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Attention levels in young children who stutter

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Abstract

Purpose: The purpose of this study was to determine whether children who stutter (CWS) and children who do not stutter (CWNS) differ in terms of attentional ability. ***Methods:*** Participants were 40 age- and gender-matched CWS and CWNS (aged between 72 and 120 months). Attentional ability was assessed using the Test of Everyday Attention for Children (TEA-Ch; Manly, Robertson, Anderson & Nimmo-Smith, 1999), a clinical assessment battery comprising 13 attentional measures, assessing 3 areas of attention - selective attention, sustained attention and attentional switching. A low score on the assessment indicates attentional difficulty.

Results: There was an overall tendency for CWS to score lower than CWNS on all 13 TEA-Ch measures and all three attentional abilities. This difference reached statistical significance for the sustained attentional component.

Conclusion: The present study provides support for the hypothesis that there are some differences between CWS and CWNS in terms of attentional ability. The findings are interpreted within existing models of attention with regard to previous studies of attention in CWS.

Keywords: stuttering; attention; TEA-Ch, cognitive control

1. Introduction

Recent research has provided evidence to suggest that there is a link between developmental stuttering and attention. Evidence from both direct experimental testing and parental reports has shown that children who stutter (CWS) overall perform more poorly on attentional tasks as compared to their non-stuttering counterparts (children who do not stutter; CWNS; Anderson, Pellowski, Conture, & Kelly, 2003; Blood, Blood, Maloney, Weaver, & Shaffer, 2007; Eggers, De Nil, & Van den Bergh, 2012, 2013; Eggers, De Nil, & Bergh, 2010; Eggers & Jansson-Verkasalo, 2017; Eichorn, Marton, & Pirutinsky, 2017; Felsenfeld, van Beijsterveldt, & Boomsma, 2010; Karrass et al., 2006; Jo Kraft, Ambrose, & Chon, 2014; Ntourou, Anderson, & Wagovich, 2018). Such findings have raised the possibility that stuttering may not be an isolated disorder, but could constitute a part of a broader spectrum of impairments, instead (Felsenfeld et al., 2010). Moreover, a very recently published adult study also confirmed this relationship (Doneva, Davis, & Cavenagh, 2017).

The current work was instigated in conjunction with a longitudinal study on childhood disfluency based in the UK (Cavenagh, Costelloe, Davis, & Howell, 2015). The initial findings from this longitudinal study showed that a group of 40 CWS exhibited significant deficits on the verbal, non-verbal and full IQ components of the Wechsler Pre-school and Primary Scale of Intelligence (WPPSI-III; Wechsler, 2003) when compared to the 42 gender- and 34 age-matched controls (CWNS). At the time of the assessment, informal reports from the CWS in the study suggested that these children found it more difficult to maintain concentration on the test. On the whole, children in the stuttering group had difficulties staying focused and needed more adult direction to keep on task. Given the growing body of literature suggesting that CWS might have attentional difficulties as compared to CWNS, the researchers hypothesized that the reduced scores on the WPPSI-III, found in the study, were due to less efficient attentional processing in the stuttering group rather than a difference in IQ between the groups. The purpose of the present study was to test whether such attentional differences between CWS and CWNS exist by incorporating a direct measure of attention (the Test of Everyday Attention for Children, TEA-Ch; Manly, Robertson, Anderson & Nimmo-Smith, 1999).

