of fixation. In each trial a face located each side of fixation could be sad, or happy, or one could be sad and one happy. Subjects searched for the presence of an angry face in one block of trials and for a happy face in another block. A critical finding was that the latency of saccadic eye movement to the first fixated face was faster when that face was angry than when it was happy, whereas the latency of eye movement away from the fixated face (a movement that was required when the first fixated expression did not match the to-be-searched-for expression) was slower when that face was angry than when it was happy. Attentional capture was faster for an angry face than for a happy face.

In perhaps the only other relevant study to have been reported, Purcell, Stewart, and Skov (1994) found that when subjects made two-alternative, forced-choice responses to the location of a face with respect to fixation, responses were not influenced by whether the face expressed anger or happiness (although responses were slower with a fixated angry face when responses were made to its gender, orientation, and identity).

Summary.

Although there is little conclusive evidence for the notion of preattentive expression processing, it would be premature to dismiss the hypothesis as totally wanting. There is a plausible basis for the idea in findings indicating that humans are hard-wired for expression recognition; some positive evidence has been found; and, to some degree, failures to find pop-out may have been due to inappropriate procedures. For instance, it must be a rare event in nature to encounter a sad or an angry face among five or 55 smiling ones (see Nothdurft, 1993), and from the point of ecological validity it should not be expected that pop-out will emerge in laboratory displays. However, it might well be expected that an angry and threatening face will pop-out from among nonface natural object distractors. Further research is indicated.

Rationale

Perhaps the clearest evidence of preattentive expression processing has come from Hansen and Hansen's (1994) finding, that latencies of overt shifts of attention were influenced by expression. The present study seeks to establish that *covert* shifts are also influenced.

The rationale is taken from an experiment that was designed to test independence of attention in reading (Kahneman & Henik, 1981, Experiment 3). In that experiment, a word printed in red, pink, blue, or green was located on one side of a fixation point, with another word printed in black on the other side. Subjects made speeded responses to the colour of the word (e.g.,"pink"). In control trials, the coloured word and the black word were noncolour names (e.g., MOST printed in blue and CUTE printed in black). In a second type of trial, the name of the coloured word was different from its ink colour (e.g., BLUE printed in red ink and CUTE in black ink). In a third type of trial, the name of the black word was of a colour different from that of the ink colour of the accompanying word (e.g., MOST printed in blue and RED printed in black). Compared with RTs for control trials, RTs for the second type of trial were significantly slower, indicating that once the colour of the word had captured attention, reading its name could not be controlled. The irrelevant name was accessed, and this slowed response to the word's colour. But RTs for the third type of trial were no different from RTs for control trials. The black word failed to capture attention, showing that it was effectively filtered. In short, word reading was found to be dependent on the direction of attention. Of course, had RTs in the third type of trial been as slow as those in the second type of trial were from control RTs, the conclusion would have had to be that reading the black word *was* independent of the direction of attention.

In each trial of the present experiment the subject fixates a mark centered in an otherwise blank field, one of the displays in Figure 1 is shown, and a response is made only if a blue-coloured face is present, that is, if the display is one of Neutral-**Neutral**, Neutral-**Angry**, and Angry-**Neutral**. (In Figure 1 blue faces are drawn in black. For ease of exposition, blue faces will be indicated in the text by boldface. Thus, a Neutral-**Angry** display is one that has a gray neutral face and a blue angry face.)

