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Visual search for basic emotional expressions in autism; impaired processing of

anger, fear and sadness, but a typical happy face advantage.

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Abstract

Facial expression recognition was investigated in twenty males with High Functioning Autism (HFA) or Asperger syndrome (AS), compared to typically developing individuals matched for chronological age (TD CA group) and verbal and non-verbal ability (TD V/NV group). This was the first study to employ a visual search, "face in the crowd" paradigm with a HFA/ AS group, which explored responses to numerous facial expressions using real-face stimuli. Results showed slower response times for processing fear, anger and sad expressions in the HFA/AS group, relative to the TD CA group, but not the TD V/NV group. Reponses to happy, disgust and surprise expressions showed no group differences. Results are discussed with reference to the amygdala theory of autism.

Key words: Autism; Emotion; Visual search; Face processing

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Autism Spectrum Disorder (ASD) is a pervasive developmental disorder, affecting approximately 1% of the population (Baird et al., 2006) with a sex distribution ranging from 4:1 to 16:1 male to female. It is characterised by a triad of impairments in language, imagination and social interaction (APA, 1994). In addition, facial expression processing is atypical in ASD (Annaz, Karmiloff-Smith, Johnson & Thomas, 2009; Grice et al., 2001; Hobson, 1986a, 1986b; Baron-Cohen, Wheelwright, Skinner, Martin & Clubley, 2001). Due to the social significance of facial expressions in communicating the outcome of social interactions, it is thought that impaired face processing skills contribute strongly to the characteristic weaknesses in social interaction observed in ASD. The current paper explores facial expression processing in individuals who fall within the autistic spectrum, namely those with High Functioning Autism (HFA) or Asperger syndrome (AS).

This study employed a visual search *"face in the crowd"* task design. In this type of design participants are presented with an array of faces and asked to determine whether a target face is present or not. In a pioneering study, Hansen and Hansen (1988) reported that, in the typical population, angry faces are detected more quickly and accurately than happy faces; the Anger Superiority Effect (ASE). This is thought to reflect an evolutionary measure which accelerates the identification of threatening stimuli and is associated with activation of the amygdala (Fox et al., 2000). However, subsequent studies do not consistently replicate the ASE (e.g. Horstmann, 2009; Juth et al., 2005; Purcell, Stewart & Skov, 1996), with a number of studies showing a happy face advantage (e.g. Eastwood, Smilek & Merikle, 2003). On reviewing this literature, the ASE is more often reported when the faces employed are schematic faces (e.g. Ashwin, Wheelwright & Baron-Cohen, 2006a; Calvo et al., 2006; Horstmann, 2009; Juth et al., 2005, exp 1) as opposed to real faces, where a happy face

advantage is most often observed (e.g. Calvo & Nummenmaa, 2008; Juth et al., 2005, exp 5).

These inconsistencies have been explored in relation to the relative input of emotional vs.

perceptual comparisons across faces (Frischen, Eastwood & Smilek, 2008; Horstman, 2009;

Juth et al., 2005). For example, the happy face advantage seems to involve an interplay

between emotional and perceptual factors. For real face stimuli the mouth is a perceptually

salient feature particularly if it is showing teeth (which introduces a high luminance contrast)

(Frischen et al., 2008), whilst the advantage for recognition of positive words and smells

demonstrates additional impact on account of emotional salience (see Juth et al., 2005).

Despite the above inconsistencies in response patterns, there is a clear consistency

that the visual system is differentially sensitive to emotions, and that visual search is sensitive

to differences in emotional expression (see Frischen et al., 2008 for a review). This study

employs visual search in order to explore facial expression processing in HFA/AS. Visual

search ability is an area of proficiency within ASD (e.g. O'Riordan & Plaisted, 2001), which

makes it an appropriate experimental design for capturing atypical patterns of expression

recognition performance in our HFA/AS group should they exist.