1.1 Stuttering

Stuttering or, as now referred to as childhood-onset fluency disorder, is characterized by 'disturbances in the normal fluency and time patterning of speech that are inappropriate for the individual's age and language skills, persist over time, and are characterized by frequent and marked occurrences of one (or more) of the following: 1. Sound and syllable repetitions; 2. Sound prolongations of consonants as well as vowels; 3. Broken words (e.g., pauses within a word); 4. Audible or silent blocking (filled or unfilled pauses in speech); 5. Circumlocutions (word substitutions to avoid problematic words); 6. Words produced with an excess of physical tension; 7. Monosyllabic whole-word repetitions (e.g., "I-I-I-I see him;)' (American Psychiatric Association, 2013, p. 45-46). Furthermore, the disorder usually starts between the ages of two and four and is known to be between 2.4 to 5.33 times more prevalent in males as compared to females (Andrews & Harris, 1964; Howell, Davis, & Williams, 2008). The prevalence of the condition has been estimated at around 1% (Gordon, 2007), however, importantly its incidence[i] is approximately 5%, with onsets occurring mainly at the preschool age (Månsson, 2000). Finally, according to a systematic investigation by Blood, Ridenour, Qualls and Hammer (2003), stuttering most often co-occurs with another speech disorder (in their sample 33.5% of the children had an articulation disorder and 12.7% - a phonology disorder); while from the comorbid non-speech disorders the most common were a learning disability (15.2%), followed by a literacy disorder (8.2%) and an attention deficit disorder (ADD; 5.9%). As the probability to outgrow the condition is highest in childhood, it is important to examine the factors that are associated with the recovery and the persistence of the disorder.

1.2 The Attentional System

Attention optimizes the processing resources of the individual by enhancing the information of interest at a given moment and inhibiting the stimuli, identified as task-irrelevant at that time (Lavie, Hirst, de Fockert, & Viding, 2004). It can operate either endogenously, driven by the goals of the perceiver (e.g., I am looking for a friend in a crowd of people) or exogenously, by the stimulus properties (e.g., a flashing light captures my attention). Importantly, individuals have only limited perceptual and cognitive resources; when faced with an abundance of information, they are forced to 'choose' what information to process and what to leave out. However, rather than being a conscious choice, the latter takes place due to the interplay between the amount and specifics of the presented stimuli (perceptual load) and the amount of available resources one can allocate to their processing. Cognitive control is a synonymous term to attentional control and executive function and 'encompass[es] a wide variety of cognitive processes such as dealing with novelty, planning, using strategies, monitoring performance, using feedback to modify performance, vigilance, and inhibiting irrelevant information' (Cohen, Bayer, Jaudas, & Gollwitzer, 2007, p.12). It lies at the heart of the three basic attentional abilities – selective attention/inhibitory control, divided attention and attentional switching (Doneva et al., 2017).

Selective attention refers to one's ability to focus on the target information in a task while ignoring goal-irrelevant information. It relies on the individual's cognitive control – the more resources are available, the better the irrelevant information can be inhibited (Lavie et al., 2004). In support, conditions, where the individual's cognitive resources are hypothesized to have diminished or be depleted, such as aging (Hedden & Gabrieli, 2004; Maylor & Lavie, 1998), anxiety (Eriksen & Hoffman, 1973) or lack of perceived power (Guinote, 2007) are all associated with imperfect information selection.

Attentional switching, on the other hand, is an indicator of mental flexibility and adaptability (Kreutzfeldt, Stephan, Sturm, Willmes, & Koch, 2015). It is often assessed with a card sorting task where participants learn to sort cards according to a particular dimension (e.g., colour) and then need to quickly adapt to the new rule for card sorting (e.g., card value) which seems to change arbitrarily and could be worked out only from the experimenter's feedback on their performance. To succeed in the task, one should have a good inhibitory control in order to suppress the old rule (Kramer, Cepeda, & Cepeda, 2001). The latter has been well-illustrated by studies with the children's card sorting task – The Dimensional Change Card Sort (DCCS) task (Frye, Zelazo, & Palfai, 1995). Results on the DCCS indicate that while preschool children demonstrate an understanding of the task rules, they have a difficulty switching rules on the first consecutive trials after the rule change (Perner & Lang, 2002). However, older children generally do not have such difficulties and are more flexible in their attentional switching on the task (Zelazo, Frye, & Rapus, 1996). Furthermore, children with Attention Deficit Hyperactivity Disorder (ADHD)[ii] had been found to be significantly better at attentional switching when on medication, as compared to off-medication (Kramer et al., 2001).

