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Is there a "language of the eyes"? Evidence from normal adults, and adults with autism or Asperger Syndrome.

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Abstract

Previous work suggests that a range of mental states can be read from facial expressions, beyond the 'basic emotions'. Experiment 1 tested this in more detail, by using a standardized method, and by testing the role of face parts (eyes versus mouth versus the whole face). Adult subjects were shown photographs of an actress posing 10 basic emotions (*happy, sad, angry, afraid*, etc.) and 10 complex mental states (*scheme, admire, interest, thoughtfulness*, etc.). For each mental state, each subject was shown the whole face, the eyes alone, or the mouth alone, and were given a forced choice of two mental state terms. Results indicated that (i) subjects show remarkable agreement in ascribing a wide range of mental states to facial expressions, (ii) for the basic emotions, the whole face is more informative than either the eyes or the mouth, (iii) For the complex mental states, seeing the eyes alone produced significantly better performance than seeing the mouth alone, and was as informative as the whole face. In Experiment 2, the eye-region effect was re-tested, this time using an actor's face, in order to test if this effect generalized across faces of different sex. Results were broadly similar to those found in Experiment 1. In Experiment 3, adults with autism or Asperger Syndrome were tested using the same procedure as Experiment 1. Results showed a significant impairment relative to normal adults on the complex mental states, and this was most marked on the eyes-alone condition. The results from all 3 experiments are discussed in relation to the role of perception in the use of our everyday "theory of mind", and the role of eye-contact in this.

One major way by which we make sense of people's actions is by attributing mental states to them (Dennett, 1978). Imagine you see someone look at their watch, and then jump out of their chair. In all likelihood you would interpret their behaviour in terms of them just *noticing* the time, *thinking* that the time was earlier than it really is, and *realizing* that if they don't run off now they will be late for their appointment. In developmental psychology, this process of ascribing mental states to ourselves and others is referred to as employing a "theory of mind" (Astington, Olson, and Harris, 1988). This phrase was originally coined by Premack and Woodruff (1978) to underscore the unobservability of mental states. Mental states, according to Premack and Woodruff, have to be inferred from behaviour, they have to be postulated as abstract entities underlying behaviour; and having been postulated they can then function in theory-like ways, to explain and predict observable behaviour.

But are mental states entirely unobservable, private entities? In previous studies we have challenged this notion. We have shown, for example, that normally developing 4 year old children can recognize when someone else is thinking, from the person's facial expression: in particular, we infer when someone is thinking from the direction of their gaze (Baron-Cohen and Cross, 1992). That is, when a person's eyes are directed away from the viewer, to the left or right upper quadrant, and when there is no apparent object to which their gaze is directed, we recognize them as *thinking about something*. Presumably, we distinguish this from attending to an external object only by virtue of there being no obvious external object present¹. Whilst

¹ Our judgement probably depends on the following reasoning: If attention is not directed at something external and visible, then it must be directed at something internal and invisible, namely, a thought. Notice that gaze is intrinsically interpreted as being directed at something (external or internal) - that is, gaze has 'intentionality' (Brentano, 1874).

Ekman and Friesen (1971, 1975), following Darwin (1872), demonstrated the universal recognition of basic emotions (*happy, sad, angry, afraid, surprise, and disgust*), this was a clear demonstration that symptoms of a *cognitive* mental state were observable in the face, in this case, the eyes.

In a second study, we showed that a small number of other mental states can also be read from direction gaze. These include *desire, refer, and goal* (Baron-Cohen, Campbell, Karmiloff-Smith, Grant, and Walker, 1995). That is, our natural reading of gaze directed at a specific object is in terms of a person's volitional states. This should come as no surprise, since we tend to look at what we want, and to what we are referring, and at what we are about to act upon. But for developmental psychology this was something of a discovery, since Premack and Woodruff had framed research in this area to expect that mental states - especially the cognitive ones - should be unobservable. Interestingly, children with autism, who have a specific deficit in understanding mental states (Baron-Cohen, Leslie and Frith, 1985; Baron-Cohen, 1990, 1993, 1995), fail to recognize the mental states of thinking, desire, refer, and goal, from a person's direction of gaze (Baron-Cohen, Campbell, et al, 1995). We return to the issue of autism later in the paper.

