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[Cognitive Processing of Stereotypes with ADHD]

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Abstract

Objective: To evaluate the performance of adults with ADHD on implicit and explicit stereotype tasks to investigate of automatic and higher order cognitive processing. **Method:** Participants with ADHD under the effect of stimulant medication (n=32) and without (n=23) and their performance was compared to the neurotypical control group (n=41). The clinical groups and the control group were comparable for age, gender and education. Automatic processing was assessed by the presence of stereotype bias on tasks. A word fragment completion task was used to assess implicit stereotyping tendency and impression formation followed by trait evaluation was used to assess explicit stereotyping. Automatic race categorisation of stimuli was also tested. **Results:** Performance of the clinical groups did not differ on the implicit stereotype task, explained by low prevalence of race categorisation, which was expected for the clinical groups, but a surprising finding for the NT group. There was no difference found between the performance of the three observed groups on the explicit stereotype task. **Conclusion:** The results suggest that adults with ADHD have impaired automatic processing but, as a result, they are not prone to apply stereotypes in their interpersonal relationships.

Key words: *ADHD, automatic process, implicit, explicit, stereotype*

Introduction

Adult ADHD was first recognised medically in the revised version of the Diagnostic and Statistical Manual of Mental Disorders (DSM) 3rd edition in 1987, although diagnosis for children was established previously in the second DSM in the 1960s. Once it was thought to affect only children and symptoms diminish through adolescence; however, there has been a growing body of evidence over the last decades of continuity into adulthood. Recent studies found a 50-80 per cent persistence rate from childhood to adulthood (Asherston, Buitelaar, Faraone & Rohde, 2016; Lara, et al., 2009; van Lieshout et al., 2016) and these results are consistent with the estimated presence of ADHD in adulthood, which is approximately 3 per cent, across the world (Simon, Czobor, Bálint, Mészáros & Bitter, 2009; Smith, 2017).

In the UK, the National Institute of Health and Clinical Excellence (NICE) released the first guidelines for adult ADHD in 2008 (National Institute for Health and Care Excellence, 2008), and with increasing awareness of the symptoms and available treatment, the number of adults with ADHD diagnosis is growing. ADHD is described as a childhood-onset neurodevelopmental disorder, although some children with high IQ might be able to mask their difficulties and others might have a supporting environment that compensates for their impairments, and only when this environment changes do the symptoms in full emerge and cause difficulty (Asherston et al., 2016). ADHD is a spectrum disorder, and there are three subtypes of ADHD: predominantly inattentive, hyperactive, and combined.

ADHD has an impact on all aspects of life; education, relationships, employment, social functioning. However, the exact nature of symptoms, the affected cognitive processes and the underlying neurological processes are still debated. In this study, three main models of ADHD are reviewed and in response to the growing recognition of affected automatic processing in ADHD in the last decade, these findings are also discussed. The existing literature contains overlapping concepts, therefore clarification is provided for how these are applied in this study.

First, the Inhibition Control model of ADHD is associated with Barkley's model (1997), where inhibition control deficit is the primary cause of symptoms and further cognitive impairments are the consequences of the primary deficit. The next model is the Functional Working Memory model of ADHD. It is based on Baddeley's Working Memory (WM) model (Baddeley & Hitch, 1974) where impairments of ADHD are investigated and described in terms of the components of this model, such as phonological loop, visuospatial sketchpad and the central executive. A third model is the Executive Function (EF) theory of ADHD, where symptoms are described in terms of the diverse components of EF that control cognitive performance. These concepts are discussed in further detail individually in the following chapters.

Behavioural Inhibition Deficit of ADHD

The medical model of adult ADHD describes the cognitive impairment of ADHD as difficulty maintaining attention and executive dysfunction, with the main impairment in inhibition control (American Psychiatric Association, 2013). The DSM-V reflects this view today, and in literature, Barkley's (1997) influential model provides further details and empirical evidence. Barkley's Hybrid Model of Executive Functions of ADHD (1997) defines behavioural inhibition as the primary deficit in ADHD and claims poor behavioural control as the underlying cause of the secondary impairments of further executive functions: working memory, emotional regulation, motivation, verbal fluency, and internalisation of speech. This model was developed, however, in the context of children in relation to developmental concepts. Further research into adults with ADHD also found evidence of the overall applicability of Barkley's (1997) model. The study by Boonstra Kooij, Oosterlaan, Sergeant and Buitelaar (2010) tested verbal and non-verbal fluency, planning, inhibition, set-shifting and working memory of a group of adults with ADHD and without. Researchers found that inhibition showed a large difference, whilst other domains of executive function showed no or

small differences between the ADHD and control group, in support of Barkley's theory. The tests included the Controlled Oral Word Association Test, Ruff Figural Fluency Test, Tower of London, Wisconsin Card Sorting Test, Change Task, WAIS Digit Span, and WAIS Letter and Number Sequencing Visual Memory Span. Inhibition tests included stop-signal reaction time, the Stroop Colour and Word Test, circle drawing test, and Change Task (Boonstra, et al., 2010). Another research project compared response times on the stop-signal task based on data from 33 studies and found that the ADHD and the control group did not differ in mean response time, but the ADHD group had longer stop-signal reaction time. The difference between these measures suggests impaired inhibitory motor control as the primary deficit in the adult ADHD population rather than attention deficit (Lijffijt, Kenemans, Verbaten & Engeland, 2005). Although these studies provide empirical evidence of the inhibition control model of ADHD, Barkley (2011) modified his proposed model with an emphasis on executive function impairment following the results of neuroscientific findings. Research in the field also changed direction, however the focus of the medical model remains on inhibition control deficit.

Functional Working Memory Model of ADHD

The Functional Working Memory (FWM) model of ADHD was described by Rapport and colleagues (2008) and is based on Baddeley's (Baddeley & Hitch, 1974) working memory (WM) model. Working memory is responsible for maintaining and manipulating information to support decision making. Information is received and provided by two subsystems, the phonological loop and the visuospatial sketchpad, to and from the central executive (CE) for controlled processing (Alderson, Kasper, Hudec & Patros, 2013). The FWM model implies that the primary deficit of ADHD is impaired working memory function, causing the symptoms of attention deficit, hyperactivity and impulsivity. Although this model was also developed based on childhood symptoms, there is evidence since of persistence of WM deficit into

adulthood; however, findings are inconsistent regarding affected modalities in individual studies. Some studies found no difference compared to normal controls on visuospatial WM tasks (Gu, Liu, Tannock & Woltering, 2018; Kim, Liu, Glizer, Tannock & Woltering, 2014), while in contrast, a meta-analytic review of 38 studies reported lower performance on a wide range of tests of both modalities for the clinical group in comparison to the control group (Alderson, et al., 2013). Common phonological loop tests in these studies are Letter-Number Sequencing (WAIS-III), and Digit Span Backward (WAIS-R) 2-Back task. Visuospatial ability tests include the Spatial Working Memory Test (CANTAB), Spatial Span Backward Task (WMS-R), and Complex Figure Task (LAMB). The inconsistent or occasionally contradicting original results of the individual studies included in the meta-analysis are explained by methodological variability (Alderson et al., 2013)

A recent study investigated the underlying neurological processes by analysing electrophysiological correlates (ERPs) (Stroux, et al., 2016). Participants in this study were tested using the N-Backward task and the result showed lower scores from the ADHD group compared to the control. Neurological observation revealed a deficit in interference control and also impaired updating function of WM on both modalities. In other words, the ADHD group had difficulty differentiating the stimuli from non-stimuli, blocking further manipulation of the carried information in the WM (Stroux et al., 2016). As interference control and updating are associated with CE functions, these results provide further evidence of deficient WM in ADHD. These studies propose impairment of both WM modalities, and the deficit of information processing in WM.