Finally, sustained attention refers to the ability to maintain focus on the task at hand without allowing one's mind to shift to external distractors (Reason, 1984). This type of attentional ability is often studied in go/no-go tasks where participants are required to respond to frequently-appearing items, while withholding their response to a non-frequent target item (Chan, 2001; Engle & Kane, 2003; Helton, Head, & Russell, 2011; Robertson, Manly, Andrade, Baddeley, & Yiend, 1997). Failures to sustain attention (i.e., *lapses of attention*) are quite common in everyday life (Reason, 1984). However, these are more frequent in some populations, such as people with ADHD (Christakou et al., 2013), brain-damaged patients (Johnson et al., 2007), aging individuals (Howard, Bessette-Symons, Zhang, & Hoyer, 2006) and young children (Kannass & Oakes, 2008). The reason behind this is that sustained attention relies on cognitive resources. Therefore, when cognitive resources are reduced due to a resource-demanding task or the individual has a generally lower cognitive resource capacity, they are easily distracted and less able to sustain attention (Engle & Kane, 2003; Grandjean & Collette, 2011).

1.3 Attention and stuttering

Attentional ability is one area where CWS have been reported to perform more poorly as compared to their fluent counterparts.

The latter has been identified for all three attentional abilities described above. For instance, analysis on merged data (Alm, 2014; Eggers et al., 2010) revealed differences between CWS and CWNS on several measures of attentional performance with CWS scoring higher on hyperactivity and lower on attentional shifting, inhibitory control and perceptual sensitivity (i.e., how quickly they notice changes in the environment). The latter has also been supported by Eggers et al. (2013) who examined children's performance on a Go/No-Go task with infrequent No-Go signals. This type of Go/No-Go task is believed to be a classic measure of sustained attention (Robertson et al., 1997), and respectively, inhibitory control, since withholding the No-Go response is particularly difficult if No-Go items are infrequent (Engle & Kane, 2003). The results of this study revealed that CWS were significantly worse at withholding their response to the No-Go targets, indicating that they could not make a good use of their inhibitory attentional mechanism (Eggers et al., 2013)[iii]. Moreover, as Go/No-Go tasks can also serve as a measure of response criterion (Doneva & De Fockert, 2014; Helton et al., 2011) it could be suggested that CWS were more impulsive and less capable of attention switching as they did not adopt a new, more efficient response criterion to complete the task (Eggers et al., 2012, 2013). Furthermore, a recent study that compared the attentional switching abilities of preschool CWS and CWNS on the DCCS, found that the CWS group exhibited greater RT slowing during the postswitch phase of the task and a possible tradeoff between speed and accuracy for CWS after the switching of the rule has occurred (Eichorn et al., 2017). Finally, the latter findings are also supported by studies, relying on parent-report questionnaires – the most common of which is the BSQ (McDevitt & Carey, 1978). For instance, Karrass et al. (2006) found that preschoolers who stutter were identified by their parents as having significantly poorer attentional regulation, being more emotionally-reactive and less able to control their emotions. Another BSQ study reported a significant difference in their sample of 3.00 to 5.40 year-old CWS and controls on three out of the nine temperamental traits, identified from the parental questionnaire (Anderson et al., 2003). These were *distractibility* (e.g., whether the child stops an activity because something else catches his/her attention); *adaptability* (e.g., how easily the child adjusts to changes in his/her routine) and *rhythmicity* (e.g., whether the child spontaneously wakes up at usual time on weekends and holidays). Taken together these studies suggest that stuttering is often associated with poorer attention.

1.4 Theoretical Basis

There is strong evidence that despite being highly practiced, word production relies on the amount of dedicated central processing resources and that the processes underlying linguistic ability also underpin other, non-linguistic tasks (Cook & Meyer, 2008; Ferreira & Pashler, 2002; Roelofs & Piai, 2011). In fact, Ferreira and Pashler (2002) demonstrated that word production is susceptible to dual-task interference, similarly to paradigms assessing attentional ability. For example, when participants had to perform a picture-naming task in conjunction with a tone-discriminating task, they experienced a classical psychological refractory period (PRP) effect (Telford, 1931; Vince, 1949) – the shorter the time interval between the two tasks, the slower were participants to discriminate the tones. Furthermore, more specifically to stuttering, there are two theoretical models that aim to account for the potential association between stuttering and poorer attentional performance: The Demands and Capacities model (Adams, 1990; Starkweather, 1987; Starkweather & Givens-Ackerman, 1997) and Eggers et al.'s (2012, 2013) impeded inhibitory control account. In simple terms, the Demands and Capacities model postulates that language production is atypically demanding for PWS and thus the sufferer's capacities (motor, linguistic, socio-emotional, or cognitive) cannot meet the number of external demands that come with speech (e.g., time pressure, speech continuity, communicating with negative listeners, etc.). On the other hand, Eggers et al. (2012, 2013)'s suggest that stuttering is associated with aberrant monitoring during linguistic processing and impeded inhibitory control. Moreover, as this model is based on Levelt (1983), it assigns a key role to inhibitory control for the detection and processing of speech errors that can arise at any of the three stages of language production: conceptualization, formulation, and articulation, and that these are normally resolved by processes of self-repair. However, importantly, neither the authors of the two models nor the present study aim to suggest that poorer cognitive control causes stuttering or vice versa; this question is beyond the scope of the current research. Our aim was to simply examine this potential association to gain more insights about the nature of stuttering.