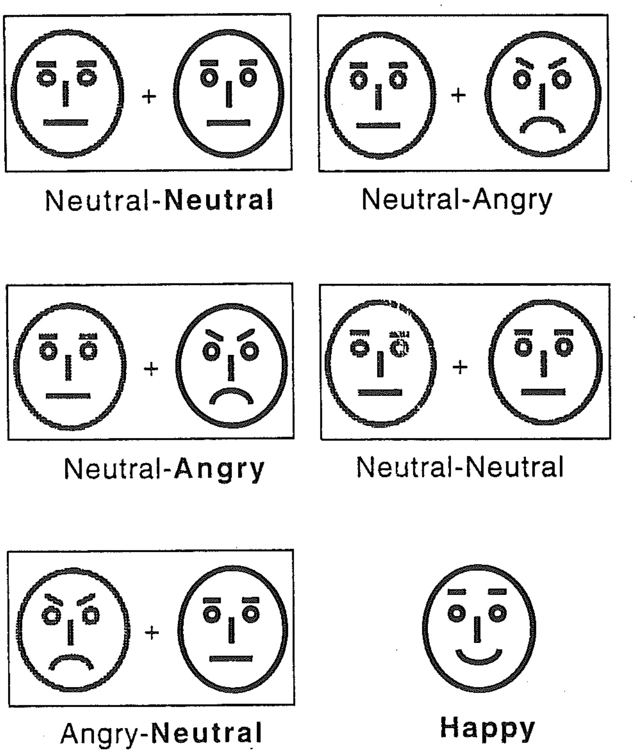
There are three types of trial, parallelling those of Kahneman and Henik, discussed above.

(1) In Neutral-**Neutral** displays, there is a neutral expression on the gray face, and a neutral expression on the attended blue face (beacuse colour is known to be preattentively detected, it is assumed that the relevant blue property captures attention). RT to these displays serves as the baseline.

(2) In Neutral-**Angry** displays, there is a neutral expression on the gray face, and an angry expression on the blue face. A difference between RT to these displays and RT to Neutral-**Neutral** displays would show that when anger was a property of an attended face, it influenced response.

(3) In Angry-**Neutral** displays, there is an angry expression on the gray face, and a neutral expression on the blue face. A difference between RT to these displays and RT to Neutral-**Neutral** displays would show that when anger was a property of an unattended face it influenced response: anger analysis was independent of the direction of attention.

Figure 1. 2-face displays used in the angry condition. A blue face is shown here as black and a dark-gray face as hatched. Face-to-display size, line thickness, and between-face separation are not to scale. Also shown is the face that was used in the happy condition.



Method

Face Displays.

The major axis of a face outline had a length of 2.5 deg, the minor axis a length of 2.1 deg, and lines had a stroke width of about .06 deg. McKelvie (1973) found that a line-drawn face that had brows that were horizontal and close to the eyes and a mouth that was horizontal and wide was not reliably judged as happy, sad, angry, scheming, or vacant. This is the "neutral" expression face. McKelvie found that a face that had brows that were medially downturned and close to the eyes and a mouth that was downturned and wide was judged more reliably as angry than it was as happy, sad, scheming, and vacant. This is the "angry" expression face. Line-drawn faces were used because they permitted a clean representation of the features in colour.

In a set of 40 1-face displays, there were equal numbers of blue and dark-gray faces, having angry and neutral expressions, centered on the fixation point. These trials served to familiarize subjects with the faces and the procedure. In a set of 60 2-face displays there were 12 of each of the five types of display shown in Figure 1. The nearest edges of faces were 1.8 deg away from the fixation point. Six of each of the Neutral-**Neutral**, Neutral-**Angry**, Angry-**Neutral**, and Neutral-Angry displays had the locations of the left and right faces reversed. There were equal numbers of each of the five types of display in each of six successive lots of ten trials. Each of three blocks of trials, 1-30, 31-60, 1-30, was separated by a pause of 15 s. The first ten trials in each block were treated as practice.

Procedure.

Events were controlled by a Gerbrands 3-field tachistoscope. The procedure was the same in all trials. A small fixation cross centered in an otherwise lighted blank field appeared for 500 ms and was replaced by a 200 ms display. On offset of the display a lighted blank field appeared for approximately 3 s before the fixation cross reappeared for the next trial. Subjects looked at the cross when it appeared, and rapidly and accurately pressed two keys simultaneously, one positioned under the left index finger and one under the right index finger, only when blue appeared and not otherwise. Previous research in this laboratory has shown that this go, no-go procedure produces fast and stable RTs with low error rates.

Before testing began, subjects were shown examples of displays outside the tachistoscope. The 1-face displays were then presented, and these were followed by the 2-face displays. Subjects were cautioned that 50% of the 1-face trials would require a response, and that about six in every ten 2-face trials would require a response.

Happy Faces.