Executive Function Theory of ADHD

Although there is no differentiating definition of executive function (EF) and the central executive (CE) in literature, CE is used more commonly in experimental psychology and is based on Baddeley's model, whilst the term EF has origins in neuropsychology and is often associated with frontal lobe functions (McCabe, Roediger III, McDaniel, Balota & Hambrick 2010). An important structural difference is that CE is a function of the WM in Baddeley's model, whilst in neuropsychology, EF is the main construct and working memory is one of many functions of EF. Executive function generally refers to higher-order mechanisms that play a central role in goal-directed behaviour. The EF model assumes "top-down" cognitive processing, integrating and monitoring information to facilitate decision making and optimal action execution. The multiple function system includes, but is not limited to, response inhibition, monitoring and regulating performance, set-shifting, updating task demands, goal maintenance, planning, and working memory. Executive control requires conscious awareness and is more effortful than automatic processes (Diamond, 2013; McCabe, et al., 2010, Willcutt, Doyle, Nigg, Faraone & Pennington 2005).

The EF theory of ADHD emphasises impairment of higher-order processes, and although there is empirical evidence of impaired executive functions, there is inconsistency in the exact modalities affected (Matte, Rhode & Grevet, 2012). The meta-analysis by Wilcutt et al. (2005) cumulated data from 83 studies, investigated response inhibition, vigilance, set-shifting, planning, and verbal and spatial working memory. The most consistent and largest difference between the clinical and the control group was found in response inhibition and working memory. The ADHD group had lower performance on planning tests but this was inconsistent across the measures. Scores on the Tower of Hanoi test and the Porteus Mazes test were lower than on the Tower of London and the Rey-Osterreith complex figure tests. Difference in set-shifting, when tested with the Wisconsin Card test, was found to show the

least reliability to differentiate the clinical group from the control group. The conclusion of the analysis was the overall difference in all EF tasks was lower performance among the ADHD group, but the most affected domains are response inhibition, attention, WM, and planning. Response inhibition tests included the stop-signal reaction time and the continuous performance test commission errors. Working memory was tested using the digit backward test, WM sentence span, self-ordered pointing and spatial working memory test (CANTAB) (Willcutt et al., 2005).

Further notable findings were presented in a recent study by Bueno, Silva, Alves, Rodrigues, Louza and Pompéia (2017). First, in contrast to previous findings by Willcutt et al. (2005), Bueno et al. (2017) suggested shifting and access to long-term memory are the most affected executive functions in ADHD, but the clinical group performed as well as controls on updating, planning, and dual-task performance. These findings are based on the results of the plus-minus task, dual-task paradigm, zoo-map test, word fluency (initial letter task), and random number generation (RGN). It is worth noting that although the tests in this study are commonly used EF tests, they are different from those in the previously described meta-analysis. Another interesting finding of the study by Bueno et al. (2017) is the non-significant difference in inhibition control based on the stop-signal reaction time. This result is in contrast with previous findings of the meta-analysis by Lijffit et al. (2005) described above, where evidence of the behavioural inhibition model was supported by the response time difference on the same task. The EF theory of ADHD supports WM impairment in accordance with the Functional WM model but it extends the deficit with further EF functions including but not limited to inhibition control, set-shifting, planning and goal maintenance.

Further Cognitive Dysfunctions of ADHD

The models so far define ADHD in the context of higher-order functions and are supported by extensive empirical evidence in the existing literature. A small number of studies argue that the existing models do not fully explain the symptoms of ADHD and suggest that automatic processes are also dysfunctional. Impaired access to long-term memory was mentioned before, and further evidence was suggested by Skodzik, Holling and Petersen (2013) in their meta-analysis of twenty studies. Data from learning and memory tests were used to investigate cognitive abilities in ADHD, and results showed significantly lower performance of the clinical group on the verbal memory acquisition and free recall tests. Researchers interpreted the results as a deficit at the encoding stage of learning, resulting in long-term memory performance deficit. The verbal tests included commonly used list learning tests (AVLT, CVLT), recalling information from orally presented texts (paragraph subtest of LAMB), and a logical memory test (WMS-R). Visual learning tests required recreating previously presented abstract figures (ROCF, visual reproduction test WMS-R, and visual memory and learning test) (Skodzik, Holling & Pedersen, 2017).

Another perspective proposes the primary deficit in ADHD in automatic processing (Fabio, 2017). Fabio's (2017) model provides a detailed explanation of the construct, such as the impaired automaticity of basic processes using up valuable resources of the limited capacity system and disabling executive functions. It also means that impaired automatic processing is causing a high cognitive load, impairing complex cognitive functions. In conclusion, the low level of automaticity of processing also impairs new learning (Fabio, 2017). Fabio supported the model with results of his research investigating auditory and visual stimuli effects in ADHD (Fabio, Castriciano & Rondanini, 2015). The visual task included categorical and perceptual identification, and the audio task required participants to listen to an audio recording of letter-

number combinations (e.g.: D5, F3) followed by a test, where participants indicated whether the heard target was recognised as previously heard. The results showed no significant difference in the number of correct answers, but the ADHD group had higher error rates explained by delayed automaticity. Interestingly, a higher error rate in task completion of ADHD participants was also reported in previous studies (Ackerman, Anhalt, Holcomb & Dykman, 1986; Bueno et al., 2017).

Attentional functions in ADHD are investigated only in a low number of research projects. Ineffective allocation of attention was found to impair the encoding stage of working memory in a recent study (Kim et al., 2014). Participants were asked to complete a match-to-sample task on a computer, whilst EPR signals were recorded. Behavioural results showed lower response time of the ADHD group compared to controls, but there was no difference in response accuracy. Recorded ERP signals detected changes during the encoding stage and showed reduced function of attention allocation. Focused and sustained attention was also tested by the Amsterdam Neuropsychological task (ANT) and found deficit in sustained attention for those with ADHD, but not in focused attention.

As it is presented, there are several existing models and views on impaired cognitive functions with ADHD with inconsistent or occasionally contradicting results. Stereotyping research as part of social psychology has a long history of cognitive approach, theoretically and in experimental design (Fiske & Taylor, 2013). A brief description of cognitive processing of stereotypes is provided in the following section, highlighting the effects of those functions that were found to be impaired in ADHD.

Cognitive Process of Stereotypes

Attention, encoding, working memory, inhibition, controlled and automatic processing as components of the cognitive process of stereotyping has been extensively researched. Stereotypes are cognitive schemas of a group of people, linked with attributes associated with the group, and information stored in the long-term memory (Amodio, 2014). Stereotype content is learned through communication within the family, people in our environment and through education. The third important carrier of stereotypical information is the media which is also thought to have a strong influence on how individuals perceive others (Macrae, Stangor & Hewstone, 1996).

The cognitive approach of social psychology explains the cognitive process of stereotyping in stages. Identification of relevant information or selecting information is the first stage, followed by categorisation and characterisation. Categorisation is automatic, and activation of stereotype content is thought to follow categorisation automatically, although it has been proven to rely to some extent on working memory capacity. The stereotype content is forwarded for higher-order processing and results in stereotype application, or inhibition (Fiske & Taylor, 2013).