1.5 The present study

Past research on the hypothesized association between stuttering and attentional ability has either relied on indirect measures of attentional ability such as parental reports (e.g., Eggers et al., 2010; Felsenfeld et al., 2010) or has focused on a single attentional ability (e.g., dual tasking in Maxfield et al., 2016) . The present investigation aimed to add to the other such study which employed an attentional assessment battery to test participants' performance on several attentional abilities at the same time (Eggers et al., 2012 who used the Attention Network Test (ANT; Fan, McCandliss, Sommer, Raz, & Posner, 2002). We determined TEA-Ch (Manly et al., 1999) most suitable for our purpose as it is a robust battery and one of the few based on a theoretical model – (Posner & Petersen, 1990)'s Attention Network Framework on which the ANT is also based. Furthermore, TEA-Ch also permits the study of children's attentional performance at both the visual and the auditory domain, unlike its counterpart, the ANT which has a separate visual and auditory versions (Roberts, Summerfield, & Hall, 2006).

Findings from previous studies examining the attentional ability of CWS have been mixed – while some found problems in sustained attention (e.g., Embrechts et al., 2000; Karrass et al., 2006), others reported poorer attentional orienting (Eggers et al., 2012) or selective attention (Eggers et al., 2013). It was, therefore, difficult to make a directional prediction on which attentional ability will be compromised in our CWS sample, especially given that this test had not been administered before to CWS, but only to adults who stutter (Doneva et al., 2017). Thus, we hypothesised that CWS would perform less well on TEA-Ch compared to age- and gender-matched controls, without making a specific prediction about which attentional abilities will be affected.

2. Method and Materials

2.1 Participants

Forty participants were recruited for this investigation from a larger cohort that participated in a longitudinal study on early childhood stuttering (Cavenagh et al., 2015). The study population comprised two groups of children – children who stutter (CWS) and children who do not stutter (CWNS).

The sample of CWS consisted of 20 participants altogether (16 boys and 4 girls) with an age range of 72 to 106 months and a mean age of 90 months. For the purposes of determining the children's level of fluency, the twenty minute speech recordings, obtained from all children at the start of the longitudinal study, conducted by Cavenagh et al. (2015) were used. The sample of CWS was determined, based on the following criteria: a) above 2% Syllables stuttered (SS) in every 200-word speech sample; b) a score of 15 or above on the Stuttering Severity Instrument – Fourth Edition (SSI-4; Riley, 2009). All of the selected CWS were diagnosed with developmental stuttering by the the first author (SC) who is also a qualified speech and language therapist (SLT). The time lapse between taking the speech recordings and the administration of TEA-Ch was one month.

The CWNS group also consisted of 20 children (15 boys and 5 girls) with an age range of 72 to 120 months and a mean age of 93 months. These children were determined to be typically fluent (not a child who stutters) for the following key reasons: (a) they had no present or prior history of parent or teacher concern with regards to the child's speech fluency; (b) after the analysis of their 20-minute recordings, obtained in the beginning of the study, the first author (SC) who is also a qualified SLT did not note any concerns regarding atypical speech fluency.