In a third study, we investigated if a broad range of mental states could be read from facial expression (Baron-Cohen, Riviere, Cross, Fukushima, Bryant, Sotillo, Hadwin, and French, 1996). We found that, using paintings and drawings of faces (by Velazquez and drawings by Hockney), normal adults and children showed considerable agreement in recognizing a range of

mental states from facial expressions. Moreover, this was true not only within a single culture, but also across different cultures. We tested mental states such as *scheme*, *revenge*, *guilt*, *recognize*, *threaten*, *regret*, and *distrust*, so called 'complex' mental states, as well as the basic emotions such as *fear* (wariness) and *surprise* (astonishment). This furnished important evidence that, cross-culturally, mental state recognition extends beyond the basic emotion category that Ekman (1982, 1992) had documented. This again suggested that, far from being unobservable, many mental states are displayed as clear as daylight on the face, as virtual print-outs of internal experience, simply waiting to be read by an observer (with a concept of mind).

Despite this impression of the observability of mental states, it is of course true that we can never really know the *content* of what someone else is thinking. For example, you may see that right now I am thinking about something (I am gazing up at the ceiling, at nothing in particular); but you would not know from my face that right now I am thinking about my grandfather. In addition, it is of course possible for a person to be experiencing a mental state, and at the time show no outward sign of this. For example, I might be sitting, eyes closed, face relaxed, in my favourite armchair, and might appear to be asleep; but I might at that very minute actually be pretending I am the newly announced winner of the National Lottery. Mental states can therefore clearly remain private.

But given these qualifications, the claim that mental states are always entirely unobservable is clearly incorrect in its strong form, as the evidence reviewed earlier implies. This suggests that the way in which we employ our theory of mind in everyday social reasoning is in fact a mixture

of 'top-down' processes, using inference from the broader context and axioms about how mental states relate to each other² (e.g., "She was out when the burglar entered the house, therefore she doesn't *know* about the burglary"), and relatively direct, 'bottom-up' indicators of mental states as expressed on the face or in behaviour (e.g., he looks *sceptical*"). Hobson (1993) makes a related point when he argues that perception of mind and body are never really separable: rather, mental states are expressed through action, and actions are driven by mental states.

In the first study to be reported here, we address the question as to whether we perceive the eyes as more expressive of mental states than the mouth, and whether this is especially true for the complex mental states. From previous work, this question remains inconclusive. For example, Dunlap (1927) had reported evidence of the superiority of the mouth in emotion recognition, but Allport (1955) posed a challenging question:

"Why do the eyes seem to us, as Kohler observes, the "visible centre of another man's personality"? Is it because... the subtleties of glance and ocular movement (including the motion of the lids and neighbouring brows) are especially rich in expressive significance? Experimental work thus far seems to favour the mouth rather than the eyes as the principal agency of expression. Why then are the eyes the focus of our attention?"

Frois-Wittman (1930) conducted an experiment comparing photos and drawings of his facial

² Such axioms include the 'seeing leads to knowing' principle (Pratt and Bryant, 1990; Baron-Cohen and Goodhart, 1993). See Wellman (1990) for a sketch of the key axioms that make up our folk 'theory' of mind.

expressions, cut into different regions of the face. He concluded that "there was not consistent dominance of either the eyes or the mouth" in recognizing emotion. Coleman (1949) concluded the same thing from his use of motion picture films: "In general, identification of the facial expressions of emotion were not made more reliably from either the mouth or the eye region."

Hanawalt (1944) introduced a further refinement however, by discovering that in identifying happy expressions the mouth was more important, whilst for recognizing fear and surprise the eyes were more important. Nummenmaa (1964) took this further by testing recognition of basic emotions (happy, sad, and anger) and blends of these (which he called "complex emotions"). He concluded that "certain simple expressions, especially perhaps anger and pleasure, can be identified from the eyebrows, eyes, nose and mouth... but the eye region is remarkable in the sense that... complex emotions can only be read in the eyes, thus making them the principal center of attention".