There is an overall agreement in the literature that categorisation happens inevitably in the presence of stimuli as a result of perception. Activation of the stereotype content is also an automatic process, however, in cases of low WM capacity, the content might not become activated (Fiske & Taylor 2013). A common procedure to reduce WM capacity in a controlled experimental environment is applying additional cognitive load by memorising a multi-digit number whilst performing the task or reducing attentional resources by completing an attention-demanding parallel task (Sherman, Macrae & Bodenhausen, 2000). Categorisation appears reliably under all conditions, but reduced WM capacity does not allow activation to

happen unless it appears as significant information – namely, it is required to complete the goal. (Bodenhausen, Todd & Richeson, 2009; Fiske & Taylor, 2013). WM memory capacity is also proven to influence stereotype application. In cases where stereotype content becomes activated, the lack of available resources at the application stage does not allow higher-order manipulation and results in a biased behavioural reaction. When there is available capacity, modification of automatic processing is available to adjust behaviour to the individual's motivation and to further information from the environment (Gilbert & Hixon, 1991; Sherman, Macrae & Bodenhausen, 2000).

Executive function and stereotyping

The role of executive function in stereotyping is associated with the ability to inhibit automatic responses. There is no agreement in the literature about the level of controllability of automatic stereotype biases. Some studies found evidence of strong behavioural bias as a result of implicit stereotypes (Moskowitz, Stone & Child, 2012), but explicit stereotyping depends on cognitive control; people try to alter stereotyped responses according to the social norms (Fiske & Taylor, 2013). Payne (2005) tested participants on the weapon identification task, IAT, and a word evaluation task to investigate the impact of executive functions and found that automatic stereotype activation appeared at the same level for both, high and low executive control groups, but the behavioural bias was more salient for those with poor EF. Scientists concluded that executive functions not only play an important role in controlled processing, but also in automatic processing (Payne, 2005). Recent research by Ito et al. (2015) provided similar conclusions from results of performance on the same tasks used by Payne (2005), although stereotype expression was reduced for those participants with higher levels of executive functions on both implicit and explicit tasks.

Attention and stereotyping

There are different approaches to the role of attention in the cognitive process of stereotyping. Payne (2005) conducted two experiments and found that participants with low attentional control were more biased in their responses than those with high control on both implicit and explicit task measures. Participants were tested on the weapon identification task, a word evaluation task, and an IAT for stereotype tendency and with the anti-saccade task as a measure of attentional control. Results suggested that selecting goal-relevant input and simultaneously avoiding the interference from additional information such as stereotype content has a critical role in the cognitive process of stereotyping. A more recent study by Ito and Tomelleri (2017) investigated how changing the focus of attention affects stereotyping and found that altered attentional focus lowered the stereotype bias and had a stronger effect on responses than the difference in attentional load. Participants were presented with racial face primes followed by a task to press a certain key on the computer if a gun or an insect appeared on the screen. In one trial the participants were asked at the beginning of the trial to determine the racial category of the stimulus. In the sequential trial, the instruction was to determine whether there was a dot on the stimulus picture or not. Biased responses were recorded in the racial categorisation trial, but when attention was diverted from the racial features to an independent feature such as the dot, responses were not affected by stereotype content (Ito & Tomelleri, 2017). In conclusion, these studies show that for the stereotype content to be activated, a certain level of attention is needed to be allocated to the stimuli, which might happen as a result of poor attention control to the task-relevant information, and also sufficient attention to stereotype features has to be allocated.

Social cognition and ADHD

The available literature on social cognition with ADHD is limited both in number and also to emotion and facial expression recognition. As in the case of other cognitive functions, the results of these experiments are also inconsistent. The recent study by Bisch et al., (2017) found impaired identification process of the ADHD group for the following facial expressions: neutral, happy, erotic, disgust, anger. During the test, a short video was presented to participants where an actor spoke a word with facial expression and intonation according to the target emotion. Researchers also collected data of attention lapses during the task, but no difference in attentional lapses was found between the ADHD and the control group. In addition, participants completed a sustained attention and alertness test and the analysis found a positive correlation between the attention test results and the performance on the emotion recognition task (Bisch et al., 2016). In contrast, another study tested emotion recognition through photos with facial expressions of anger, sadness, fear, and happiness, and found the ADHD-combined group had a lower overall error rate compared to the control group, whilst the ADHD-inattentive group had a higher overall error rate compared to the control group. Looking at each target emotion individually, recognition of fearful expressions showed impairment in both clinical groups, however the error rate was significantly higher for those in the inattentive group (Miller, Hanford, Fassbender, Duke & Schweitzer, 2011). Attention allocation in the context of social cognition was tested in the study by Petersen and Grahe (2012), investigating effective cue utilisation with several deceptive-truthful tests. Results revealed a difference between the ADHD and the control group, and also between the group of participants with ADHD taking stimulant medication and those without treatment. The ADHD group with no medication was found to assess too much information, relevant and irrelevant, whilst the group with stimulant medication showed better focus, but it was increased for both valid cues and distractors compared to the control group (Petersen & Grahe, 2012). Top-down

attentional control dysfunction was also found in a visual experiment with children, in a task in which the ADHD group performed as well as controls on the discrimination difficulty test to tell apart a woman's face or an ape's face from morphed variations, but the ADHD group was significantly slower when distractors around the target picture were introduced (Friedman-Hill, et al., 2010).

This study aims to investigate the presence of stereotype bias and so to observe cognitive processing with ADHD. The three main models of ADHD define the disorder with impaired higher order processes such as response inhibition, working memory and executive functions, all of which were shown to increase stereotype bias in previous studies with neurotypical participants. As it was described before, without executive control, the bottom-up stereotype information impacts the response selection process (Gilbert & Hixon, 1991; Sherman, Macrae & Bodenhausen, 2000). On the contrary, if automatic processing is delayed or impaired in ADHD, stereotype content does not impact the response. In the current study, automatic and higher order processing is tested via an implicit stereotype task, race categorisation test and an explicit stereotype task, as developed and described by Gilbert and Hixon (1991). The implicit stereotype task enables comparison of automatic activation of stereotype content between groups, and in addition, the categorisation test shows if the perceptual cues of the subconscious stimuli were attended. The explicit stereotype task intends to investigate if the performance of the clinical groups reflect deficit of executive control which would be supported by high stereotype bias, or in contrast, a low stereotype bias result supports impaired automatic processing.

Stimulant medication has been shown to improve cognitive abilities in most cases. On task performance it was shown to improve inhibition, attentiveness, reduced errors and reaction time (Boonstra, Kooij, Oosterlaan, Sergeant & Buitelaar, 2007). These results are

supported by neuroimaging results of children, fMRI studies shown that stimulant medication normalized brain activation patterns and improved functional cognition (Schweren, de Zeeuw & Durston, 2013). Therefore, participants with ADHD were divided to two groups, with and without stimulant medication treatment (ADHD and ADHDmed).

First, we hypothesised that:

1.1 Participants in the NT group will generate more stereotype consistent words when exposed to the Asian stimuli, but participants in the ADHD and ADHDmed groups would not, due to impaired automatic processing;

1.2 And, the race categorisation test provides information about basic perceptual processing, and consequently, both ADHD groups are expected to underperform the control group on the test.

Hypothesis 2 is that participants with ADHD are expected to have similarly low scores on the explicit stereotype task compared to controls due to delayed automatic processing. The interpretation of the no difference result is that normal participants have the cognitive capacity to inhibit explicit stereotype bias to conform social norms; however, for the ADHD participants with executive function deficit, the low stereotype bias is the result of impaired automatic processing.