Moreover, as performance on the TEA-Ch is sensitive to the participants' level of vision and hearing abilities, it was also ensured that all children had normal hearing and normal or corrected to normal-vision. These were assessed both by the parents/teachers and the first author (SC) who met the children in person and performed the testing. There were no reports of head injury from the parents of either the CWS or the CWNS. Finally, a written informed consent was obtained from the parents of all children who took part of the study. The parents were also fully debriefed about the purposes of the study at the end of the experimental testing.

2.2 Materials

Test of Attentional Ability

TEA-Ch is a standardised normative clinical battery for children that allows the assessment of different attentional capacities (Manly et al., 1999). It comprises of 9 subtests each making different attentional demands but minimising the need for other skills such as memory, language and comprehension. Furthermore, as one subtest can provide more than one measures (e.g., speed, accuracy), TEA-Ch provides a total of 13 attentional measures (see the description below for details). The assessment is suitable for participants aged 6-16 years (the children in our sample were aged between 6 and 10 years) and provides age-normed scores. The TEA-Ch covers three areas of attention: selective attention, sustained attention and attentional switching. These have been explained below (Manly et al., 2001).

Selective Attention

(1) 'Sky Search' is a timed subtest where children have to find as many of the pairs of identical spacecrafts as possible while ignoring the unmatched pairs, presented to serve as distractors in this task. Both speed and accuracy are recorded in this task. Additionally, to control for the effect of motor speed on visual attentional

selection, children also completed a motor control version of the test which was identical to the first task, with the exception that all of the distractor items were removed. A time-per-target score (time/targets found) was then calculated for both conditions and then each child's motor control time per target score was subtracted by their time per target score in the more attentionally demanding Sky Search condition. This measure is called Sky Search Attention score.

(2) 'Map Mission' is a subtest in which children have to search a map to find as many target symbols (i.e., pairs of knives and forks) as they can in one minute. The final score represents the number of correctly identified targets (accuracy).

Sustained Attention

(1) 'Score!' is a subtest in which children have to silently count the number of tones they hear and announce them at the end of each trial. The final score corresponds to the number of trials in which the child gave a correct response (accuracy).

(2) 'Score Dual Task' (Score DT) requires children to do two tasks at the same time – while counting the number of tones they hear, they also need to listen to an audio news broadcast and notice what animal is mentioned in it. The score depends on the number of correct tones and animal responses (accuracy).

(3) 'Sky Search Dual Task' (Sky Search DT) requires children to look for pairs of identical spacecraft while counting the number of tones they hear. Here a decrement measure was calculated – first each child's total time per target was calculated, which was then divided by their proportion of correct scores. This made the child's Sky Search DT score. Finally, to obtain the decrement, the child's Sky Search score was subtracted from their Sky Search DT score.

(4) In 'Walk Don't Walk' children are presented with a sheet showing footprints on a path made up of 14 squares. Children then have to 'walk' (with their pen on the

paper) when they hear a tone and 'stop walking' when they hear another. The moves are made by dotting each square with a marker pen. The final score corresponds to the number of correct responses given by the child (accuracy).

(5) 'Code Transmission' requires children to listen to a monotonous series of digits while trying to identify a priorly specified target sequence (e.g., two fives presented one after the other). Their task is to say the digit that came before the target sequence. The final score corresponds to the number of digits, correctly identified by the child (accuracy).

Attentional Switching

(1) In 'Creature Counting' children are presented with rows of creatures depicted in their dens with arrows pointing up or down inserted between them. The task is to count the number of creatures presented, while at the same time following the arrows and count either upwards or downwards, depending on the direction of the arrow. The number of correct responses and the time taken to complete the trials were recorded (speed and accuracy).

(2) In 'Opposite Worlds' children are presented with a 'path' made up of the digits '1' and '2'. There were two conditions in this task – 'Same Worlds' and 'Opposite Worlds'. In the 'Same Worlds' children had to pronounce the digit they see (e.g., '1' when they see '1') and then move on the next 'step' until they have reached the end. In the 'Opposite Worlds' they had to pronounce the opposite digit of what they see, instead (e.g., '1' when they see '2'). The total time, corresponding to the correct responses in each condition was recorded (speed).