The first experiment reported below uses Nummenmaa's method (comparing parts of photos of an actress' face), with a broader range of mental states, in order to test two hypotheses: (i) That subjects can detect a broad range of mental states (both basic and complex) from the whole face; and (ii) That information from the eyes is particularly important in detecting complex mental states. Experiment 1 went beyond Nummenmaa's important studies by testing the role of face parts in detecting mental states as varied as *guilt*, *flirtation*, *interest*, *arrogance*, *boredom*, and *scheming*. Furthermore, whereas Nummenmaa (1964) proposed a "language of the face", Baron-Cohen (1995) proposed the existence of a "language of the eyes", ie, that information in the eye-

region of the face alone conveyed cues to the person's mental states. These claims were tested below. Finally, in these experiments photographs of a real face were used, in order to improve on the ecological validity absent in our previous study, which used paintings and drawings.

Experiment 1: Do the eyes have it?

Subjects

50 subjects (25 male and 25 female) were tested. All were undergraduate students at the University of Cambridge. They ranged in age from 18-21 years. All were students of science (medicine, veterinary science, or natural science).

Method

An actress was invited to pose facial expressions and her face was photographed under controlled and standardized lighting conditions, with her head always facing forward. She posed 10 "basic" emotions (*happy, sad, angry, afraid, surprised, disgust, and distress*)³, and 10 "complex" mental states (*scheme, guilt, thoughtful, admiring, quizzical, flirting, bored, interested, and arrogant*)⁴. Examples of 4 basic mental states are shown in Figure 1, and

³ Since there are only 6 or 7 basic emotions, according to Ekman and Friesen (1975), surprise, happy, and angry were repeated, using new poses, to make the set up to 10.

⁴ "Interested" was repeated in the set of complex mental states, to make this set up to 10, but using a new pose.

examples of 4 complex mental states are shown in Figure 2. In the actual experiment, the photographs were black and white prints, measuring 10"x8". The full-face photographs were then copied into two additional sets, and from one of the sets, just the eyes were used, (Figures 3 and 4 show the eyes corresponding to the faces in Figures 1 and 2, respectively) while from the other copy, just the mouth of each face was used (Figures 5 and 6 are the mouths corresponding to the faces in Figures 1 and 2, respectively).

insert Figures 1-6 here

Under each photo (full face, eyes, or mouth) a target word was typed, describing the mental state the actress was posing. These words were chosen by a panel of 4 independent judges (2 male, 2 female), and only those terms were used that produced unanimous agreement. An alternative, or foil term, was typed next to the target word, the foil being selected on the grounds that it was in the same superordinate semantic category as the target term. That is, if the target was a basic emotion, then the foil also was. If the target was a complex mental state term, then so was the foil. Equally, the target and its foil both had the same valence (negative or positive). This method has been used previously (Baron-Cohen, Riviere, et al, 1996).

Each subject was tested individually in a quiet room in the University. Subjects were presented with 60 stimuli (10 basic emotions, 10 complex mental states: in 3 forms [full face, eyes only, or mouth only]) in a randomized order. Half of the subjects received one randomized order, and the other half received this in reverse. For each stimulus, the subject was asked to choose the word

under each photo that best described what the person was thinking or feeling. The position of the target and foil words was randomly positioned in respect of left/right position on the page, to guard against position effects. Subjects were asked to respond as quickly as possible. Finally, if subjects said that neither term was quite right, they were nevertheless asked to choose one of the terms, thus conforming to a forced-choice procedure⁵.

Results

Table 1 shows the number of subjects choosing the correct mental state term for each stimulus. We first analysed if subjects were above chance in their choices for all stimuli, taking chance as equal to or more than 30/50 subjects selecting the correct term. This shows that subjects were above chance on all of the whole face and eyes stimuli, but were at chance (or below) on 6 mouth stimuli (Figures 2,7,10, 12, 15, and 19). This suggests that the mouth may be less expressive than the eyes or whole face.

Comparing performance on the eyes, mouth, and whole face for just the basic mental states showed that these 3 conditions differed significantly (Friedman 2-Way ANOVA for non-normative distribution, Chi Square = 10.85, 2df, $p = 0.007$). Wilcoxon tests were then carried out to identify where this difference lay. Scores on the whole face were marginally better than those from the eyes ($z = -1.94$, $p = 0.05$), and scores on the whole face were also significantly better

⁵ The forced choice method was used in order to constrain the otherwise wide range of terms that subjects might produce if the task was an open-ended one. For example, given a sad face, subjects might describe this as "sad", "distressed", "tearful", "heartbroken", "down", etc., making responses difficult to compare.

than those from the mouth ($z = -2.8$, $p = 0.005$). The eyes did not differ from the mouth ($z = -1.3$, $p = 0.19$). This suggests that for the basic emotions, the whole face is most informative.

