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The comparative study of facial emotion recognition ability in ADHD individuals and individuals with high functioning autism/Asperger syndrome

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Abstract

This study describes and compares the facial emotion recognition abilities and specific recognition profiles of ADHD individuals and HFA/AS individuals in review- related articles selected from the last 10 years. It is concluded that, in facial emotional recognition tasks, individuals from the HFA/AS groups out-perform those from the ADHD groups. HFA/AS groups showed impairments only for complex tasks which required the detection of subtle facial expressions. ADHD groups showed deficits for more simple facial labeling tasks. Directions calling for further study are pointed out.

Key words

ADHD, High Functioning Autism, Asperger Syndrome, facial emotional recognition

Introduction

Recently, an increasing number of researchers in the fields of ADHD (Attention-Deficit Hyperactivity Disorder) and HFA/AS (High Functioning Autism/Asperger Syndrome) have focused attention on the topic of facial emotion recognition. In the field of ADHD, cognitive impairment and deficits in social interaction or communication are not included in the core deficits of individuals with ADHD, a common psychiatric disorder which affect 3–5% of school-age children (Barkley, 2005). Yet, researchers and doctors began to notice that increasing numbers of ADHD individuals may have impairments in facial emotion understanding. On the other hand, in the field of HFA/AS, although ASD (Autism Spectrum Disorder), also a common neurodevelopment disorders affecting approximately 1% of the population (Barid et al., 2006) and is characterized by deficits in cognitive ability and social interaction or communication skills, researchers pointed out that the cognitive profile of HFA/AS may differ from ASD on account of normality in intellectual scores and the absence of early language delay. This paper focuses on the facial emotional recognition ability profiles of both ADHD and HFA/AS groups. Profiles of both groups will be described and compared by a review of selected articles from the last 10 years.

Emotional Facial Expression Recognition & Social Skills

The ability to recognize emotional facial expression, a paralinguistic cue, is amongst the most basic skills of emotional competence (Semrud-Clikeman, Guy, & Griffin, 2000). Since emotional facial expression includes essential information for human social interaction (Tannock, Martinussen, & Frijters, 2000), the ability to accurately interpret and respond appropriately to others people's facial expressions is crucial to interpersonal interaction and social skills (Morrison & Bellack, 1981; Kinsbourne & Bemporad, 1984). Recognition of basic emotions is developed in early childhood and is expected of the individuals in mid-childhood (Herba & Phillips, 2004).

ADHD – Emotional Facial Expression Recognition

Responding/Reaction time

Kats-Gold, Besser and Priel's (2007) study records the response times to emotion recognition of 50 ADHD at-risk boys and a control sample of 61 normal children. The data showed that the ADHD at-risk group needed more time to recognize the emotional expression when compared to the control group with mean reaction times of 2224.60ms and 1988.33ms, respectively. Further, the longer reaction times did not seem to improve recognition accuracy.

Accuracy or error rates and specific emotional subtype bias

According to Kats-Gold, et al.'s (2007) study, members of the ADHD at-risk group performed worse than the control group. They were found to have impairments in simple emotion recognition skills. The authors found that the at- risk group tended to 1) equate diverse emotions (happy, sad and angry) with fear, and 2) confuse anger with sadness. They came to the conclusion that boys at risk of ADHD present a negative bias and exaggerated negative emotions (sadness and fear) more than was expected.

It is interesting to compare the Kats-Gold, et al.'s (2007) study with that of Williams et al.'s (2008) where similar tasks were used but with partially different results. The studies differed in that the earlier study included 4 basic emotional subtypes (happy, sad, anger, and fear) whilst the later study used 6 subtypes (fear, anger, sad, disgust, happy, and neutral). The finding that ADHD group made most errors in misidentifying the emotions of anger and fear with neutral states or sadness was partial contradictory to the conclusion of the previous study where the ADHD group is said to have a tendency to exaggerate negative emotions. This contradictory conclusion might have been due to the use of different emotions types.

Fonseca et al. (2008) also tested facial emotional understanding by utilizing colorful real-life photographs. The result revealed that the control group significantly outperformed the ADHD group. Also, happy and anger were better recognized than fear and sadness.