Method

Participants

The target group was established with consideration of the stereotype content. Stereotypes are considered culture-specific where education and mass media are important transmitters therefore no race-specific exclusion is applied for UK citizens. The aim of the study is to observe if there are differences between participants with ADHD and neurotypicals. In conclusion, UK residents over 18 were invited to participate with and without ADHD. Social media was used for recruitment, via the researcher's own account and via ADHD peer-support groups, following approval from group administrators. Data of participants' racial background was collected for further analysis, however, all participants identified themselves as Caucasian UK residents. A total of 97 participants were recruited, 27 male, 67 female and 3 non-binary individuals. Some information about the study was provided in the invitation, including a link to the online survey.

Materials and Measures

Organisational difficulties and timekeeping are the main symptoms affecting adults with ADHD; attending laboratory appointments might cause extra stress, therefore an experimental design was planned to accommodate participation in the individuals' own environment. An online survey was therefore designed. A modified version of two tasks developed and described by Gilbert and Hixon (1991) was applied in this study. These tasks measured implicit and explicit stereotypes, categorisation and stereotype application. Although the original experiment was conducted in a controlled laboratory environment, both the word-fragment task and the impression formation task were appropriate for online distribution (Koopman, Howe, Johnson, Tan and Chang, 2013; Tanis & Postmes 2003).

Unfortunately, full description of the tasks was not available as the recording keeping deadline expired, however the published study contained sufficient details for replication.

Word fragment task as implicit stereotype measure

Word fragment-tasks are widely used implicit stereotype measures, where priming is used to automatically activate the schema content and influence the respondent when generating words. Participants were instructed to write the words as quickly as they can. Gilbert and Hixon (1991) described a video clip where an Asian or a Caucasian woman presented the word fragments. In the present study, the word fragments were placed in a thought-bubble on a photo of a woman close to the face, with blue coloured fonts. Video was replaced with photo, as the dynamic video might contain more distractor elements than the still photo. A further advantage of applying the photo in this task is being able to present the stimuli in the participants' visual periphery whilst writing down the words. In practice, participants clicked "continue" on one page, when the new word-fragment appeared with the stimuli; physical movement only had to change from the "enter" button to the keys according to the letter to type the word. Eye-gaze moved from left to right, namely from the picture on the right to the textbox on the left, and "continue" button right below the textbox. Each word fragment was presented on a separate screen. The photo was placed in a large format on the left side of the screen and the text box on the right. Each page was developed to contain the instruction, the picture, the textbox and the button to proceed to the next page on one screen without additional activity to scroll down, to avoid extra working memory load and/or distraction. The task has a 2x2 design, the control and the ADHD group were randomly allocated to either to the Asian or the Caucasian condition.

Five stereotype words and fourteen fillers were used in the task, but due to an experimental error, only four of the five words were included in the analysis. The critical words were *shy, rice*, *polite* and *short*; presented in the following fragments: S_Y, RI_E, POLI_E, S_ORT. Critical words were placed individually among the fillers. Participants were instructed to write the words that come to mind as quickly as they can and go to the next one when they cannot think a word immediately.

Word fragment completion task was shown to be less dependent on frontal lobe functions than word stem completion (Winocur, Moscovitch and Stuss, 1996) and the difficulty of completion depends on where the blank space is placed within the word, the more letters given at the beginning, the easier to use recognition rather than complex cognitive processes. It is also the case with the number of missing letters, the more blanks in the word fragment increase the effort to think of a matching word (Koopman, et al., 2013). The critical words in this task are short words, with only one letter missing, and the first letter is given, therefore completing them does not require additional cognitive processing, which might affect the performance of the ADHD group. Filler words were also developed to fill these requirements, e.g.: C_B, ME_T, SHA_ _ (see detailed description of the task in Appendix A, and online source of the stimuli in Appendix C and D).

Impression formation task as explicit stereotype measure

The task presented a description of an average day of a woman, in the morning, going to work and how she spends time after work, illustrated with pictures. Participants were asked to imagine the person who was describing her day whilst reading the passage, and continue to the next page, where they were asked to rate the person they read about on 9 different traits. Details and events of the day in the description were kept culture neutral. The same description was presented in both conditions, only the visual cues ensured cultural association. Four pictures of everyday scenes from Asian or Caucasian culture were

presented to each paragraph of the description. The first picture showed breakfast associated with the culture (beginning of the day), second picture a busy metro scene (on the way to work), third, a work scene with multiple people (work life), and lastly a busy town centre scene (leisure time). Participants were instructed to imagine the person whilst reading, and on the next screen to rate the person on nine traits using an 11- point Likert scale, e. g.: *She is….* *not very timid* on one end of the scale and *very timid person* on the other end, or *not very intelligent* versus *very intelligent person*, and so on. Five out of the nine traits are synonyms of the target group (timid, intelligent, calm, composed, aloof) and four traits are antonyms (sociable, friendly, happy, conversational). The high number of scale points allows detection of fine differences in stereotyping tendency.

The activation phase in the original study is an audio record where the woman from the word fragment task describes a day of her life, and it is different from the present study. The modification was introduced for the following reasons. In the case of the auditory content in the online survey the task would require switching between sensory modalities between tasks and also within the task, the stimuli source and reaction execution, i.e., between hearing the information and reading the trait evaluation and selecting rating. To simplify cognitive processing, visual stimuli was used in this task instead of audio. Content of the text of the impression formation was developed based on an online resource extended to a similar length to that in the original study of 90 seconds when reading out loud.

Another important difference is reinforcing the stereotype activation by including photos in the written material (Adaval, Isbell & Wyer Jr, 2007). The aim of the Gilbert and Hixon (1991) study was to investigate how cognitive load affects the activation of stereotype content at different stages of stereotyping, therefore in the original study applied implicit priming was only at the first task, and the second task aimed to measure if reduced cognitive capacity resulted in heuristic associations in explicit stereotyping. Results showed that

priming only biased the responses of the group with no cognitive load at the activation phase. In this study the dysfunction of attention allocation might impair the stereotype activation for the clinical group in the word fragment task. Therefore, to measure explicit stereotype application, a second activation phase was introduced with the culture-specific photos. Only copyright-free photos were used in the survey (see detailed description of the task in Appendix B, and online source of the stimuli in Appendix C and D).

Categorisation test

At the end of the survey participants were asked to answer a question about the race of the woman in the photos on the word fragment task, and the colour of font the words were typed in. Correct answer to both questions shows that some attention to the person on the picture and to the colour of the fonts was allocated. Whilst the colour of the font is clear visual information, race perception was shown to be an automatic categorisation and also to automatically activate stereotype content (Fiske & Taylor, 2013; Gilbert & Hixon, 1991; Ito & Tomelleri, 2017).

Manipulation check

To test if the implicit priming remained covert, at the end of the survey participants were asked to describe with their own words what they thought the aim of the study was. The answers reflected unawareness about the stereotype content of the study.

Tasks were self-paced to reduce the effect of time restrictions on working memory for ADHD participants, however, overall completion time of the survey was recorded to compare group performance (Kim, et al., 2014). Word fragment task is an effective implicit measure without timing (Nelson, 2009) and explicit measures are widely used self-paced measures.

Adult ADHD Self-Report Scale (ASRS-v1.1) Symptom Checklist

In the UK, information about the diagnosis of adult ADHD was first released in the NICE guidelines in 2008, and the number of diagnosed adults is still only a fraction of the estimated prevalence in the population. The ADHD and non-ADHD group were allocated based on self-report of existing diagnosis, however, to ensure that participants without awareness of their symptoms are not included in the non-ADHD group, questions from the self-report scale were included in the survey. The questions ask how often individuals have trouble finishing projects, remembering appointments, delaying to start complex tasks and being overly active. The scale is a two-part questionnaire of 18 questions, with the first six questions showing high correlation with ADHD diagnosis, and a further twelve provide additional information of struggles for health professionals (Kessler et al., 2005). Therefore in this study, Part A of the scale was used to screen participants with no official diagnosis of ADHD.