In previous studies, responses to angry faces have been compared with responses to happy faces, rather than with responses to neutral-expression faces. A "happy" condition was included here. The happy face is shown in Figure 1. McKelvie (1973, Table 5) found that a line-drawn face that had horizontal brows that were distant from the eyes and a mouth that was upturned and wide was judged more reliably as happy than it was as sad, angry, scheming, and vacant. Apart from substituting the happy face for the angry one, the happy condition was identical to the angry one.

Subjects.

Twenty-four men and women were recruited from around the campus and paid a nominal amount for participating. Twelve were assigned to the angry condition and 12 to the happy condition.

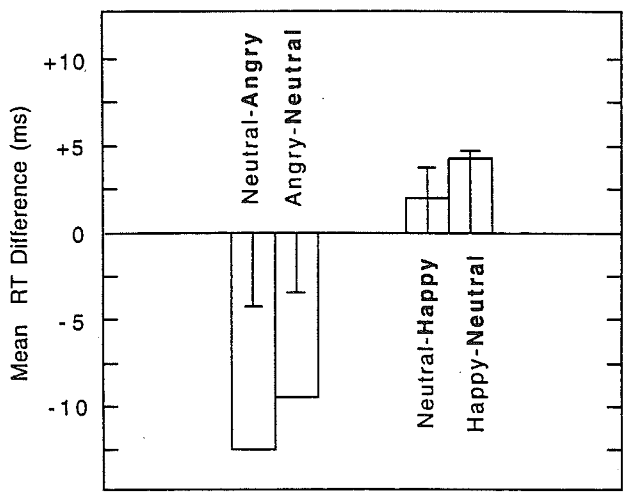
Results

The basic datum was the mean correct RT for each subject at each treatment level once RTs exceeding ±2.5 SDs of the subject's overall mean were removed. These outliers amounted to 3.2% of correct responses in the case of angry condition subjects, and 2.3% in the case of happy condition subjects. For angry subjects the mean false alarm rate was 2.9% and the miss rate 0.8%; for happy subjects the figures were 2.1% and 0.3%. Twenty subjects committed two or fewer false alarms. The error data were not analyzed further.

The mean RTs (2-face displays) in the angry condition were: 326 ms for Neutral-**Neutral** displays, 339 ms for Neutral-**Angry** displays, and 336 ms for Angry-**Neutral** displays. The mean RTs in the happy condition were: 333 ms for Neutral-**Neutral** displays, 331 ms for Neutral-**Happy** displays, and 328.5 ms for Happy-**Neutral** displays. An ANOVA of the mean RTs showed nonsignificant effects of condition, $F < 1$, and display type, $F(2, 44) = 1.47$, $p > .05$, but a significant interaction, $F(2, 44) = 3.70$, $p < .05$. In the angry condition the Neutral-**Angry** RT was slower than the Neutral-**Neutral** RT, Dunnett's $t = 3.16$, $p < .05$ (two-tailed), as was the Angry-**Neutral** RT, Dunnett's $t = 2.43$, $p < .05$. But in the happy condition neither the Neutral-**Happy** RT nor the Happy-**Neutral** RT was different from the Neutral-**Neutral** RT, Dunnett's ts <1. Figure 2 shows the RT differences using RTs for Neutral-**Neutral** displays as the zero baselines.

For the record, there were no effects with the 1-face displays. The mean RTs in the angry condition were: 329 ms for angry faces and 331 ms for neutral faces, and in the happy condition, 311 ms for happy faces and 318 ms for neutral faces (all Fs < 1).

Figure 2. Mean RT differences using RTs for Neutral-Neutral faces as zero baselines. Vertical bars indicate ±1SE



Discussion

The Angry-**Neutral** result indicated that analysis of anger was independent of spatial attention. But it is possible that this result had nothing to do with expression and valence. Consideration of the 2-face displays at the left of Figure 1 shows that each had a gray face and a blue face, but where in the baseline (top) display the faces had the same configurations of line features, in the other (middle and bottom) displays the faces had different configurations. If the blue feature captured attention with equal facility in each display, the faster RT to the top display than to the other two may have been the outcome of a "fast-same" and "slow-different" perceptual matching of the paired faces (Farell, 1985).