In light of the link between the detection of threat and the amygdala in the typical

population (Fox et al., 2000), facial expression processing is an ideal forum in which to

assess the amygdala theory of autism (Baron-Cohen et al., 2000). In reference to impairments

in 'social intelligence' observed in ASD, the amygdala theory proposes that the amygdala is

one of a number of atypical brain regions in individuals with ASD (Baron-Cohen et al.,

2000). In the typical population, amygdala activation is reported for detection of fearful

expressions (Ashwin, Baron-Cohen, Wheelwright, O'Riordan & Bullmore, 2007), but has

also been reported for other negative or threat related emotions, such as anger and sadness

(Adolphs, 1999). Individuals with ASD have been shown to have reduced amygdala volume

(Abell et al., 1999) as well as reduced amygdala activation relative to typically developing

control participants when asked to judge the valence of fearful or angry faces (Ashwin et al., 2007; Baron Cohen et al., 2000; Critchley et al, 2000).

Behaviourally, only two studies have explored face expression processing in ASD using visual search. These studies have focused on determining whether individuals with ASD demonstrate an ASE, and so have only employed angry, happy and neutral expressions (Ashwin et al., 2006a; Krysko & Rutherford, 2009). Ashwin et al. (2006a) presented adults with HFA\AS and typically developing adult controls with a matrix of schematic line drawn faces that contained a single target (happy or angry) among neutral faces or the other emotional face. Both groups demonstrated an ASE, and there was some evidence that the HFA/AS group were less efficient than the control group at detecting angry faces (i.e. in their Experiment 2, but not Experiment 3). Krysko and Rutherford (2009) digitally modified real faces such that their stimuli only showed pixels that belonged to eye, eyebrow, mouth, nose and cheek regions. Happy or angry target faces were presented among neutral distracter faces. Results showed poorer overall accuracy for adults with HFA relative to typically developing adults and a comparable ASE for RT and accuracy data in both groups. Although not supported by significant interactions, the authors point out that the ASE was stronger for small than large display sizes (4 vs. 12 distracters) in the HFA group only.

The above two studies, therefore, show limited support for an atypical ASE in ASD. To explore whether this reflected the stimuli employed, the current study employed real face stimuli without any pixel reduction. This is based on evidence from adults with ASD for impaired expression processing of real-face stimuli showing negative emotions, on face expression identification tasks (participants identify the expression of a singly presented real-face) (Ashwin, Chapman, Colle & Baron-Cohen, 2006b; Boraston, Blakemore, Chilvers & Skuse, 2007; Humphreys, Minshew, Leonard & Behrmann, 2007; Wallace, Coleman & Bailey, 2008). Interestingly, this appears to be a developmental effect as children with ASD do not show an atypical profile of

expression recognition on this kind of task (Castelli, 2005; Ozonoff, Pennington & Rogers, 1991).

Whilst previous studies of visual search for facial expressions in ASD have employed just two emotions, happy and angry (Ashwin et al., 2006a; Krysko & Rutherford, 2009), we used visual search to investigate the speed and accuracy of processing six emotions (happiness, sadness, anger, fear, surprise, disgust) of standardised real face stimuli developed by Vanger, Hoenlinger and Haken (1998). The study focused on children and adolescents with HFA/AS. As visual search is particularly sensitive to differentiating between facial expressions (Frischen et al., 2008), we argue that this measure provides a stronger possibility of capturing any atypical patterns present in children and adolescents with HFA/AS should they exist. If amygdala dysfunction is a feature of children and adolescents with HFA/AS, we expected to minimally see impaired performance (longer response times and possibly increased error rates) in trials containing the socially threatening targets fear and anger, possibly extending to sadness and disgust, as these are also negative emotions. Any advantage for search for happy faces was not predicted to differentiate across groups. As we used real faces rather than schematic faces, based on the literature on the typical population, we did not necessarily predict an ASE, but predicted that the profile of abilities in the typical control groups would differentiate anger (and possibly all negative emotions) from positive emotions.

Method

Participants

Three groups of right-handed males (N=60) were recruited from local mainstream schools, specialist ASD units and branches of the National Autistic Society. All participants were assessed for Verbal ability using the British Picture Vocabulary Scale-second edition (BPVS II; Dunn et al, 1997), and for non-verbal ability using Ravens Coloured Progressive Matrices (RCPM; Raven, 1998). The experimental group comprised 20 males, all of whom had been clinically diagnosed with HFA/AS according to DSM-IV criteria, with no co-morbid Axis 1 or 2 disorders. Two typically developing control groups were recruited. The

first was individually matched to the HFA/AS group by chronological age (henceforth referred to as TD CA) and the second control group (henceforth referred to as TD V/NV), were individually matched by verbal and non-verbal ability using raw scores on the BPVS and RCPM. Participant details are shown in Table 1.