The allocation to the observed groups was based on self-report of diagnosis. Data were also collected about medication status, comorbidities, gender and level of education.

Procedure

Jisc Online Surveys software was used to develop and distribute the online survey. The software complies with data protection and regulations for secure data handling. An online invitation on social media contained a link and directed participants straight to the online survey, beginning with the information sheet and agreement with participation and data handling.

Demographic questions and questions to identify group allocation were placed at the beginning of the survey. The effect of questions about the mental health status of participants on performance was considered during the development of the design, however, previous

research has shown a better completion rate of demographic questions when they were placed at the beginning of the survey rather than at the end without affecting response rate (Teclaw, Price & Osatuke, 2012). Therefore, in consideration of the significance of the information gained from these questions, they were included at the beginning. The questions included gender, age, level of education, ADHD diagnosis and medication status and additional mental health diagnosis. According to the self-report, participants were allocated to one of the three observed groups (ADHD, ADHDmed, NT) and participants of each group were allocated to a condition (Asian or Caucasian). Allocation to condition was based on their answer to a binary question (e.g.: if the day the participant was born was an odd or an even number). In both conditions this question was followed by the word fragment task and the impression formation task, with stimuli according to the condition. At the end, all participants filled in the Adult ADHD self-report scale, followed by the categorisation test, manipulation check (question about the aim of the study), and their racial and national identity. On the last screen participants were thanked for their participation and debriefed.

The research was approved by the University of Glasgow's School of Education Ethics Committee prior to the data collection in accordance with the British Psychological Society (BPS) Code of Conduct. See the copy of the approval letter of the Ethical Committee in Appendix D, and copy of the online consent form in Appendix E.

Results

Data Preparation

All participants completed the survey from the beginning to the end and provided sufficient data for analysis (n= 97). The clinical groups and the control group were comparable for age, gender and education, details of group characteristics are provided in Table 1. Participants were divided into three groups: participants with ADHD with regular stimulant medication use (ADHDmed, n=32), participants with ADHD but without stimulant medication (ADHD, n=23) and neurotypical control group (NT, n= 41). Participants of each group were allocated either to the Asian or the Caucasian condition. Part A of the ADHD self-report scale was a screening tool to screen for ADHD symptoms among NT participants, all results were under the ADHD threshold. Results of the manipulation check indicated that participants were not aware of the stereotype content.

Implicit stereotype bias was measured by the WFC task: each stereotype word equals 1 score and the sum of scores was calculated for each participant. Responses varied from typing only the missing letter to one word and multiple word completions (e.g. responses for S_Y: “h”, “shy”, “sly”, “shy, sly, soy, spy”). In the case of multiple word completions, the first word was included in the analyses. No spelling mistakes were found within the critical words. Results of the explicit stereotype task were evaluated as follows: first, the scores of the four antonym traits were reverse coded, then the nine rating scores were added up and averaged for each participant to calculate a “stereotypic perception index”. The data from each task was tested for normality by the Shapiro-Wilk test and homoscedasticity was tested by Levene’s test, and in the case of the impression formation task and the completion time, the data met all assumptions for ANOVA. Results of the WFC failed the normality test,

however, ANOVA was used to analyse the data as it was shown to be robust in the case of non-normally distributed data (Blanca, Alarcón, Arnau, Bono & Bendayan, 2017; Khan & Rayner, 2003). Independent two-way ANOVAs were used to investigate group differences in the performance of the implicit and explicit stereotype tasks, and one-way ANOVA to test the completion time differences. Detailed results are presented in Table 2.

Table 2.

ANOVA Test Results

DV		*df*	*F*	*p*	η^2
Implicit stereotype task	Group	2	0.41	.66	.01
	Condition	1	1.67	.20	.02
	Group x condition	2	1.11	.33	.02
Explicit stereotype task	Group	2	0.26	.77	.01
	Condition	1	1.21	.27	.01
	Group x condition	2	0.32	.73	.01
Completion time	Group	2	2.37	.10	.05

Note: Significance level: $p<0.05$., DV= dependent variable; Group: ADHD, ADHDmed and NT; Condition: Asian and Caucasian.

Data Analysis

The first hypothesis expected first that the (1.1) participants of the NT group would have higher scores in the Asian condition than in the Caucasian condition on the WFC task, but that the ADHD and ADHDmed groups would not, and second (B), that the NT group would have high scores on the categorisation test whilst the ADHD and the ADHDmed groups would have lower scores. In order to test the first hypothesis for part A, the sum of scores of stereotype consistent completion of the four critical words was compared a 3(ADHD, ADHDmed, NT) x 2(condition) ANOVA. There was no significant effect found of group [$F(2, 91) = 0.41$, $p = .66$, $\eta^2 = .01$] or condition [$F(1, 91) = 1.67$, $p = 0.20$, $\eta^2 = .02$], and no significant interaction was found [$F(2, 91) = 1.11$, $p = 0.33$, $\eta^2 = .02$]. These results show that the number of generated words did not differ between the ADHD, ADHDmed and NT groups, within each condition, and did not differ between the Asian and Caucasian condition. The hypothesis that people with ADHD generate less stereotype consistent words than neurotypicals is not confirmed.

In order to test hypothesis 1.2, a Chi-square test of independence was performed to examine the relationship between categorisation and the groups. There was no significant relation between the groups [X^2 (2, N=97) = 3.69, p = .158]. This means that group membership and thus ADHD, does not impact categorisation. The result does not support the hypothesis. The percentage of correct race identification for each group is shown in Table 3. Although the Chi-square test did not show independence of groups, the ADHD group had the lowest performance on the categorisation test, and the ADHDmed group had a slightly better but still low result. Unexpectedly, the prevalence of categorisation among participants in the NT group was also low. For further investigation, the percentage was also calculated for each condition and results revealed a different level of categorisation between conditions for those in the ADHD and the NT groups, but not for the ADHDmed group as it is shown in Table 3.

The group sizes in condition division did not provide sufficient data to conduct a Chi-square test.

Table 3.

Percentage of Participants Performed Race Categorisation

	Condition		Difference	Cumulated
Group	Caucasian	Asian		
ADHD	46,15 %	20,00%	34,78%	26,15%
ADHDmed	53,33%	52,94%	53,13%	0,39%
NT	78,95%	43,48%	59,52%	35,47%

Note: ADHD= ADHD group without prescribed stimulant medication, ADHDmed = ADHD group with regular stimulant medication use, NT = neurotypical group.

Hypothesis 2 was that the clinical groups will have low scores in the Asian condition as well as in the Caucasian condition, similar to the NT group. In order to test the second hypothesis, the calculated stereotype perception indexes were compared in a 3 x 2 ANOVA with observed groups (ADHD, ADHDmed and NT) and condition (Asian and Caucasian) as between-subject factors. There was no significant effect of group [$F(2, 91) = .26$, $p = .77$, $\eta^2 = .01$] or condition [$F(1, 91) = 1.21$, $p = .27$, $\eta^2 = .01$], and no significant effect of interaction was found [$F(2, 91) = .32$, $p = .73$, $\eta^2 = .01$]. These results show that the participants in the ADHD, ADHDmed and the NT groups did not have higher stereotypic ratings in the Asian condition than in the Caucasian condition. The results supported the hypothesis that patients with ADHD, with prescribed stimulant medication and without, are no different to neurotypical participants when performing this task.

