

Writing with imagination: the influence of hot and cold executive functions in children with
autism characteristics and typically developing peers

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Introduction

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4 Children with autism experience persistent impairment in social communication and
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6 social interaction across different contexts that cannot be explained by general
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8 developmental delays, along with the presence of a narrow range of interests and repetitive
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10 behaviours (DSM-5, American Psychiatric Association [APA], 2013). Although there are a
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12 number of theoretical explanations posited to account for the characteristics of autism, they
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14 can be conceptualised within models of hot (i.e., self-management skills in situations which
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16 are motivationally significant and accompanied by heightened emotion) and cold (i.e.,
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18 internal self-regulation processes that occur independently of emotion factors) executive
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20 functions (e.g., Zelazo, 2015; Zelazo & Cunningham, 2007; see Peterson & Welsh, 2014 for a
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22 review).
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31 A lack of imagination and ideas found in children with autism is demonstrated through
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33 communication difficulties and very repetitive play (Honey, Leekam, Turner, & McConachie,
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35 2007). Moreover, the development of imagination involves the inhibition of salient
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37 representations of reality, self-regulation of emotion, and thinking flexibly about ideas based
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39 in fantasy (Carlson & White, 2013). Furthermore, divergent thinking and an understanding of
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41 different perspectives and feelings, provide the creative ideas from which develop strong and
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43 coherent written narratives (Dillon & Underwood, 2012; Ward, 1994). Therefore, writing is
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45 regarded as a multi-representational and resource demanding activity that draws upon
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47 executive functions to control and monitor task-relevant information (Altemeier, Abbot, &
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49 Berninger, 2008; Berninger & Richards, 2012; Drijbooms, Groen, & Verhoeven, 2015, 2017;
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51 Kellogg, Whiteford, Turner, Cahill, & Mertens, 2013; Quinlan, Loncke, Leijten, & Van Waes,
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53 2012). To date, there is limited research evaluating the relationship between executive
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1 functions and writing development in children with autism. Yet, a direct comparison of
2 performance between children with autism and peers who are typically developing would
3 provide an opportunity to gain a unique insight into the hypothesised predictive capacity of
4 two conceptually distinct types of executive function, for producing novel content in written
5 narratives. Hence, the present study aimed to explore the extent to which the interaction
6 between autism characteristics and executive functions impacted upon the ability to develop
7 imaginative content in story writing.
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19 **Social, cognitive and emotion theories of autism**

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23 A consistent amount of empirical work has corroborated the link between autism and
24 a lack of Theory of Mind (ToM) (DSM-5, APA, 2013; Baron-Cohen et al., 2001; Lord & Bishop,
25 2015). For instance, deficits in ToM (and related skills) are aligned to the difficulties children
26 with autism experience, such as, incorporating details of internal representations of emotion
27 within narratives (Barnes & Baron-Cohen, 2012). However, the finding that not all children
28 with autism fail false belief tasks to assess ToM skills cast doubt on its ability to provide a
29 causal explanation of the difficulties found in empathising and perspective taking (Happé &
30 Frith, 2006).
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45 Social motivation theory was proposed to clarify the inconsistency in findings between
46 children on ToM tasks (Chevallier, Kohls, Troiani, Brodtkin, & Schulz, 2012). The theory is
47 plausible as it explains the impact of autism on strategies to maintain social experiences, an
48 understanding of the dynamics of which are important for the structure of narratives (Crespi,
49 Leach, Dinsdale, Mokkonen, & Hurd, 2016). It is limited, though, in its ability to account for
50 non-social deficits (e.g., lack of divergent thinking or imagination, preference for sameness,
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1 and clinically significant difficulties in important areas of everyday functioning [e.g.,
2 schooling] not explained by intellectual disability or global developmental delay) that
3 characterise important elements of the diagnosis (DSM-5, APA, 2013; Baron-Cohen et al.,
4 2001; Chevallier et al., 2012).