[Table 1 about here]

Design and Procedure

As individuals with AS/ASD show impaired gender perception (Njiokiktjien et al, 2001; Deruelle et al, 2004), only male images were employed, to avoid the introduction of a potential confound. The facial images employed were from the image set created by Vanger et al. (1998) (see Figure 2), used with the authors' permission. These were created using the photos of ten male participants who were instructed by trained facial action coding system (FACS) coders to produce six emotional faces and a neutral face (FACS codes discrete facial muscular movements to facial expression; Ekman & Friesen, 1976). Twenty-nine reference points from the participants' faces were recorded and averaged for each expression in order to create a "facial stencil". Each face was then digitally distorted to match the stencil creating prototypes with facial features that have identical dimensions, as shown in Figure 1. This process significantly mutes the idiosyncrasies of the human face, whilst still producing natural looking images that conform to FACS guidelines. Use of such prototypes addresses existing validity problems providing improved internal validity than would be achieved if we were to incorporate photographic stimuli.

Facial images were arranged in a 3 by 3 formation to create each stimulus matrix. Each matrix contained one target emotional expression, one distracter emotional expression and seven distracter neutral expressions (see Figure 3). On account of the atypical population being assessed, we chose to use a methodology in which participants were required to look for a specific emotion (cf. Horstmann, 2009), rather than to detect an odd-one-out. The distracter emotion was therefore included to ensure procedural consistency across

participants. It also increased the sensitivity of the task, such that detection of more salient emotions would be less affected by a distracter emotion than less salient emotions. Thirty matrices were created in total (6 target emotions x 5 distracter emotions) and the position of target, distracter and neutral faces was randomised across trials.

[Figures 1, 2 and 3 about here]

A small pilot study was carried out to compare responses to the prototypical faces (Figres 2 and 3) to the standardised Ekman faces (Ekman & Friesen, 1976). Three participants were recruited, one diagnosed with AS, and the other two selected as to be close chronological age matches. Two sets of 15 expression matrices were created as described above, one utilising Ekman faces and the other using Vanger et al. (1998) prototypical expressions. Both stimuli sets were presented to each of the participants in turn, and reaction times and accuracy were recorded. Accuracy rates were higher for the prototypical stimuli (100%) than for the Ekman faces stimuli (94%). Also noted was a steadily decreasing reaction time trend across the first 10 trials. Accordingly, 10 practice trials were employed in the experimental study.

For the experimental study, stimuli were presented on a laptop with a 15" TFT XGA screen (1024x768 pixels, 72dpi resolution) in 24-bit gray-scale colour format, using SuperLab and participants were seated approximately 50cm from the laptop screen. To ensure baseline recognition of each emotion a preliminary emotion recognition task was conducted; participants were required to identify each emotional face from a matrix. This produced high accuracy akin to the pilot study. Incorrect responses were discussed with the children.

The experiment consisted of ten practise trials followed by two randomised blocks of the 30 experimental trials (60 experimental trials in total). Participants were instructed that,

on hearing the name of an emotion (presented as audio recordings of the male experimenter: WAV digital audio files, 52kbps, 44.1KHz sampling rate), they were required to click on the face that displayed the named emotion, using their mouse. Accuracy and response time were recorded by the computer. Correct responses also received visual feedback ("correct" appeared centre screen), with no feedback provided for incorrect trials. Presentations were displayed for a maximum of 10 seconds and a 500 ms inter-stimulus-interval (ISI) comprising a white screen was presented between trials. Participants also completed two standardised measures, the Raven's Coloured Progressive Matrices (RCPM; Raven, 1993) and the British Picture Vocabulary Scale II (BPVS II; Dunn, Dunn, Whetton & Burley, 1997).

<div align="center">Results</div>

Analysis of response times (RT)

RTs of correct response only were analysed. One participant from the ASD group responded incorrectly to every trial with fear as a target. This empty cell was replaced with the mean RT for the remaining 19 HFA/AS participants for this expression. Results are shown in Figure 4.