Sinzig, Morsch and Lehmkuhl (2007) made a study that compared the facial emotional reading ability of ADHD individuals and HFA/AS individuals by using the Frankfurt Test and Training of Social Affect (FEFA). What should be noted is that the ADHD group performed not only significantly worse than the control group in total accuracy but also made most errors for the emotion of fear with an accuracy rate 48% compared with 70% in the control group.

The study of Boakes et al. (2008), in which static colorful photographs were used, found that the ADHD boys had significant deficits in emotional recognition relative to their healthy peers with the specific error pattern that most errors were recorded for disgust and fear while the subtypes happiness, anger and sadness showed no impairments.

The Lee et al.'s (2009) study is one of the few with the opposite result and failed to find impairments. Forty-two Chinese children with ADHD and normal matched children were tested with a facial recognition task which consisted of colorful facial photographs of Asians. A 73% accuracy of ADHD and a 74% accuracy of control group showed that there was no significant difference between two groups. Since three others studies using the same set of photographs of Asian faces gave similar outcomes, researchers suggested that the inconclusive result may due to the differences between Asians and Caucasians for negative emotions on the grounds that Asians may express negative emotions in more subdued way.

Emotional and Non-emotional Tasks

Specific social cognitive or general cognitive impairment?

Yuill and Lyon (2007) addressed this question by adding an 'inhibitory scaffolding' procedure. Boys with ADHD and control groups were asked to label photographs which included 6 basic emotional subtypes (happy, sad, anger, surprise, fear and disgust) and 6 non-emotional objects on the face (sunglasses, woolly hat, wet hair, thermometer in mouth, sticking plaster on face and safety helmet) in emotional or non-emotional situations. The results showed that ADHD group performed significantly worse than control groups in the emotional labeling task whether or not impulses were controlled, whilst showing a dramatic improvement relative to the normal level when using the 'inhibitory scaffolding'. It was concluded that ADHD individuals may have a general cognitive deficit due to the ADHD syndrome (impulsive) but also had a specific cognition difficulty in emotional facial expression recognition processing.

Fonseca et al. (2009) also used a task which required ADHD children to match missing parts (facial expression or object) by using contextual situation cues. The result of this study was in line with Yuill and Lyon's (2007) study which indicated that an ADHD group performed significantly lower in the emotional task when compared to the control group when object tasks were not included. The same conclusion can be drawn from the second study, namely, that individuals with ADHD show impairments in specific facial emotional recognition which are not the secondary consequences of more general cognitive deficits.

ADHD syndromes and Emotional Facial Expression Recognition Impairment

Are inattention or inhibitory deficits associated with emotion recognition impairment?

According to the Yuill and Lyon's (2007) study, impulsivity is a factor in the low accuracy of emotional facial expression recognition in ADHD children when compared to their healthy peers but it is not the only reason. As has been mentioned above, although the ADHD group's scores in emotional task did show some improvements after using the 'inhibitory scaffolding', they still performed significantly worse than those in the control group.

Some researchers tried to understand this association by data analysis rather than in terms of external control. In the Sinzig et al.'s (2007) study the scores of ADHD children in facial emotion labeling task were correlated with the variables of the sustained attention, inhibition and set-shifting. High correlations were found which indicated that ADHD symptoms (inattention, impulsivity) have an impact on facial affect recognition which is compatible with Yuill and Lyon's (2007) study.

However, Lee et al.'s study (2009) failed to find the association by using the indices of omission error, commission error, attentiveness, and variability of Conners' Continuous Performance Test (CPT II) (Conners, 2004; Epstein et al., 2001). No significant correlation was found between the scores of facial emotion recognition test of ADHD subjects and their CPT II indices. This inconclusive result may be due to different data and stimuli being used.

MPH and Emotional Facial Expression Recognition Impairment

In Williams et al.'s (2007) study, 51 ADHD adolescents were tested in a medicated (n = 25) or unmedicated (n = 26) status with MPH by using a facial emotion labeling task. The results indicated that MPH made a significant improvement in the total performance which was attributed to improvements in the emotion subtypes of anger and fear but not otherwise. This may be due to the reason that the scores in other emotional subtypes (neutral, sadness, happiness and disgust) of unmedicited ADHD group did not differ significantly compared to the control group, whereas the scores for anger and fear were markedly lower than those in the normal control group. However, the two subtypes (anger and fear) still showed deficits when compared to the normal control group.