Of course, it would have to follow that the null findings in the happy condition were due to the perceived sameness of paired happy and neutral faces, that is, to an inability to discriminate between a curve (happy mouth) and a straight line (neutral mouth), the only feature that distinguished one face from the other. Although this seems unlikely, given Wolfe, Yee, and Friedman-Hill's (1992) finding that a curve is preattentively detected when it is shown among straight-line distractors, a test of the perceptual matching explanation can be made by showing the displays inverted. Inversion does not affect the between-face feature relationships, but it could be expected to interfere with the encoding of the stimulus objects as faces (Carey, 1992; Farah, Tanaka, & Drain, 1995; Magnussen, Sunda, & Dyrnes, 1994; Tanaka & Farah, 1993).

A supplementary experiment was run in which 16 new subjects were shown angry and neutral displays inverted 180 deg. The results gave no support to a perceptual matching hypothesis, the mean RTs being 332 ms for Neutral-**Neutral** displays, 332 ms for Neutral-**Angry** displays, and 334 ms for Angry-**Neutral** displays.

General Discussion

The results of the main experiment showed that covert shifts of attention were influenced by an angry facial expression, a finding that falls nicely into line with Hansen and Hansen's (1994), showing that latencies of overt shifts were faster for an angry expression than for a happy one. The following interpretation is proposed: The sudden appearance of a blue face on one side of fixation captured the subject's spatial attention (blue being the task-relevant property). Because allocation of attention to an object necessitates the detailed analysis of other properties of the object (Kahneman & Henik, 1981; Kahneman & Treisman, 1984), the meaning of the blue face's expression was accessed, triggering associated and related representations. These representations had more or less influence on evocation of the relevant response (to blue) according to how they attracted limited-capacity resources. Stronger representations were primed by the angry expression in Neutral-**Angry** displays than were primed by the neutral expression in Neutral-**Neutral** displays and by the happy expression in Neutral-**Happy** displays. Anger analysis inhibited response to blue.

The Neutral-**Angry** result showed that anger analysis influenced response when it was not relevant to the task; anger analysis was automatic in that it was involuntary and uncontrollable. The Angry-**Neutral** result also reflected this automaticity, as well it showed that anger analysis was independent of the direction of attention. In attending to the blue of the relevant **Neutral** face, the subject could not filter the expression on the irrelevant Angry face. In terms of the stated rationale, the Angry-**Neutral** result showed that anger captured spatial attention.

What was it about the angry expression that captured attention? There are two possibilities. One involves an anger-signalling feature or features, and the other anger in the form of affect or valence implicit in the face representation. The present results do not speak conclusively to this question, and there are findings favouring both possibilities. Interestingly, the issue is reminiscent of the early-selection vs. late-selection debate over whether only basic features such as colour, size, and curvature, are preattentively available or objects are fully and routinely categorized independently of spatial attention. Whether or not it is as equally intractable remains to be seen. Thus, on the one hand, Aronoff, Woike, and Hyman (1992) found that people evaluated two acutely-angled lines (corresponding to the V shape of the eyebrows in the angry face shown in Figure 1) as "more bad" than other diagonal shapes and acute angles in other orientations, suggesting that a task-irrelevant angry brow-line without any face context might capture attention in a visual search task.

On the other hand, Suzuki and Cavanagh (1995) found that a target set of three curves (e.g., two curves having a U orientation and one curve having an inverted-U orientation) shown among a varying number of distractor sets (three curves having a U orientation) was faster when the curves within sets formed a meaningless pattern than when they formed a face outline (e.g., two brows formed by the U oriented curves and a mouth formed by the inverted-U curve). Although the feature information required to detect the target was the same in meaningless and face patterns, the face patterns inhibited search. "If stimuli reach the "search" level in the form of complex gestalts, such as faces, the search is obligated to operate on those representations even though the lower levels of coding, for example, the curves within a face, could offer much faster processing" (1995, p. 910).

Conclusion

The present findings support the notion of preattentive expression processing, but they must be seen in the context of a small number of largely inconclusive findings. More evidence is required. Assuming that this evidence is forthcoming, the question will be whether preattentive availability is of valence or of some valence-triggering feature.

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