Comparing performance on the eyes, mouth, and whole face for just the complex mental states showed that these 3 conditions again differed significantly (Friedman's 2-Way ANOVA, Chi Square = 9.8, 2df, $p = 0.007$). Wilcoxon tests showed that scores on the whole face were significantly better than scores from the mouth ($z = -2.8$, $p = 0.005$), but the whole face did not differ significantly from those of the eyes ($z = -0.92$, $p = 0.36$). Instead, the eyes and the whole face were both equally informative, and the eyes were significantly more informative than the mouth ($z = -2.29$, $p = 0.02$). This suggests that for the complex mental states, the eyes contain as much information as the whole face, and more than the mouth. Sex differences were all non-significant ($p > 0.05$), although there was a trend towards female superiority in the eyes condition of the complex mental states.

insert Table 1 here

Discussion

The results of Experiment 1 strongly support both predictions. First, normal adult subjects are able to detect a range of mental states (both basic and complex) from whole facial expressions, showing strong agreement. This replicates our earlier study which used paintings and drawings of whole faces (Baron-Cohen, Riviere, et al, 1996), but shows this ability under tightly controlled, standardized conditions (photographs of the same actress). Secondly, whilst for basic mental states the whole face provides significantly more information than either the mouth or the eyes, for complex mental states the eyes (but not the mouth) provide as much information as the full face. This may be because complex mental states are not easily expressed just by the mouth, whilst basic ones (happy, sad, etc.,) are. These results are consistent with Numenmaa's (1964) result, but demonstrates it for a wider set of mental states. They are also consistent with the idea that there is a language of the eyes. In Experiment 2, we tested if the eye-region effect would replicate if photos of a male face were used, in order to test the robustness of the effect.

Experiment 2: A replication using male faces

Subjects and method

A new sample of students ($n = 17$, comprising 8 males and 9 females) were tested in exactly the same manner as in Experiment 1. They were drawn from the same subject areas, and had a similar age-range. The only difference was that in Experiment 2 the face stimuli were of a male

face, whilst in Experiment 1 the face stimuli were of a female face. Using a similar design to Experiment 1, 6 faces expressed basic mental states, whilst 7 others expressed complex mental states. These covered a similar range of mental states to those tested in Experiment 1. The basic mental states included *afraid*, *disgust*, *angry*, *happy*, and *excited*. The complex mental states included *thoughtful*, *scheming*, *arrogant*, and *preoccupied*. Stimuli were prepared identically to those in Experiment 1, save for using a male stimulus-head, instead of a female one. As before, each subject was tested in random order with the whole face, the eyes alone, and the mouth alone.

Results

Results are shown in Table 2. ANOVA on the percentage of subjects passing showed that basic emotions were recognized slightly but significantly more accurately than complex mental states ($F(16,1) = 11.01$, $p < 0.004$). Similarly, on face-parts, mental states were recognized most accurately from the whole face, and almost as well from the eyes alone, with the mouth alone leading to worst performance (overall ANOVA on face parts $F(16,2) = 27.57$, $p < 0.0001$). Neuman Keuls tests showed all face parts to be significantly different at the $p < 0.01$ level. Finally, there was a significant interaction between type of emotion (Basic vs Complex) and face part (whole face, eyes alone, or mouth alone) ($F(32,2) = 5.02$, $p < 0.013$). Neuman Keuls tests showed that using the mouth alone led to better performance on the basic relative to the complex mental states, whereas using the whole face or the eyes alone led to equally good performance across these two types of mental state.

insert Table 2 here

Discussion

Experiment 2 replicated the eye-region effect from Experiment 1 even more strongly in finding that for all mental states, the eyes contain almost as much information as the whole face, and significantly more than the mouth. It also demonstrates that the eye region effect is not a function of the face being observed, since the effect transfers across models of different sex. In Experiment 3 we investigated if adults with autism and Asperger Syndrome are “blind to the mentalistic significance of the eyes”, as has previously been reported (Baron-Cohen et al, 1995), that is, whether they are impaired in reading the language of the eyes.