ANOVA was carried out with target emotion (6 levels; anger, disgust, fear, happiness, sadness, surprise) as the within-subjects factor, and group (3 levels; HFA/AS, TD CA, TD V/NV) as the between-subjects factor. This showed a significant main effect of target emotion ($F(3.64, 207.53) = 55.91$, $p < 0.001$, *partial $\eta^2 = 0.50$*). Pair-wise comparison (Bonferroni corrected) showed that this was due to significantly faster reaction times for happy faces than for all other emotional expressions ($p<.05$ for all), and significantly slower recognition of sad, fearful and angry faces than surprise, disgust and happy emotional expressions ($p<.05$ for all). The main effect of group was also significant ($F(2, 57) = 4.52$, $p =.02$, *partial $\eta^2 = 0.14$*). Post-hoc Tukey analysis indicated that the HFA/AS participants were

significantly slower than TD CA participants ($p<.05$), but not the TD V/NV control group ($p>.05$) overall. The responses of the TD CA and TD V/NV groups did not differ from one another ($p>.05$).

The interaction between group and target emotion was also significant ($F(7.28, 207.53) = 2.45$, $p =0.01$, *partial η^2* $= 0.08$). Further exploration revealed that the main effect of group above was driven by a subset of emotional expressions; there was no significant difference between groups in the perception of disgusted faces ($F(2, 57) = 2.30$, $p > 0.05$), happy faces ($F<1$) or surprised faces ($F<1$). Significant differences between groups were found for angry faces ($F(2, 57) = 3.79$, $p < 0.05$), fearful faces ($F(2, 57) = 6.84$, $p < 0.01$) and sad faces ($F(2, 57) = 4.60$, $p < 0.05$). Further Tukey post hoc analysis for angry, fearful and sad faces showed similar patterns in that the HFA/AS showed significantly longer RTs than the TD CA group ($p<.05$), but not the TD V/NV group ($p>.05$), and that the RTs of the TD CA and TD V/NV groups did not differ ($p>.05$).

[Figure 4 about here]

Analysis of errors

As visual search tasks are designed to produce no or very low numbers of errors, RT analyses are typically most informative. However, as errors were made, performance was compared to ceiling to determine whether analysis of error rates was justified. In the ASD group errors were all significantly different from zero ($p < 0.05$) with the exception of disgust ($p=.10$) and happy ($p=.08$). In the TD CA group performance was significantly different from zero in each emotion ($p<0.05$ for all). In the TD V/NV group, performance for all emotions was significantly different from zero ($p<0.05$ for all) except for happy ($p=0.08$). Results are shown in Figure 5.

As ceiling effects were infrequent, ANOVA was carried out on error rates with target emotion (6 levels; anger, disgust, fear, happiness, sadness, surprise) as the within-subjects

factor, and group (3 levels; HFA/AS, TD CA, TD V/NV) as the between-subjects factor. Results revealed no main effect of group ($F < 1$). There was however a main effect of emotion (F (3.22, 183.37) = 11.81, $p < 0.001$, *partial η^2 = 0.17*). Post hoc analysis (Bonferroni corrected) revealed the least errors for responses to happy (significantly lower than anger, fear, sad and surprise, *p*<.05 for all) and disgusted faces (significantly lower than anger, fear and surprise, *p*<.05 for all) and the most errors for anger (significantly higher than happy and disgust, *p*<.05 for both) and fear (significantly higher than happy, disgust and sad, *p*<.05 for all), with intermediate and similar (*p*>.05) error rates for sad and surprise. No significant emotion x group interaction was found (F (6.43, 183.37) = 1.06, p =0.39, *partial η^2 = 0.04*).

[Figure 5 about here]

Correlational analysis

Mean RT and mean error variables were calculated for each participant across the six emotional expression variables, and their relationship to chronological age (CA), level of verbal ability (measured by the BPVS) and level of non-verbal ability (measured by the RCPM) determined through correlational analysis. In order to take a conservative approach, two-tailed significance values are reported. Mean RT scores were negatively associated with CA only for the ASD and TD V/NV groups (ASD: R= -.52, p=.02; TD V/NV: R=-.58, p=.01), with no significant associations for the TD CA group (R= -.36, p=.12) . Mean error scores were negatively associated with RCPM for all three groups, although only marginally so for the ASD group (TD CA: R=-.52, p=.02; TD V/NV: R=-.51, p=.02 ASD: R=-.39, p=.09), and also with BPVS for the TD V/NV group (R=-.68, p=.001). There were no other significant associations.