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HFA/AS Emotional Facial Expression Recognition Deficits

Responding/Reaction time

In Farran, Branson, and King's (2006) study, participants were divided into three groups: A HFA/AS group, a chronological age matched control group (TD CA) and a verbal and non-verbal ability matched control group (TD V/NV). Members of the groups were asked to determine whether a target face was present or not. The responding time (RT) record showed that the HAF/AS group was significantly slower than the TD CA group but not the TD V/NV group for the emotion subtypes anger, fear and sad but not happy, surprise and disgust. It seemed that the significant impairment in RTs in HAF/AS group was associated with years of experience rather than level of non-verbal or verbal ability.

However, Smith et al. (2010) failed to find the differences by utilizing a sensitive facial emotion recognition task which used dynamic stimuli with different intensities ranging from 20% to 100%. No differences in reaction time between HAF/AS and control groups were found, whether for total scores, emotion subtypes or emotion intensities. The inconclusive result may be due to the fact that the control group in this study was both aged-matched and IQ-matched.

Miyahara et al.'s (2007) study was in line with Smith et al.'s (2010) study, which tested the participants by using four separate stimulus modes (static cartoon, static real, moving cartoon, moving real) based on two emotion subtypes (happy and disgusted). Again no significant differences were found between two groups in terms of stimulus modality or emotional subtypes. It should be noted that Miyahara et al.'s (2007) study also controlled both age and non-verbal level.

Accuracy and Specific Emotion Bias

Although Farran, et al.'s (2006) study showed that HFA/AS group was significantly slower than the typical developing age matched group in responding to sadness, fear and anger, the error rates in all 6 basic emotions were similar to those of control group. The HFA/AS group demonstrated a typical error pattern. It was concluded that although individuals with HFA/AS may find sadness, fear and anger target emotion subtypes more difficult, they overcame this difficulty and attained similar results by spending more time on tasks.

Miyahara et al.'s (2007) study was in line with Farran, et al.'s (2006) study on accuracy. No significant differences were found in responding times, error rates for any emotional subtypes (happy and disgust) or any stimulus modality (static cartoon, static real, moving cartoon and moving real). However, what should be noted is that 20% of HFA/AS group (4/20) recognized the happy face faster than the disgust face, while 65% of the control group (13/20) exhibited happy face advantage. It indicated that happy face advantage was less common in the Asperger group which may reveal a unique pattern of decoding facial emotion in individuals with Asperger syndrome.

Wright et al.'s (2008) study also failed to find the difference of performances in the facial emotion recognition tasks (with or without context) between the HFA/AS group and normal control group with the exception of the anger, which may be due to the pho-

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tographs used (Ekman series), and happy subtypes. Individual scores showed that the standard deviation was much wider in the HFA/AS group though the group had lowest errors for the happy face subtype while none of normal individuals scored below 90%. This finding seemed to be in line with the previous one about the smaller size of happy face advantage in HFA/AS group.

The highlight of Sinzig & Morsch & Lehmkuhl' s (2008) study was the comparison of ADHD, HFA/AS, HFA/AS+ADHD and control group facial emotional recognition abilities. No significant differences were found between the pure autism group and the normal control group in either accuracy or recognition pattern, while ADHD and HFA/AS+ADHD both performed significantly worse than the non-clinic group. It is suggested that ADHD syndrome (inattention or impulsive) but not Pervasive Developmental Disorders symptoms (impairments in social interaction and communication or stereotype behavior) seemed to have a significant effect on performance in facial emotional understanding tasks.

However, Katsyri et al.'s (2008) used a designed experiment to verify that HFA/AS individuals had impairments only in detecting subtle emotions. Participants were presented with dynamic stimuli in filtering conditions: none, slight and strong. The authors failed to find any marked differences between two groups in non-filtered or slightly filtered displays. The only significant difference was found in recognizing facial expressions with strongly filtered displays.

Smith et al. (2010) also found deficits in the autistic individuals by using a more sensitive facial emotional stimulus with mixed intensities (e.g. 70% fear mixed with 30% anger) instead of the 100% 'full-blown' expressions photographs which were utilized in previous studies to avoid the exaggerated and unrealistic facial expression. Recognition impairment for surprise was only showed at the low level intensity (20%-40%). Anger impairment occurred in low and medium intensities (20%-70%) and disgust impairment in any levels of intensity.