Experiment 3: Performance of adults with autism and Asperger Syndrome

There are a large number of clues which would lead one to hypothesize that people with autism and Asperger Syndrome (see Frith, 1991) would have significant impairments in decoding a language of the eyes. For example, young children with autism show (i) abnormal use of gaze (Kanner, 1943); (ii) a failure to monitor gaze for joint attention (Sigman, Mundy, Ungerer, and Sherman, 1986; Phillips, Baron-Cohen, and Rutter, 1992), (iii) a failure to direct someone else's gaze via the pointing gesture, as an end in itself (Baron-Cohen, 1989; Baron-Cohen, Allen, and Gillberg, 1992; Goodhart and Baron-Cohen, 1993; Baron-Cohen, Cox, Baird, Swettenham,

Drew, Morgan, Nightingale, and Charman, 1996); (iv) a failure to monitor gaze direction to infer a speaker's intended reference (Baron-Cohen, Baldwin, and Crowson, in press); and later, (v) a failure to understand mental state concepts (see Baron-Cohen, 1993, 1995). They therefore not surprisingly also have difficulties in inferring a person's goal or desire, and inferring when someone is thinking, from their gaze-direction alone (Baron-Cohen et al, 1995). In this final experiment, we tested a group of adults with autism or Asperger Syndrome, who were selected on the basis of being of normal intelligence. The procedure followed that used in Experiment 1, strictly.

Subjects

The sample for this experiment comprised 16 subjects with high functioning autism (HFA) or AS (4 with high-functioning autism and 12 with AS). The sex ratio was 13:3 (m:f). The HFA Group all showed a history of 'classical' autism (i.e. autism accompanied by language delay) and fulfilled established diagnostic criteria (DSM-IV, 1994). Note that because they were high-functioning adults, they would be considered "residual" cases. The AS Group all met the same criteria for autism, but without any clinically significant language delay (i.e., they had single words by 2, or phrase speech by 3). They thus met criteria for AS as defined in ICD-10 (1994). They were all of normal intelligence. As such, they are relatively rare and were therefore recruited via a wide range of sources. They can be considered as cases of "pure" autism or AS, unconfounded by mental handicap.

The control group for this experiment comprised 16 normal age and IQ matched adults (sex ratio = 13:3, m:f), drawn from the general population of Cambridge (excluding members of the University), all of whom were all free of any psychiatric symptoms. The subjects with autism or AS were selected for being of at least normal intelligence (i.e., scoring >85) on the WAIS-R (full scale, performance, and verbal IQ). The WAIS-R was used because of previous work showing discrepancies between performance and verbal IQ in these groups (Frith, 1989, Happe, 1994a). We therefore ensured that these subjects were above average in IQ on both verbal and performance IQ.

The normal controls were also selected for being of at least normal intelligence (i.e., scoring > 85), as measured on the NART. This was administered because of its brevity, because subjects were only available for limited testing in this study. It was not used as a matching criterion, but rather to check that the normal subjects were indeed functioning in the normal range. Table 3 gives the subject characteristics in terms of chronological age (CA) and IQ. ANOVA revealed no significant differences between groups on age or NART/IQ ($p > 0.05$).

Methods

Methods for Experiment 3 were identical to those used in Experiment 1, except that only the whole face and the eyes condition were used, since the earlier results had already shown that the mouth alone in the complex mental states condition produced relatively poor performance by normal subjects. We predicted that subjects with autism/AS would be relatively intact at

recognizing basic mental states, but would show impairments in recognition of complex mental states, both from the whole face and the eyes alone.

Results

Results from Experiment 3 confirmed these predictions. The group with autism/AS scored a mean of 8.0 on the basic faces ($sd = 2.71$), whilst the normal group scored a mean of 9.13 ($sd = 0.96$). On the complex faces, the group with autism/AS scored a mean of 7.19 ($sd = 2.04$), whilst the normal group scored a mean of 9.38 ($sd = 0.62$). For the whole face, there was a significant effect of group ($F(1,30) = 17.28$, $p = 0.0002$) and a significant effect of group x condition ($F(1,30) = 5.27$, $p = 0.029$), the group with autism/AS performing significantly worse on the complex mental states compared to controls. These differences were even more marked for the eyes alone condition. Here, on the basic eyes, the group with autism/AS scored a mean of 6.7 ($sd = 2.8$), whilst the normal group scored a mean of 8.8 ($sd = 0.67$). On the complex eyes, the group with autism/AS scored a mean of 6.0 ($sd = 2.6$), whilst the normal group scored a mean of 9.4 ($sd = 0.73$). ANOVA revealed a strong group x condition interaction ($F(1,30) = 18.4$, $p = 0.0001$).