Discussion

The present study investigated the abilities of children and adolescents with HFA/AS to search for a target face in a crowd based on six basic emotional expressions. Results

showed a consistent pattern across HFA/AS and TD control groups such that identification of fear, anger and sadness target expressions was significantly slower than other emotions, with a corresponding reduction in accuracy for searches for fear and anger. In addition, identification of happy expressions showed the fastest responses and the least errors were shown for detection of happy and disgust. The disadvantage for detecting anger and fear parallels the findings of other visual search studies incorporating "real face" as opposed to schematic stimuli (Purcell et al, 1996; Juth et al, 2005). Furthermore, due to the range of emotions employed we were able to extend the finding to demonstrate that there is also a happy face advantage in a visual search task, akin to that observed in face identification tasks (e.g. Leppanen & Hietanen, 2004). This is consistent with Calvo and Nummenmaa (2008) which is the only other study, to our knowledge, to employ a range of emotional expressions in a 'face in the crowd' experiment.

The groups differentiated in terms of RTs only. This was not surprising as, for visual search, it is recognised that this is the most sensitive measure of performance. Specifically, the participants with HFA/AS were significantly slower than the TD CA group in responding to fear, anger and sad target expressions. Thus, for these emotional expressions, participants with HFA/AS were slower, but not less accurate at detecting the target emotion, indicating that although they find these emotions more difficult to detect than TD participants of the same age, they overcome this difficulty and produce typical levels of accuracy (at least for prototypical facial expressions) by spending more time studying the stimulus array. The correlation between non-verbal ability and error rates for all three groups further indicates that the HFA/AS group approached the task in a typical manner. The RT impairment in the HFA/AS group is specific to fear, anger and sadness; for the remaining emotional expressions, surprise, disgust and happy, individuals with HFA/AS demonstrated a typical pattern of RTs and error rates. Taking into account the pattern of response of the TD groups,

one could explain the group difference as an exaggerated disadvantage in detecting anger, fear and sadness in HFA/AS. Notably, the HFA/AS group show a typical happy advantage. This has hitherto not been demonstrated in ASD samples due to the small number of emotional expressions employed in 'face in the crowd' tasks.

It is important to highlight that the significant group differences in RT were shown between HFA/AS and TD CA groups, but not between HFA/AS and TD V/NV groups. This suggests that the deficit relates to years of experience rather than level of non-verbal ability or level of verbal ability and is further supported by the correlational analysis which showed that RT performance was significantly related to CA for the ASD and TD V/NV groups. The lack of a relationship between CA and RT for the TD CA group suggests that in typical development, at least for prototypical facial expressions, this developmental process reaches a plateau in late childhood / adolescence, despite the fact that for individuals with HFA/AS this skill is still developing. Typically developing children are perceptive to faces and emotions during infancy, and knowledge of their social value develops naturally through interactions and experience. As facial expression processing is driven by social experience, this suggests that the relative reduction in social interaction experienced by individuals with HFA/AS compared to the typical population has an impact on the development of their ability to process facial expressions. As such, their RT performance is at the level of younger TD children (the TD V/NV group). The fact that this is specific to fear, angry and sad expressions supports the amygdala hypothesis of autism (Baron-Cohen et al., 2000).

The subtlety of the deficit observed here might explain why previous studies that have employed children with ASD do not report an atypical profile of face expression processing (Castelli, 2005; Ozonoff et al., 1991), whilst studies with adults do. Ozonoff et al. (1991) employed younger children with ASD, aged 3.4 to 10.8 years. Castelli (2005) employed participants of similar CA (mean: 12.3 years, s.d.: 2.3 years) to the participants in the current

study, but employed verbal mental aged matched control participants only. If years of experience is an important contributing factor, then in both of the above studies the TD control children would not have had the opportunity to differentiate themselves from an ASD group in the same way as has been shown in adult TD groups because their own abilities are still developing. By including a TD group matched for CA we were able to capture the emergence of the impairment observed in adulthood. A further possibility for the discrepant results is that Castelli (2005) investigated facial expression recognition as opposed to visual search. It is possible that our visual search measure was simply more sensitive to detecting group differences.