The start and completion times of the survey were collected, and the length of time between the two sets of data was analysed as completion time. The completion time was expected to be between 10-15 mins. Data from participants with longer than 25 mins completion time was removed as these participants were outliers. After the outliers were removed, data were analysed with one-way ANOVA test to compare group results of the ADHD, ADHDmed and NT groups. The analysis indicated that there was no significant effect of group [F (2, 87) = 2.37, p = .10, η^2 = .05] on length of time. The results show that it took as much time for the ADHD and the ADHDmed groups than the NT group to complete the survey.

Discussion

This study investigated the cognitive functions of implicit and explicit stereotyping in adults with ADHD. ADHD participants were divided into two groups according to stimulant medication status and their task performance was compared to neurotypical controls. Word fragment completion task with implicit priming aimed to detect differences of implicit stereotyping and impression formation followed by a trait evaluation task which was used to investigate explicit stereotype bias of the participants. Neither the implicit or the explicit measure revealed a difference between the performance of the two clinical groups (ADHD and ADHDmed) and the controls. The ADHD and ADHDmed groups were expected to have lower scores than controls on the implicit stereotype task as a result of the deficit in automatic processes and so race categorisation and activation of the stereotype content is deflated. Surprisingly, the results show no implicit stereotype bias for all three groups and no significant difference in performance was observed. Thus, the first hypothesis of the current study is rejected. The second hypothesis predicted that both ADHD groups would perform as low as the controls on the explicit stereotype task as a result of impaired automatic processing. The second hypothesis was supported by the results and consistent with the literature on impaired automatic processing in ADHD.

Implicit Stereotyping and Race Categorisation

Word fragment task with visual priming aimed to test implicit stereotyping. Participants of the NT group were expected to generate more stereotype consistent words following the Asian priming than the Caucasian, whilst the ADHD and the ADHDmed groups were expected to have no difference in scores in the two conditions due to impaired automatic processing. The ADHD and the ADHDmed groups did not generate more

stereotype consistent words in the ASIAN condition than in the Caucasian, and this outcome supports the hypothesis and corroborates the results of the cognitively loaded group in the study by Gilbert and Hixon (1991). The unexpected result is that the number of generated stereotypic words of the NT group did not differ between the conditions, similar to the clinical groups. This is in contrast to the previous finding where participants with free cognitive capacity produced higher scores in the Asian condition than in the Caucasian condition (Gilbert & Hixon, 1991). As it is shown in Table 4. there is a slight difference between the group means. Participants in the ADHD group generated slightly higher scores in the Caucasian condition than in the Asian condition whilst the scores of the NT group and the ADHDmed group did not differ between the Asian condition and the Caucasian condition, but the difference did not reach a significant level.

The categorisation test might explain the unexpected results of the word fragment task. Surprisingly, only 60% of the NT group selected the correct race of the prime and it is even lower in the Asian condition, 43%. The ADHD group scored the lowest, 35% overall had the correct answer and 20% for the Asian prime, and the ADHDmed group provided an overall 53% correct answers in both conditions. The difference of correct race categorisations between conditions is explained by the Own Race Bias (Levin, 1996) and showed robust replicability (Brown, Uncapher, Chow, Eberhardt, Wagner, 2017; Ge et al., 2009; Lovén et al., 2012); however, it is present for the ADHD and the NT groups, but not the ADHDmed group. Categorisation in the normal population was proven to be automatic and inevitable in previous studies (Gilbert & Hixon, 1991; Ito & Tomelleri, 2017; Steele, George, Cease, Fabry & Schlosser, 2018); however, the low number of correct answers on the categorisation task in the present study does not support these findings.

The poor performance on the categorisation task for the ADHD and the ADHDmed group is supported by the ADHD literature; categorisation was found to be impaired in children with

ADHD previously (Fabio, Castriciano & Rondanini, 2015), and was found to be caused by impaired access to long-term memory by Bueno et al. (2017). In the absence of categorisation, no bias could be expected on the word fragment task. Petersen and Grahe (2012) also found that cue utilisation was impaired for those with ADHD due to dysfunctional attention allocation, and the present results are consistent with those findings.

The poor performance of the NT group on the categorisation task is inconsistent with previous literature. Race categorisation was found to happen automatically in the presence of stimuli in the study by Gilbert and Hixon (1991) and supported by further literature (Bodehausen, Todd, Richeson, 2009; Fiske & Taylor, 2013). Only assumptions could be made for the absence of race categorisation for the NT group. The experiment by Ito and Tomelleri (2017) demonstrated that the focus of attention has a stronger effect than cognitive load on stereotype activation, and although all efforts were made to ensure attention is paid to racial features during the development of the present design, participants in the NT group might have reduced their focus of attention to the actual word-fragments and avoided the picture as a distractor. Although Ito and Tomelleri (2017) reported the presence of categorisation even for those with altered attentional focus, their observations are based on the results of the IAT test, and categorisation was tested right after the presentation of the stimuli, whilst in the present study there were several tasks between the stimuli and the categorisation test; therefore, the difference might be caused by the short term memory use in the previous study and long term memory use in the current study for the categorisation test. The categorisation was also shown to be dependent on attention to the association-relevant stimulus by Gawronski, Deutsch, LeBel and Peters (2008). Thus, if the word fragments did not indicate an implicit association with the picture, attention was diverted from it and no stimulus information entered to the working memory for computation. Stereotype content

cannot occur in the absence of categorisation, therefore the low performance of the NT group on the categorisation task resulted in low stereotype bias on the word fragment task.

The evaluation process of the completed word fragments highlighted an unexpected pattern. One of the critical fragments was S_Y and the expected stereotype consistent completion was SHY, however, there were a higher number of completions for SOY across the groups than SHY. Also, whilst SHY appeared in both conditions, SOY only appeared in the Asian condition and none in the Caucasian condition. Soy sauce has Eastern Asian origin (Luh, 1995), and it is also a commonly used condiment in Chinese cuisine in the UK. Therefore, the SOY completions in the Asian condition and the absence of it in the Caucasian condition could be evaluated as implicit stereotyping. This also suggests the effectiveness of the visual priming, but the low frequency of the expected stereotype associative completions suggests the word fragments might have low stereotype content.

In conclusion, there was no difference found between the groups in implicit stereotype bias and no difference in race categorisation, therefore the hypothesis of the present study is rejected.

There were spelling mistakes noted, however only a low number, with similar frequency across groups. The majority of the participants provided a one-word response for each fragment, but there were also a low number of multiple words and missing letter responses, both evenly distributed in all observed groups. There was also no difference in common and non-common word use among groups when comparing the completion of the filler fragments. Data of commonality of words were extracted from the British National Corpus, distributed by the University of Oxford on behalf of the BNC Consortium.

Explicit Stereotyping

As expected, there was no significant difference found in the explicit stereotype task performance between groups and conditions, therefore, the second hypothesis is confirmed. Participants in the ADHD, ADHDmed and the NT groups rated the target similarly on the nine traits in both conditions. This result suggests that people with ADHD are no more prone to be biased by stereotypes in their interpersonal contacts than neurotypical peers due to reduced access to stereotype content in long-term memory. Although the result shows no difference between stereotype bias of the groups, this might be achieved through different cognitive processing for the two clinical and the NT groups. In neurotypical groups, cognitive control is used to suppress unwanted bias to enable individuation and to conform to social norms (Fiske & Taylor, 2013). With intact executive functions and available WM capacity, the NT group in the present study is expected to be able to inhibit the automatic stereotype bias, as it is reflected in the result.