One study may explain why facial emotion understanding ability of high functioning individuals with autism has so many inconsistent results. Mazefsky & Oswald's (2006) divided HFA and AS groups using a new diagnostic system developed by Klin et al. (2005) wherein HFA diagnostic criteria allowed early language delays and greater social withdrawal whilst AS's was not (Klin et al., 2005). Significantly deficits were found in the HFA group but not in the AS group.

The Theory of 'Weak Central Coherence'

Are recognized facial expressions of HFA/AS individuals more dependent on overall global shapes than on local features?

Katsyri et al. (2008) used the 'circularly symmetric ideal low-pass filter' to make slight-filter and strong-filter stimuli. That significant differences between two groups were only found in strongly filter stimuli indicated the AS group did have a global processing deficit in very low-spatial frequencies (< 1.8 or 3.7 c/fw). It was verified again in that impairment of AS individuals' facial emotion recognition ability which only showed in the detection of subtle facial expressions. This may be partial due to the 'weak central coherence'.

Fonseca and Deruelle (2010) designed the target face to be composed of two overlapping faces, one with high and the other with low spatial frequency. The result revealed that the Asperger subjects did show a tendency to use the high spatial frequency face in emotion recognition, contrary to their normal peers' performances which was in line with Katsyri et al.'s (2008) study.

Eye-Tracking Measure

Where do HFA/AS individuals tend to look most in facial emotional recognition processing – eye or mouth areas?

Boraston et al. (2008) highlighted this question by designing a task for distinguishing between genuine and posed smiles on the basis that the description of the eye region was important when identifying genuine smiles, sincere smiles causing wrinkles around eyes whereas posted smiles do not (Hager & Ekman, 1985; Ekman 1989). The results revealed that the HFA group performed significantly worse than control group in the genuine or posed smiles distinguishing task. At the same time, gaze time records and fixation data both indicated that the HFA group did look less at the eye region and relied heavily on the mouth part for facial emotional recognition processing.

Falkmer et al. (2010) also recorded eye movements of AS individuals when testing with a puzzle matching tasks where a given face was cut into 6 puzzles (eyes, mouth and other), requiring participants to identify emotion being presented. Data from eye tracking also indicated that AS group had fewer fixations at eyes in the information stage (viewing the puzzles) and showed more fixations on the other part of face (exception of eyes and mouth areas) in the identification stage (making choices).

The Heterogeneous Group

Is there a heterogeneous group amongst individuals with HFA/AS in facial emotional expressions recognition?

In Falkmer et al.' s (2010) study, the researchers found that some AS individuals actually identified all emotions correctly despite the use of a complicated rather than simple task of facial emotion labeling. The possibility that heterogeneous sub-categories may exist within the Asperger group has been mentioned in this study and was also supported by Rutherford et al.'s study (2007).

A large variation between individual subjects among HFA/AS group was also found in Katsyri et al.'s (2008) study. The researchers pointed out the high level of uncertainty in the AS group.

Conclusion

The aim of current study is to describe and compare the profiles of facial emotion perception between ADHD and HFA/AS groups by reviewing articles from last 10 years. Discussion and conclusion are given in three parts herewith below.

Responding Times

By reviewing articles, we find that ADHD individuals need longer responding time to read facial emotion expressions compared to their normal peers, though it seemed they did not benefit from longer RT with significantly lower accuracy rates (Kats-Gol, Besser, & Priel's, 2007). However, in the field of HFA/AS, two studies did not find significant differences (Smith et al., 2010; Miyahara et al., 2007) while one study found HFA/AS individuals needed longer responding time in the emotional subtypes of anger, fear and sadness (Farran, Branson, & King, 2010). However, it should be noted that the longer reaction times seemed to give improved recognition accuracy since no significant differences between two groups in the accuracy rates were found.