There is some discussion over the relative inputs of perceptual discrimination and emotional discrimination in visual search tasks (e.g. Juth et al., 2005). Juth et al. (2005) found that angry and fearful real faces were frequently confused with one another and with neutral faces, whereas happy faces were rarely confused with neutrality. By employing participants who are reported to show a reduced response to threat, we were able to explore the role of emotion, over and above the role of perception. The fact that our HFA/AS group show an atypical response to anger, fear and sad expressions is predicted by an emotional discrimination hypothesis, but not by a perceptual discrimination hypothesis, which would predict, if anything, a uniform superiority across all expressions in our HFA/AS group (individuals with ASD show evidence of enhanced perceptual discrimination abilities; e.g. O' Riordan & Plaisted, 2001). Thus, we can be confident that our stimuli tapped into emotion discrimination abilities.

The happy face advantage observed is consistent with evidence for a special status of happy expressions (Frischen et al., 2008). This is the only expression in which teeth are clearly visible, and thus it is possible to process this stimulus by featural perceptual processing alone. If this was the case, the characteristic featural processing bias reported in

ASD (e.g. Happé, 1999) would predict an exaggerated happy face advantage in this group. As this was not observed, our results suggest that the happy face advantage cannot be accounted for by featural perceptual processing alone. It is thought that a happy face advantage relates to our familiarity with happy expressions over other expressions, and the fact that, developmentally, recognition of positive emotions emerges prior to negative emotions (Sroufe, 1995). Recent meta-analysis has shown that the processing of happy faces specifically activates the right anterior cingulate cortex (Fusar-Poli et al., 2009), an area which shows typical activation to happy faces in ASD (Critchley et al., 2000). Thus, the typical happy face advantage observed here in our HFA/AS group relates to the relative frequency of social opportunities to become familiar with happy faces, and the fact that the detection of happy faces is predominantly driven by cortical areas that are not specifically impaired in ASD.

The relatively superior performance in recognition of disgust was not predicted. This effect was demonstrated across all three participant groups. On observation of Figure 2, the disgusted expression employed here involves the eyes, nose and mouth, which differentiates it from the background neutral face considerably. This suggests that the anomalous result might be attributed by perceptual, rather than emotional salience. As this expression is classed as a negative emotion, one might have predicted impaired performance in the HFA/AS group. However, meta-analysis has shown that recognition of disgust does not involve the amygdala, but predominantly activates insular cortex (Fusar-Poli et al., 2009). In face identification tasks, Ashwin et al. (2006b) and Wallace et al. (2008) demonstrated relative impairments for recognition of disgust in participants with ASD compared to typical development, whilst Humphreys et al. (2007) and Boraston et al. (2007) did not, which is consistent with the present study. Differential brain activation for fear vs. disgust relates to perception of threat vs. distress respectively (Fusar-Poli et al., 2009). A tentative suggestion

is that if 'disgust' facial expression stimuli can be interpreted as either threat or distress with corresponding differential brain activation, dependent on the stimulus employed, this would explain discrepancies in results.

In summary, in the first study of the ability to process a variety of facial expressions using real-face stimuli, in the "face in the crowd" paradigm, with children and adolescents with HFA/AS, we have shown impaired recognition for anger, fear and sadness in HFA/AS, relative to the level expected by their chronological age. We suggest, in support of the amygdala theory of autism, that the pattern of results reflect differential activation of social brain areas in ASD.

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Table 1: Participant details

Group	CA (years; months)	BPVS score	RCPM score
	Mean (S.D.)	Mean (S.D.)	Mean (S.D.)
HFA/AS	12.33 (1.55)	113.05 (18.23)	31.05 (4.17)
TD V/NV	10.88 (1.64)	115.25 (17.59)	30.70 (3.96)
TD CA	12.31 (1.49)	130.45 (11.42)	31.00(3.11)

Figure Captions

Figure 1*. Processing stages of facial images, a) point referencing of a subjects face, b) adjustment of the facial image to the "stencil", c) facial prototype produced by averaging "stencilled" facial images depicting the same emotional expression.