The low stereotype bias of the clinical groups is an interesting finding if the effect of the impaired executive control and working memory on stereotype bias is considered. In the present experiment participants did not perform in accordance to the impaired executive functions and WM capacity, but more in support of the impaired automatic processing. Previously, healthy participants with a lower level of executive functioning showed more stereotype bias in their responses (Ito et al., 2015; Payne, 2005). Reduced working memory capacity also increases the influence of stereotypes (Gilbert & Hixon, 1991, Wigboldus, Sherman, Franzese & van Knippenberg, 2004) and inhibitory control was also found to negatively correlate with stereotype bias (von Hippel, Silver & Lynch 2000). However, the results of the clinical groups in the current study are in contrast to these findings. The deficit of higher-order processing in ADHD has robust empirical evidence in the literature, thus the

current results of no stereotype bias support the assumption that not only controlled, but automatic processing is also affected in ADHD in accordance with the findings of Fabio (2017) and Bueno et al. (2017). The low performance of the ADHD and ADHDmed groups is also consistent with the findings of impaired cue utilisation of visual stimulus by Petersen and Grahe (2012). Impaired access to long-term memory was also shown in the study by Kim et al. (2014) where the ERP signal analysis showed impaired information encoding in memory. As stereotype content is stored in the long-term memory, the result of the current study supports the literature of deficit in automatic processing in ADHD

Completion Time

The average time to complete the survey was also compared: the ADHD, ADHDmed and NT groups had no difference in the overall completion time after outliers were removed. Outliers were participants with completion time that reflected a length of leaving the survey and returning at a later time. Six out of the seven outliers were from the ADHD group, in accordance with the basic symptoms of ADHD, such as distractibility and impaired inhibition control which was shown to improve with medication (DSM-V). The existing literature in ADHD reports reaction time of participants. There is a lack of self-paced performance tests reported, therefore it is difficult to compare our results to previous observations. Whilst the present study did not find a difference between the groups, the other self-paced study by Kim et al. (2014) also recorded completion times and reported that ADHD participants were overall quicker to complete the tests than the control group in a controlled experimental environment. Previous studies comparing reaction time reported inconsistent results. A slower response time of the ADHD group was reported in the meta-analysis by Lijffit et al. (2005); however, no difference was found in reaction time by Bueno et al. (2017).

Conclusion

This study aimed to provide further information about cognitive processing of stereotypes with ADHD, investigating the presence of implicit and explicit stereotype bias via an online survey. The first hypothesis of this study was that the ADHD and the ADHDmed groups show lower stereotype bias than the control group on the implicit stereotype task because the ADHD group fails to perform the race categorisation. The results showed no difference between groups on the categorisation and implicit stereotype task, therefore, the first assumption is not supported. Although the ADHD and the ADHDmed group showed low stereotype bias on the word fragment task and as expected, the number of correct responses on the categorisation task was also low, the results of the NT group were similarly low. The assumption is that whilst the performance of the groups was similar, the cognitive processing was different. The low performance of the ADHD and ADHDmed groups was the result of impaired automatic processing, whilst the NT group was able to focus attentional resources exclusively on the word fragment and filtered out the priming stimulus as a distractor and thereby, eliminating race perception and activation of stereotype content. Explicit stereotyping tendency was also investigated with the assumption that the clinical groups show low stereotype bias similar to the control group on the explicit stereotype measure due to the impaired automatic processing.

The second hypothesis was confirmed: the results of the trait evaluation task showed no significant difference between groups and conditions. This no result is significant when looking at the role of automatic and controlled processes on stereotype bias. Impaired cognitive control enables automatic processes to influence thoughts and behaviour, therefore, if only higher-order processing would be dysfunctional in ADHD and automatic processing was intact, the clinical groups were expected to show higher stereotype bias. As the clinical

groups did not show stereotype bias despite the impaired cognitive control, the result supports the assumption of deficit in automatic processing for those with ADHD.

Overall, the performance of participants with ADHD regardless of medication status was no different to neurotypical participants on stereotype tasks and length of survey completion. The contribution to the existing literature is that these experiments confirmed that not only higher-order cognitive processes, but automatic processing is also affected by ADHD. The behavioural interpretation of the results indicates that the cognitive impairments of ADHD do not increase stereotype bias when making judgments of others, and there is a possibility that cognition with ADHD is less contaminated by stereotypes than for neurotypicals.

The results are promising but some precautions need to be considered. The experimental design was developed by Gilbert and Hixon in 1991, stereotype associative words and traits were selected based on pre-test results prior to the original study. Although an online frequency search of word-combinations was carried out to evaluate their relevance today, this might not reflect common stereotype value of the words which can have a significant impact on the results, as it might be the case of the WFC task. A further limitation of the current research is the unbalanced size of the observed groups, which could impact the comparability of group performance and thus the outcome. Although the Type 3 ANOVA is appropriate analysis for unequal sample sizes, the number of participants in the ADHD group in the two conditions is lower than the recommended size in the original study (Gilbert & Hixon). The effect size of each analysis is small; therefore, the observations cannot be generalised. Lastly, the simplicity of the experimental tasks is as much a limitation as a strength. The present design enables to investigate automatic and controlled cognitive processing but does not provide sufficient information to differentiate between the underlying

mechanisms such as if it is caused by impaired attentional resources, memory or any other function.

The research project also has several strengths. The online distribution via peer support groups enabled a wider population of people with ADHD to be reached than would be the case with recruitment via medical professionals, hence the demographic factors (age, gender, level of education, additional mental health conditions) are comparable between participants with ADHD and healthy controls with the sampling method. The online survey also enabled participants to complete the tasks in their usual environment and so possibly reduced or eliminated the negative stereotype threat effect which might be more prevalent in a controlled environment.

The current study generates further questions about how stereotypes are processed with ADHD. First observations needed with further implicit and explicit measures with improved validity. Future studies may benefit from more specific tasks to identify which cognitive function caused the behaviour. The present results also indicate that investigation of individuation and processing of stereotype inconsistent information for those with ADHD might provide significant findings.

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Supplemental Materials

Table 1.

Sample Characteristic

Group		n	Gender			Age			Education				+ MH
			F	M	N.D.	18-30	31-50	50-70	GCSE/A -Level	H. E.	Graduate	PG Edu.	
ADHD	n	23	14	8	1	5	15	3	4	6	6	7	7
	%		60.9%	34.8%	4.3%	21.7%	65.2%	13.0%	17.4%	26.1%	26.6%	30.4%	30.4%
ADHDmed	n	32	23	8	1	8	17	7	4	3	14	10	5
	%		71.9%	25.0%	3.1%	25.0%	53.1%	21.9%	12.9%	9.7%	45.2%	32.3%	15.6%
NT	n	41	30	11	1	24	15	3	4	3	15	20	5
	%		71.4%	26.2%	2.4%	57.1%	35.7%	7.1%	9.5%	7.1%	35.7%	47.6%	11.9%
Total	n	95	67	27	3	37	47	13	12	12	35	37	17

Note. ADHD= ADHD group without prescribed stimulant medication, ADHDmed = ADHD group with regular stimulant medication use, NT = neurotypical group. F= Female, M = Male, N. D. = Not disclosed. H. E. = Higher education, Graduate = University Degree, P. G. Edu. = Postgraduate education, + MH = Additional mental health condition

Table 4.