2.3 Procedure

The TEA-Ch was administered by a qualified speech and language therapist (SC; the first author) under the supervision of a qualified psychologist either in a quiet room at the child's house or the child's school. No-one else was present during the testing.

3. Results

The 9 TEA-Ch subtests yielded 13 attentional measures (the number of measures for each subtest is outlined in Materials; e.g., Sky Search has a speed, accuracy and an Attention score, see above). Each of the raw scores was transformed into norm-referenced scaled scores that adjust for age and gender, according to the TEA-Ch manual (Manly et al., 1999). The scaled scores of the 13 measures were then entered into a 2x13 mixed Analysis of Variance (ANOVA) with task measure as a within-participants factor (where each of the 13 TEA-Ch measures was a level of this factor; see Table 1) and group (CWS vs CWNS) as a between-participants factor. Following this, planned post-hoc comparisons were carried out to explore the simple main effects of participants' group (CWS vs CWNS) at each of the 13 TEA-Ch measures (See Section 3.1). Furthermore, a composite score for each of the three attentional abilities was created from the scaled scores of the relevant attentional measures (See Section 3.2). Finally, the performance of the two groups was compared by performing a t test for each attentional ability.

3. 1 Analysis on the TEA-Ch Measures

The 2x13 mixed ANOVA analysis yielded a significant main effect of attentional measure (F (12, 456) = 11.26, $p < .001$, partial eta sq = .229). The main effect of group was also significant (F (1, 38) = 6.87, $p < .013$). Indeed, as it could be seen from the descriptive statistics, CWNS overall had a higher score on all 13 measures, when compared to CWS. However, no significant interaction emerged between attentional measure and group ($p > 0.76$). Still, for merely data exploration purposes, planned post-hoc analyses exploring the simple main effects of participants' group at each of the 13 attentional measures were performed. Although three of these were significant at the .05 level, none reached significance at the Bonferroni adjusted alpha level for the 13 comparisons (alpha = .004). These were the Sky Search DT, Walk, Don't Walk, and Code Transmission subtests which all measure participants' sustained attentional ability.

Table 1. Mean scaled scores for CWS and CWNS on the 13 measures of the TEA Ch.

Table 1 about here

3.2 Types of Attentional Ability

Composite scores for each of the three attentional abilities were created from the scaled scores of the relevant measures. Selective attention was estimated by adding together the Sky Search Attentional Score together with the Map mission score. The sustained attention composite score was composed by Score! , Score DT, Walk Don't Walk and Code Transmission. Finally, attentional switching was estimated by adding together Creature Counting, Same Worlds and Different Worlds. CWS scored lower than CWNS for all three of the attention categories measured by TEA-Ch (See Table 2). Importantly, the difference between the CWS and CWNS group was significant for the sustained attention factor (t (38) = 3.02, p < .005).

Table 2. Mean scores for CWS and CWNS on type of attentional ability by TEA-Ch.

Table 2 about here

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4. Discussion

The present results revealed that when the two groups were compared on each of the three attentional abilities, the CWS had an overall poorer performance on all three abilities – selective attention, sustained attention and attentional switching, with the difference reaching statistical significance for the sustained attention factor. Furthermore, there was also a tendency for our group of CWS to consistently score lower on the TEA-Ch subtests compared to controls, especially on subtests tapping into sustained attention: Sky Search DT, Walk, Don't Walk and Code Transmission.

4.1 How the present findings fit with previous research

These results are consistent with recent published work reporting that stuttering is associated with attentional problems in both adults and children (e.g., Bosshardt, 2006; Doneva et al., 2017; Eggers et al., 2010, 2012, 2013; Eggers & Jansson-Verkasalo, 2017; Eichorn et al., 2017; Jo Kraft et al., 2014; Karrass et al., 2006; Maxfield et al., 2016; Ntourou et al., 2018). Our finding that the control group achieved an overall higher score on all 13 test measures, when compared to our stuttering group, is consistent with the notion that the disorder is associated with a general weakness in executive functioning/cognitive control. Furthermore, the latter seems to manifest differently depending on the specifics of the sample and the applied research method.