Figure 2*. Prototypical male faces (Vanger et al., 1998)

Figure 3. Example stimulus matrix. a) Target: happy; Distracters: neutral and angry b) Target: surprise; Distracters: neutral and sad

Figure 4. Response times to presentations of each target emotion: mean (s.e.)

Figure 5. Number of errors to presentations of each target emotion: mean (s.e.)

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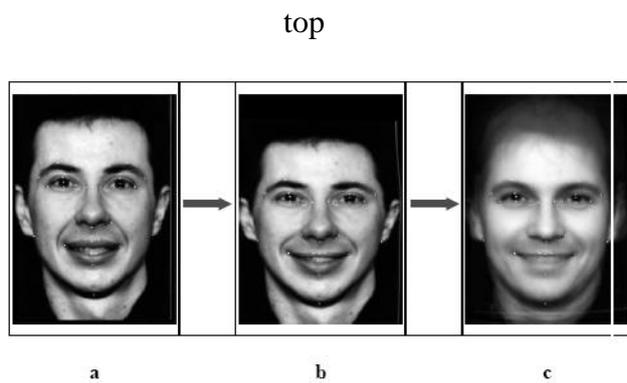
Figure 1

top

a   b   c

Figure 2

top

| Fear | Anger | Sad | Surprise | Disgust | Happy | Neutral |

Figure 3

top

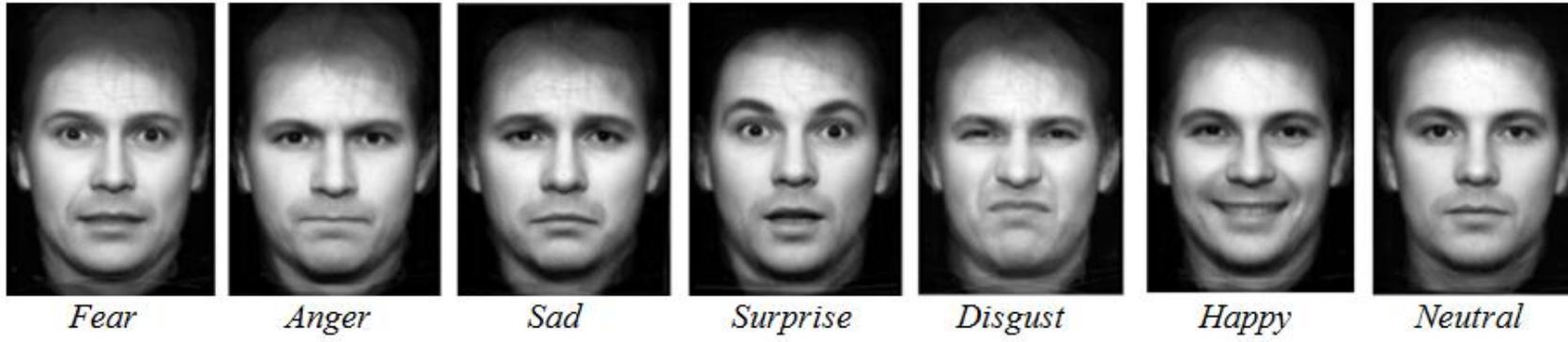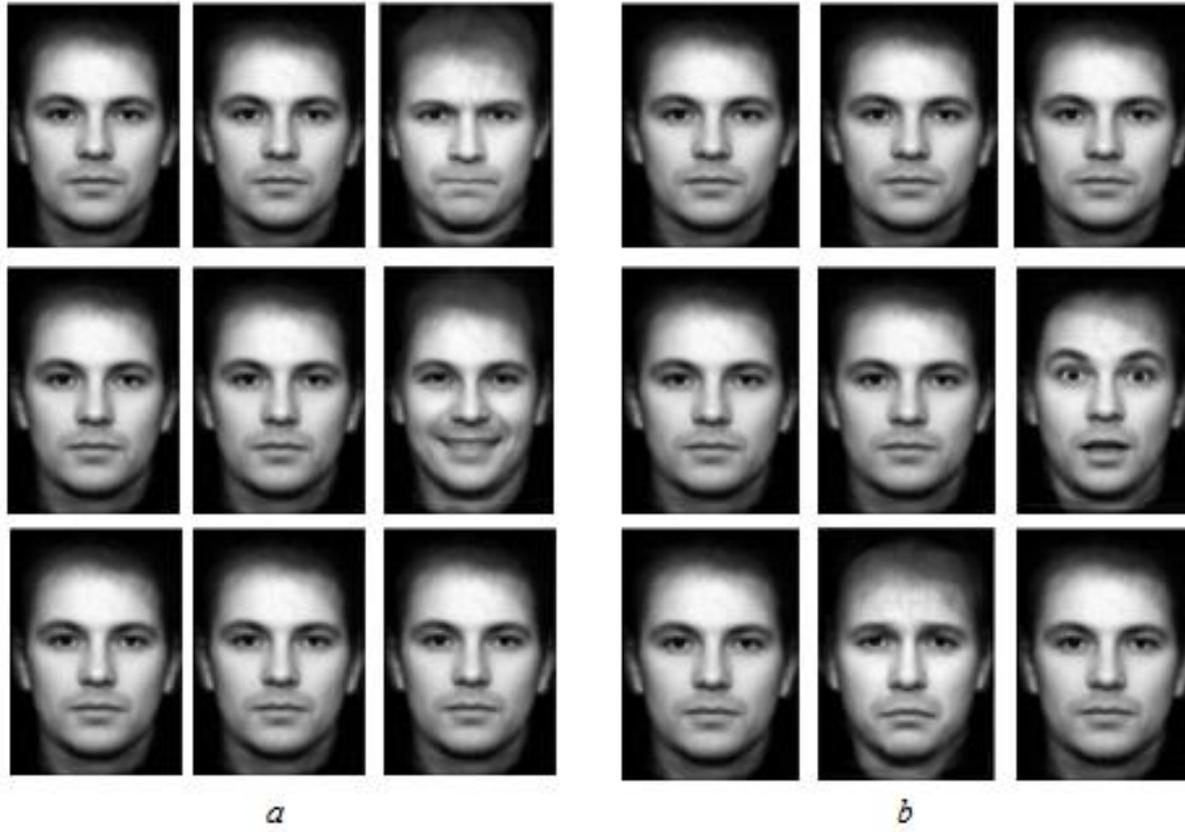a   b