Group Means and Standard Deviation of Independent Variables

Measure	ADHD				ADHDmed				NT			
	Asian		Caucasian		Asian		Caucasian		Asian		Caucasian	
	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD
Implicit	0.70	0.48	1.15	0.55	0.94	0.75	1.13	0.74	1.13	0.69	1.05	0.78
Explicit	5.92	1.10	5.85	0.82	6.01	1.30	5.84	0.79	6.29	0.83	5.82	1.26
Time (sec)	686.6			333.0	545.8			190.3	538.5			261.7

Note. Mean and standard deviation of time is overall group level; ADHD= ADHD group without prescribed stimulant medication, ADHDmed = ADHD group with regular stimulant medication use, NT = neurotypical group/control; Implicit: implicit stereotype task, Explicit: explicit stereotype task.

Appendices

Appendix A

Word Fragment Completion Task

Stimuli – each word fragment was inserted into the thought bubble on separate pages

Asian

Caucasian

Critical words and stereotype consistent completion (Gilbert and Hixon, 1991)

S_Y	Shy,	RI_E	Rice,
POLI_E	Polite,	S_ORT	Short

Fillers

C_B	CAR_	HA_D
_OG	_EAN	SHA _ _
B_D	_OLD	QUI_ _
	ME_T	P_INT
	P_CK	S_ART
	BA_K	

Appendix B

Explicit Stereotype Task

Impression formation text (developed by the author of the current study)

"I get up at 7 am, I have breakfast. Some days I eat toast with milk, sometimes I eat something more traditional. In the morning I water my plants and give my pets something to eat too. I have a dog, a rabbit and a pair of birds. Then I get ready for work. I go to work by subway, it's faster, on time and cheaper, no traffic jam. Once I went to work by taxi, and I was late by about 30 min. The traffic is horrible, subways are best, although it gets very crowded in rush hours, especially line 10. I still prefer the subway. I usually work from 9 am to 6 pm, with 90 mins lunch break. I work in a small office with few other people. My job can be stressful at times, but I like working there. Sometimes I work until late and after work, I just go shopping and straight home. Sometimes I go out with friends after work. If I want to find places to relax in my town, there are lots of choices. Malls, cinemas, myriad restaurants. I like home cooking, so I usually cook and eat at home."

Stereotype traits (Gilbert & Hixon, 1991)

Synonyms:	Antonyms:
"She is…	Not very sociable – very sociable person
Not a very timid – very timid person	Not very friendly – very friendly person
Not very intelligent- very intelligent person	Not very happy – very happy person
Not very calm – very calm person	Not very conversational – very
Not very composed – very composed person	conversational person
Not very aloof – very aloof person	

Appendix C

Online Sources of Stimuli: Asian Condition

WFC

https://www.shutterstock.com/image-photo/asian-woman-448142461

Impression formation

Metro scene: https://pxhere.com/en/photo/968999

Work scene: https://www.flickr.com/photos/ksulib/5857329004/in/photolist-9VAkR7-nUznvy-2eexHCT-9ipyKE-ab2Utg-HLaJY2-cq98V5-23PiGeS-29TqvRW-2bM8wxB-3PiQT-HLaLpZ-27D9tme-9bCsRR-ocUBF9-7eJDVY-938FoG-6w2Cr1-eSDByb-djV2bW-dcT5XV-8HhUsA-Lm9Xcn-fgcV1i-e4XD9U-awd8z1-rp24As-8Lo56a-6UAKaw-52tjbg-oHT7Vn-5KGXht-9G1mvA-afTSYn-8D1ajc-8zJsCM-9fQG6H-8xamkQ-2bg9ciH-5nctDW-6e5CBy-8mrF84-7G4YYe-p9T5rR-gXKhrq-afWCpQ-FZtcRo-wvGWqW-6K6Z2d-XFs1Tw

Shopping scene: https://www.pexels.com/photo/chinese-lanterns-iphone-5s-new-york-city-queens-new-york-866352/

Appendix D

Online Sources of Stimuli: Caucasian Condition

WFC

https://www.shutterstock.com/image-photo/young-beautiful-girl-glasses-thinking-looking-662919112

Impression formation

Metro scene: https://creativecommons.org/licenses/by-nc-sa/2.0/

Work scene: https://www.flickr.com/photos/oxfordian/15527204990/in/photolist-dDP8uu-2Sfz8N-uvYDA-pk2S2a-7RA2P6-oFFwrF-42Lg8Y-6cQpfh-bF83KD-9shA6s-cvA8Gd-9YMRFE-2i9rpv-2SbMcE-7RA1tt-5xh97W-pE5Z5S-ejZTod-7mQ3nv-ULHcgR-8oxe2T-5Hnb8i-7RA4Nx-9wzdTW-deipDq-4RT8HY-yVUtew-8FY4bx-5faUXH-ergHF7-7njxdC-7njCL5-6QG7JB-LoZVnr-Ajbxv-8jUSyp-ehwhCE-DYPvBk-67vDp9-8uqEbM-bxguE8-87ju51-cNdrDN-3FKSgV-dqdsuJ

Shopping scene: https://www.flickr.com/photos/kliefi/2085536945/in/photolist-4bhVtx-2eiZNbK-22iYkAH-9Cr9em-22Qq625-q3vVDo-nR8q9H-7tHhTK-28MRYUo-dAHGRS-ZvTy9x-8c7JvK-26UJcLv-pR2hnt-2ffyLwc-qcruMe-9jxchL-2dZ6Ya4-eauo9d-QdPDp6-9Gi6SL-qtqxw3-2enN8RQ-vSW8xv-MrDL3H-pZ1syM-QdPs9a-2dUw4Uo-o7o1Af-qbEVv9-2dZ77tD-nqTbyG-26qYGgy-mvv5AV-nrZTyT-fcRUHD-257Ancy-oBQwYE-Y3WHd-QdPwUT-o98Zf5-aHpuP-25pJi5h-QdPuWp-odqura-2b8c5As-E6AV5a-2dUw3F1-pmzmWT-7tUk8c

Appendix E

SOE Approval Letter

12th June 2019

Dear Xxxxxx Xxxxx

School of Education Research Ethics Committee

Project Title: The effect of attention deficit on stereotype activation and application

Application No: 402180366

The School of Education Research Ethics Committee has reviewed your application and has agreed that there is no objection on ethical grounds to the proposed study. It is happy therefore to approve the project, subject to the following conditions:

Start date of ethical approval: 12th June 2019

- Project end date: 31st August 2019
- Any outstanding permissions needed from third parties in order to recruit research participants or to access facilities or venues for research purposes must be obtained in writing and submitted to the School of Education Research Ethics Administrator before research commences. Permissions you must provide are shown in the reviewer feedback form, titled *Notification of Ethics Application Outcome*, that has been sent to you.
- Data collected should be held securely for the period you indicated in the application and any personal data collected should be appropriately managed in accordance with the General Data Protection Regulation.
- The research should be carried out only on the sites, and/or with the groups and using the methods defined in the application.
- Any proposed changes in the protocol should be submitted for reassessment as an amendment to the original application. The *Request for Amendments to an Approved Application* form should be used: https://www.gla.ac.uk/schools/education/research/ethics/forms/

Yours sincerely,

Dr Kara Makara
School of Education Ethics Officer

Appendix E

Online Consent Form

Consent Form

Please read the statements below and indicate your agreement by ticking the boxes at the end.

- I confirm that my participation is voluntary and that I can withdraw from the study, at any time and for any reason by closing the browser window;
- I understand that all data collected is anonymous,
- I understand that the anonymous data will be treated as confidential and kept in secure storage at all times;
- I consent to the anonymous data to be retained in secure storage for use in future academic research;
- I consent to the data being stored for a period of ten years;
- I agree to waive my copyright to any data collected as part of this project;
- I am a British citizen and over the age of 18;

I confirm that I understand all of the above and consent to participate in this study ☐