While some authors have suggested problems in inhibitory control/selective attention, others have instead reported poorer performance in attentional switching, sustained or divided attention. For example, no RT differences emerged in Eggers and Jansson-Verkasalo (2017) between their school-aged CWS and CWNS groups with regards to participants' attentional switching and inhibitory control performance as compared to baseline on an auditory attentional set-shifting test (De Sonneville, 2009). However, importantly, only the control group benefitted from the slowing down in responding, resulting in significantly higher response accuracy for this group. Thus, arguably CWS were less able to adapt their response style and experienced a higher switch cost (i.e., 'mental "gear changing" necessary before appropriate task-specific processes can proceed'; (Monsell, 2003, p. 135 in Eggers & Jansson-Verkasalo, 2017). On the other hand, in their sample of preschoolers, Eichorn et al. (2017) found CWS to be significantly slower than their fluent counterparts in the postswitch phase of the DCCS task which again measures attentional switching. Furthermore, Piispala, Kallio, Bloigu and Jansson-Verkasalo (2016) studied school-aged children of a very similar age to Eggers and Jansson-Verkasalo (2017) on a visual Go/Nogo paradigm where they also recorded event-related potentials (ERP). Surprisingly, neither the behavioural nor ERP data revealed any differences between the groups in the Nogo condition[iv], showing no evidence of abnormal inhibitory control in the CWS group. However, more generally, these studies taken together with the present study all point to atypical attentional processing in CWS in terms of stimulus evaluation, response selection and execution.

It is still challenging to determine why a conflicting pattern of findings is revealed by different studies in terms of where the attentional difficulties lie in stuttering. As we already mention, in our opinion, these are most likely due to the specifics of the test itself and the participants' age. Previous research has employed a number of instruments to examine the attentional abilities of individuals who stutter which makes it difficult to make comparisons between studies (Bosshardt, 2006; Doneva et al., 2017; Eggers et al., 2012, 2013; Embrechts et al., 2000, Eichorn et al., 2017; Karrass et al., 2006; Maxfield et al., 2016). To our knowledge only one study has previously explored the attentional abilities of individuals who stutter using the Test of Everyday Attention (Doneva et al., 2017). This experiment was conducted with adult participants and therefore, used the adult version of the test (Robertson, Ward, Ridgeway, & Nimmo-Smith, 1996). The findings revealed that people who stutter (PWS) demonstrated worse divided and visual selective attention. There was also a trend in the results for the PWS group to perform more poorly on tasks measuring attentional switching. Interestingly, the results also revealed a negative association between stuttering severity and performance on two TEA subtests measuring visual selective attention (i.e., the more severe one's stuttering was, the worse their performance on the task). One possibility is that the discrepancy in findings between Doneva et al. (2017) and the present research can be explained by the age of the participants – sustained attention is normally more problematic in childhood, before consistently improving during adolescence (Klenberg, Korkman, & Lahti-Nuuttila, 2001; Rebok et al., 1997).

4.2 Limitations and future direction

It is important to note the limitations of the present investigation. On first place, the study would have potentially benefitted from a larger number of participants in each group. Unfortunately, this was not possible due to the high attrition rates we experienced and because we wanted to match the two groups for number of participants, age and gender. Additionally, this might be the reason why none of the comparisons between the groups on attentional measure performance reached statistical significance. Arguably, Sky Search DT, Walk, Don't Walk, and Code Transmission might have been significant at the Bonferroni corrected alpha level if more participants were included. Still, we believe that the identified tendencies in the data are a valuable contribution in the right direction for the better understanding of the attentional abilities of CWS and PWS, in general. Another limitation of the present study is that children were not screened for ADHD or any other relevant comorbidities; therefore, it is possible that another condition, such as ADHD contributed to the overall poorer attentional performance in some of the CWS. For example, by using a parent perception scale, Donaher and Richels (2012) found that 21 out of the 36 school-age CWS in their sample were identified by their parents as needing a further testing for their ADHD-like symptoms. Future research should address this concern by controlling for ADHD and other of the most common comorbidities that have been reported to co-occur with stuttering in some children (Blood et al., 2003).