Figure 4
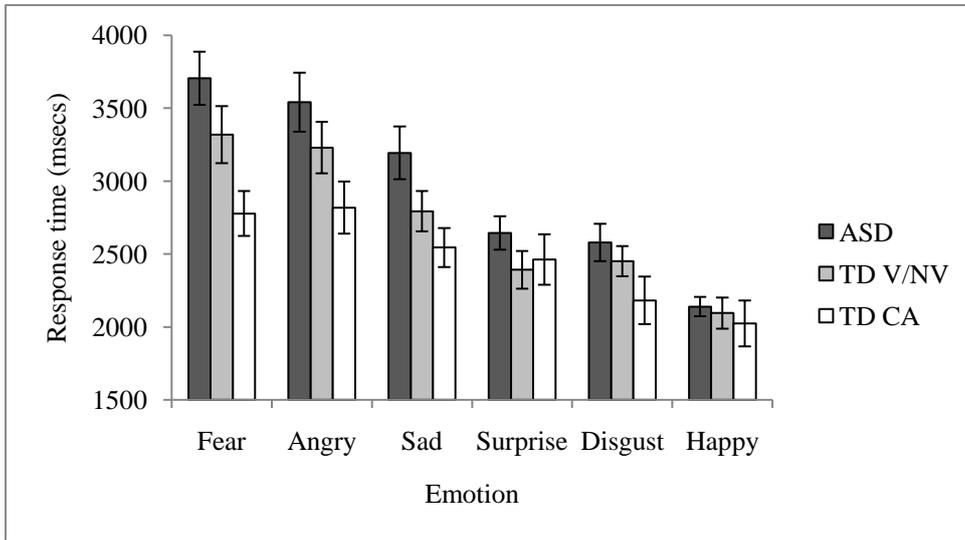
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Figure 5

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