General Discussion

The three experiments reported here go some way towards answering some fundamental questions about how we interpret mental states in the face. First, Experiment 1 shows that

normal adults are remarkably consistent with each other in how they interpret mental states in the face, and this is true both for basic and complex mental states. Experiment 1 also shows that in judgements about the complex mental states, the eyes convey as much as the whole face, and significantly more information than the mouth. Experiment 2 demonstrates that this effect is robust across both male and female stimulus faces. Finally, Experiment 3 demonstrated that whilst adults with autism and Asperger Syndrome are able to detect basic mental states in the whole face, they are impaired at recognizing complex mental states, and are markedly impaired at recognizing such mental states from the eyes alone. These findings from autism and Asperger Syndrome replicate earlier work (Baron-Cohen, Spitz, and Cross, 1993; Baron-Cohen, Campbell et al, 1995), but at a more subtle level.

All three experiments therefore demonstrate that there is a nonverbal communicative channel corresponding to what Baron-Cohen (1995) calls "the language of the eyes". From the present results, it seems we are highly adept at comprehending this unspoken language, whilst people with autism or Asperger Syndrome experience considerable difficulty in decoding this. That gaze should play such a major role in non-verbal communication is not a new finding (see Argyle and Cook, 1976; and Kleinke, 1986, for reviews). However, the demonstration that another person's eyes contain sufficient information for detecting complex mental states in their face is, as far as we are aware, new.

These findings open up a set of further questions for research. How does the normal person acquire the capacity to understand the language of the eyes? One suggestion is that attention to

eyes, and joint attention, are both hard-wired into normal development (see Baron-Cohen, 1994, 1995; Scaife and Bruner, 1975), ensuring that the normal infant picks up the relevant information about eyes and simple mental states like *attend* and *goal*. Whether a further mechanism is required for understanding the full range of mental states, as Leslie (1987) suggests, is not clear. Either way, the assumption is that once a person has such mental state concepts, these can be read into different aspects of behaviour, both in the face and in posture and gesture. Clearly, the eyes retain a privileged position in this, as the present evidence shows.

It also suggests that to the extent that people with autism or Asperger Syndrome recognize mental states, they are not acquiring a language of the eyes in the same way. This may point to their use of a different strategy in this domain. Indeed, many of our subjects said that given the whole face, they could identify basic mental states from gross features like the shape of the mouth in 'happy' versus 'sad', but that such obvious features were not readily available to help them decode either basic or complex mental states from the eyes alone. As students of psychology, we still have a long way to go before the language of the eyes is fully mapped. Nevertheless, the studies reported here suggest that the old folklore that "the eyes are the windows to the soul"⁶ is a scientifically tractable issue.

⁶ For "soul", read "mind".

Table 1: Results from Experiment 1, showing number of subjects passing on each trial (n = 50). The first term (in upper case) is the target (or correct) term. Note that in the experiment, the position of the target term was randomized (left/right position).

	Fig 1	Fig 3	Fig 5
	Face	Eyes	Mouth
<u>Basic emotions</u>			
Picture 1: HAPPY vs Surprise	50	46	49
Picture 2: AFRAID vs Angry	45	42	24
Picture 3: SURPRISE vs Happy	50	48	43
Picture 4: DISGUST vs Sad	50	41	49
Picture 5: SAD vs Disgust	43	47	34
Picture 6: ANGRY vs Afraid	47	45	44
Picture 7: SURPRISE vs Happy	48	49	15
Picture 8: DISTRESS vs Sad	46	44	45
Picture 9: HAPPY vs Surprise	48	46	46
Picture 10: ANGRY vs Afraid	37	31	29
	x	46.4#	43.9
	sd	4.03	5.17
			37.8
			11.72
<u>Complex mental states</u>			
	Fig 2	Fig 4	Fig 6
Picture 1: SCHEMING vs Arrogant	44	46	40
Picture 2: GUILT vs Arrogant	44	48	18
Picture 3: THOUGHTFUL vs Arrogant	46	50	30
Picture 4: ADMIRING vs Surprise	49	43	45
Picture 5: QUIZZICAL vs guilt	48	50	28
Picture 6: FLIRTING vs Happy	34	47	32
Picture 7: BORED vs Sleepy	45	32	43
Picture 8: INTERESTED vs Disint	46	50	31
Picture 9: INTERESTED vs Disint	39	38	29
Picture 10: ARROGANT vs Guilt	46	48	36
	x	44.1	45.2*
	sd	4.46	5.96
			33.2
			8.04
Combined	x	45.25	44.55*
	sd	4.30	5.47
			35.5
			10.07