Finally, future research should explore the therapeutic benefits of attentional training on speech fluency in CWS. For example, it might be helpful to assess the attentional skills of young children prior to commencing speech therapy, so that the course can be adapted to suit the needs of children with combined stuttering and attentional difficulties. For example, the clinician can make allowances for the child with sustained attention difficulties by delivering shorter therapy sessions, having regular breaks and rewarding effort to stay focused on tasks. Communication targets could also include the areas where the child exhibits particular difficulties in attentional control like listening and turn-taking. Furthermore, together with Doneva et al. (2017), the present study provides support for the potential benefit of attentional training programs, aimed at improving cognitive control, such as the Neurocognitive Joyful Attentive Training Intervention (Nejati, Pouretemad, & Bahrami, 2013).

4.3 Conclusion

To conclude, when compared to fluent, age- and gender-matched controls, our CWS group exhibited a significantly worse performance on the composite measure of sustained attentional ability. Furthermore, the CWS achieved a lower score than the CWNS group on virtually every single of the 13 attentional measures of TEA-Ch, although none of the differences could reach statistical significance. The present findings lend support to the growing evidence that stuttering is associated with an overall poorer attentional ability and have potential practical implications for stuttering therapy.

6. References

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Endnotes

[i] How many people have ever stuttered in their life.

[ii] Symptoms of inattention in ADHD include difficulty sustaining attention on tasks, especially ones requiring mental effort, failing to give close attention to detail, inability to follow instructions, difficulty organizing tasks and activities (DSM-V; American Psychiatric Association, 2013). Moreover, symptoms of hyperactivity-impulsivity include blurting out answers, excessive talking, fidgeting and an inability to wait turn and remain seated.

[iii] This was also corroborated by a more recent study by Eggers and Jansson-Verkasalo (2017) who compared the IC ability of 16 Finnish school-aged CWS to 16 Finnish fluent counterparts in another computer task and found the CWS group to be less efficient at slowing down their response latency, resulting in significantly lower response accuracy.

[iv] The CWS differed from the CWNS group only in the ERPs in the Go condition.

Table 1. Mean scaled scores for CWS and CWNS on the 13 measures of the TEA Ch.

Attentional Ability	Measure	Group	Mean Scaled Scores (SD)	P value
Selective Attention	Sky Search (accuracy)	CWS	9 (2.49)	> .154
		CWNS	10.2 (2.73)	
	Sky Search (speed)	CWS	7.8 (3.04)	> .275
		CWNS	8.85 (2.96)	
	Sky Search (attention score)	CWS	7.9 (3.71)	> .189
		CWNS	9.5 (3.85)	
	Map Mission (accuracy)	CWS	7.85 (1.73)	> .417
		CWNS	8.35 (2.11)	
Sustained Attention	Score! (accuracy)	CWS	10.15 (3.13)	> .170
		CWNS	11.45 (2.73)	
	Sky Search DT (decrement)	CWS	8.35 (4.71)	<.05
		CWNS	11 (3.20)	
	Score DT (accuracy)	CWS	10.4 (4.38)	< .102
		CWNS	12.45 (3.28)	
	Walk Don't Walk (accuracy)	CWS	6.6 (2.62)	<.04
		CWNS	8.25 (2.20)	
	Code Transmission (accuracy)	CWS	8.25 (2.67)	<.05
		CWNS	10.10 (3.03)	
Attentional Switching	Creature Counting (accuracy)	CWS	12.35 (2.60)	> .890
		CWNS	12.45 (1.88)	
	Creature Counting (speed)	CWS	10.35 (3.50)	> .501
		CWNS	11 (2.47)	
	Same Worlds (speed)	CWS	10.25 (2.97)	> .114
		CWNS	11.85 (3.28)	
	Opposite Worlds (speed)	CWS	10.4 (3.80)	> .432
		CWNS	11.35 (3.77)	

Table 2. Mean scores for CWS and CWNS on type of attentional ability by TEA-Ch.

Attentional Ability	Group	Mean	SD	P value
Selective Attention	CWS	15.75	4.61	> .189
	CWNS	17.85	5.29	
Sustained Attention	CWS	43.75	11.25	< .005
	CWNS	53.25	8.45	
Attentional Switching	CWS	43.35	8.37	> .219
	CWNS	46.65	8.34	