Accuracy in Facial Emotional Recognition Tasks

Most of the results demonstrated that ADHD individuals did have impairments in reading facial emotion with significantly higher error rates whether using static black-and-white photographs (Kats-Cold, Besser, & Priel, 2007; Williams et al., 2008, Sinzig, Morsch, & Lehmkuhl, 2008), static colorful photographs (Guyer et al., 2007, Boakes et al., 2008), static-contextualized version (Fonseca et al., 2009; Yuill & Lyon, 2007, Boakes et al., 2008) or dynamic-decontextualized and dynamic-contextualized versions (Boakes et al, 2008). Lee et al.'s (2009) study is one of few which failed to find this difference among Chinese ADHD subjects. However, the inconclusive results may be due to the fact the pictures the tasks used contained Asian faces and differences in facial emotion reading abilities between Asian and Caucasian groups even in the field of ADHD. This calls for further study.

By paper reviewing, it was suggested that HFA/AS group did not feature severe facial expressing reading impairments as we expected. Rather, individuals with HFA/AS only showed deficits in more subtle emotional detecting tasks. Among the 6 studies, 4 did not find differences between HFA/AS group and control group using either static or dynamic stimuli (Farran, Branson, & King, 2010; Miyahara et al., 2007; Wright et al., 2008; Katsyri et al., 2008) while the other 2 studies found some facial emotional recognition impairments by the utilization of more complicated and subtle emotional detecting tasks with stimuli of mixed intensities instead of 100% 'full blown' expression (Katsyri et al., 2008; Smith et al., 2010). By reviewing different studies with different group classification and subjects, we find that inconsistency in results may be due to that 1) most studies did not separate HFA and AS groups (Mazefsky & Oswald, 2006), 2) different performances between ASD+ADHD group and pure ASD group were not differentiated (Sinzig, Morsch, & Lehmkuhl, 2008) and 3) that heterogeneous groups existed within HFA/AS groups (Falkmer et al., 2010).

In summary, the HFA/AS groups out-performed the ADHD groups in the facial emotional recognition tasks since HFA/AS groups showed impairments only in complex tasks which needed the detection of subtle facial expressions, while ADHD groups showed deficits in more simple facial labeling tasks. This is in line with two comparison studies about the two groups' facial expression reading abilities. Studies by both Downs and Smith (2004) and Sinzig, Morsch and Lehmkuhl's (2008) found ADHD groups performed worse than HFA/AS groups. Furthermore, the results revealed that ADHD symptoms showed significant impacts on the facial emotional reading ability while PDD symptoms did not.

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Specific Emotional Subtypes Bias and Specific Facial Emotional Recognition Profiles

Although it seemed that the specific emotional subtypes bias were inconclusive, which may be due to the utilization of different basic emotional subtypes, generally speaking, ADHD groups showed negative emotion bias especially for the subtype of fear. However, contrary to the findings of Kars-Gold, Besser and Priel's (2007) study, most studies demonstrated that ADHD groups tended to confuse negative emotions with neutral emotions, which may be linked with behavior problems in individuals with ADHD, whilst not exaggerating negative emotions.

On the other hand, two studies pointed out that although HFA/AS groups had lower error rates for the happy subtype, they did show a smaller rate of happy face advantage compared to control groups (Miyahara et al., 2007; Wright et al., 2008). Furthermore, though higher error rates for the subtypes of fear and anger were pointed out in previous studies, it was suggested that they were both associated with the fact that HFA/AS individuals tended to have less eye contact when watching stimuli. In summary, the two groups show different emotional subtypes bias, the ADHD groups tend to have negative emotions bias and HFA/AS groups have lesser rates of happy face advantages.

Several studies have pointed out that 'weak central coherence' also affected the facial emotional recognition ability of HFA/AS individuals, which may be explain why HFA/AS individuals showed deficits in detecting subtle emotions (Katsyri et al., 2008; Fonseca & Deruelle, 2010). Moreover it was also revealed, by using eye tracking, that HFA/AS individuals tended to look less at the eye area and more at the mouth area in the information stage but look more at the mouth area (Boraston et al., 2008; Falkmer et al., 2010). These two findings formed the specific recognition profile of HFA/AS group.

On the other hand, the specific recognition profile of ADHD group, for example, what part of facial area information did individuals with ADHD tend to use, is still unknown and needs further study, this notwithstanding the findings that MPH may have positive impacts on the facial emotion recognition performances and the deficit was a specific social cognitive impairment rather than a general cognitive impairment. It has been noticed consistently that ADHD children tend to have less eye gaze or eye contact, possibly due to the inattention. It is also worth studying if less eye gaze is also significant in the process of facial emotion reading and specific emotion subtype bias.

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