* = Face + Eyes > Mouth, $p < 0.002$

= Face > Eyes and Mouth, $p < 0.053$

Table 2: Results from Experiment 2, showing percentage of subjects passing on each trial (n = 17). The first term (in upper case) is the target (or correct) term. Note that in the experiment, the position of the target term was randomized (left/right position).

	Face	Eyes	Mouth
AFRAID vs angry	82.4	76.5	82.4
SURPRISE vs happy	82.4	88.2	82.4
DISGUST vs sad	82.4	88.2	76.5
ANGRY VS afraid	88.2	52.9	82.4
HAPPY vs surprise	88.2	88.2	88.2
EXCITED vs disinterested	88.2	88.2	88.2
STARTLED vs angry	88.2	88.2	88.2
mean	85.7	81.5	76.5
SD	3.14	13.34	18.60
THOUGHTFUL vs arrogant	88.2	76.5	58.8
SCHEMING vs arrogant	76.5	82.4	58.8
THOUGHTFUL vs bored	70.6	58.8	35.3
PREOCCUPIED vs enthralled	88.2	70.6	70.6
INCREDULOUS vs guilt	82.4	58.8	64.7
ARROGANT vs guilt	88.2	88.2	82.4
mean	82.4	72.5	61.8
SD	7.44	12.15	15.67
Combined mean	84.16	77.38	69.68
SD	5.57	13.12	18.26

Table 3: Chronological age (CA) and IQ of the subjects in each group.

		CA	FSIQ
AUTISM/ AS (n = 16)	mean	28.6	105.31
	sd	9.7	13.0
	range	18-49	86-133
		CA	NART
NORMAL (n = 16)	mean	30.0	100.0
	sd	9.12	10.0
	range	18-48	90-110

Figure Legends

Figure 1: Photographs of 4 examples of the basic emotion/full face stimuli used in Experiment 1.

Fig 1(a) HAPPY vs Surprise

Fig 1(b) AFRAID vs Angry

Fig 1(c) DISGUST vs Sad

Fig 1(d) DISTRESS vs Sad

Figure 2: Photographs of 4 examples of the complex mental states/full face stimuli used in Experiment 1.

Fig 2(a) GUILT vs Arrogant

Fig 2(b) THOUGHTFUL vs Arrogant

Fig 2(c) FLIRTING vs Happy

Fig 2(d) ARROGANT vs Guilt

Figure 3: Photographs of the 4 basic emotion/eye stimuli corresponding to the faces in Figure 1, and used as part of Experiment 1.

Fig 3(a) HAPPY vs Surprise

Fig 3(b) AFRAID vs Angry

Fig 3(c) DISGUST vs Sad

Fig 3(d) DISTRESS vs Sad

Figure 4: Photographs of the 4 complex mental states/eye stimuli corresponding to the faces in Figure 2, and used as part of Experiment 1.

Fig 4(a) GUILT vs Arrogant

Fig 4(b) THOUGHTFUL vs Arrogant

Fig 4(c) FLIRTING vs Happy

Fig 4(d) ARROGANT vs Guilt

Figure 5: Photographs of the 4 basic emotion/mouth stimuli corresponding to the faces in Figure 1, and used as part of Experiment 1.

Fig 5(a) HAPPY vs Surprise

Fig 5(b) AFRAID vs Angry

Fig 5(c) DISGUST vs Sad

Fig 5(d) DISTRESS vs Sad

Figure 6: Photographs of the 4 complex mental states/mouth stimuli corresponding to the faces in Figure 2, and used as part of Experiment 1.

Fig 6(a) GUILT vs Arrogant

Fig 6(b) THOUGHTFUL vs Arrogant

Fig 6(c) FLIRTING vs Happy

Fig 6(d) ARROGANT vs Guilt

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