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11 Central coherence theory was an attempt to explain the stereotypical and rigid
12 behaviours associated with non-social impairments. It proposes they occur through the
13 inability to integrate salient global features caused by perceptual deficits in recalling and
14 processing information from others and the environment (Frith, 2012; Happé & Frith, 2006);
15 thereby, resulting in a greater focus on the minutiae of incoming details (Eberhardt & Nadig,
16 2018). A limited ability to develop an understanding of the context of a situation was
17 proposed as the causal explanation of difficulties children with autism encountered, when
18 disambiguating the narrative structure and semantic properties of sentence-based tasks
19 (Jarrold & Russell, 1997; López & Leekam, 2003). A modification of the original version of the
20 theory took into consideration children who were able to perform as well as age-matched
21 controls on the global-local processing measures, despite experiencing deficits in cognitive
22 flexibility (i.e., attention shifting) (Adams & Jarrold, 2012; Eylon et al., 2015; Ozonoff, Strayer,
23 McMahon, & Filloux, 1994). This was a critical step to acknowledging the degrees of variation
24 within clinical and typical populations. A particular bias towards focusing on detail was
25 considered one part of the cognitive style associated with the manifestation of autism traits
26 (Booth & Happé, 2010), and their likely interaction with narrative coherence. An alternative
27 to central coherence theories is to understand the complex spectrum of difficulties autism
28 presents within models of executive functions (Hill, 2004; Kleinhaus et al., 2005). They have
29 the potential to provide greater specificity to a wide range of factors that underpin the
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1 challenges faced in autism (Bock, Gallaway, & Hund, 2015; Yerys et al., 2009; Zelazo &
2 Cunningham, 2007).
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6 Executive functions (EF) are purported to include three main components (Diamond,
7 2013; Miyake, Friedman, Emerson, Witzki, & Howerter, 2000); first, updating information in
8 working memory (e.g., storage, monitoring and processing of information); second, inhibition
9 of prepotent responses (response inhibition) and distractor information (sustained
10 attention); and third, shifting of attention (cognitive flexibility) between tasks and mental
11 sets. Deficits in response inhibition, sustained attention, and shifting attention are the most
12 widely researched in autism. Therefore, the experimental protocols developed to assess
13 these factors, directed the measurement of them in the current research (e.g., Adams &
14 Jarrold, 2012; Christ, White, Holt, & Green, 2007; Eylen et al., 2015). Furthermore,
15 impairments in cognitive control processes were found to be the primary cause of the
16 repetitive and stereotyped traits associated with autism (Ozonoff, et al., 1994; Pooragha, Kafi,
17 & Sotodeh, 2013; Reynolds, Lincoln, Irvani, Toma, & Brown, 2018; Russell, Jarrold, & Henry,
18 1996).
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41 Response inhibition (i.e., the ability to withhold prepotent responses to practiced
42 stimuli) can be measured by Stop-signal (e.g., Go-No-Go; Verbruggen & Logan, 2008) and
43 Stroop tasks. Stop-signal tasks are considered to be more reliable measures, as the Stroop
44 task does not provide as much distraction from the colour of the stimulus as anticipated,
45 when measuring response inhibition in children with autism (Adams & Jarrold, 2012; Christ et
46 al., 2007). Conversely, sustained attention (i.e., resistance to distractor information) can be
47 measured by the Flanker task (Eriksen & Eriksen, 1974). This task, in particular, is considered
48 to be a valid measure of the underlying resources that explain the everyday difficulties in
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1 cognitive functioning, found in autism (e.g., highly repetitive thought and action) (Adams &
2 Jarrold, 2012; Hill, 2004). It was also noted that perceptual ability should be taken into
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4 account, as some children with autism were able to process a greater number of distractors
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6 before their perceptual capacity was overloaded (Adams & Jarrold, 2012). Additional
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8 mediating factors for performance on inhibition, sustained attention, and attention shifting
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10 tasks include gender of participants, IQ discrepancy (distance between verbal and
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12 performance IQ) and age of the participants (Boland et al., 2018; Christ et al., 2007; Eylon et
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14 al., 2015; Pellicano, 2011). All of which have been found to act as a protective factors and/or
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16 compensatory influences on achievement by children with autism, who are attending
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18 mainstream school settings and were taken into consideration in the current research
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21 (Kalbfleisch & Loughlan, 2012).
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31 Of further relevance to the current research were the findings that children with
32 autism who have deficits in cold EF, experience difficulty generating spontaneous pretense
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34 (Jarrold, Boucher, & Smith, 1996), imagining things that conflict with reality (Scott & Baron-
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36 Cohen, 1996); and have problems with the self-regulation of emotion, which is important for
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38 creating emotion awareness in the self and others (Cai, Richdale, Uljarević, Dissanayake, &
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40 Samson, 2018; Garfinkel et al., 2016; Mazefsky Pelphrey, & Dahl, 2012). In addition, EF and
41
42 pretense were robustly correlated in preschool children (Carlson & White, 2013).
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44 Furthermore, maladaptive emotion regulation practices related to hot EF could directly
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46 influence cognitive processes in writing. They include rumination (perseveration), the act of
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48 repetitively going over a thought or idea without completion, which inhibits the ability to shift
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50 information between the goals of a task (Ozonoff et al., 1994; see Yang, Cao, Shields, Teng, &
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52 Liu, 2017 for review). In association with the high level, goal-orientated cognition involved in
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1 writing, this could limit the availability of cognitive resources to support the generation of
2 ideas and the development of syntactic complexity required to express them, which is in
3 place around 9 years of age (Dockrell et al., 2014). It is worth noting that perseveration can
4 be regarded as a positive response that allows the writer to concentrate on the various sub-
5 goals of the task, and thus potentially increasing performance. Diary entries by young people
6 with autism (aged 8-20 years), support evidence for the engagement in repetitive behaviours,
7 and indicated they were a means of coping with the emotions they were feeling (Samson et
8 al., 2015). They were found to develop alongside difficulties in cognitive control (Mazefsky et
9 al., 2012) and empathising (Baron-Cohen, 2009). The limited research (Mazefsky et al., 2012)
10 that has been conducted exploring the relationship between cold and hot EF indicates they
11 are not necessarily related and could make independent contributions to writing outcomes
12 (Reynolds et al., 2018). Therefore, the current study sought to further an understanding of
13 the extent of the relative contribution made by both concepts of EF and autism traits to
14 narrative coherence in writing.

36 **Narrative coherence in writing, imagination and executive functioning**

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41 Closely aligned to EF theories of autism, models of writing development also include
42 a central role for attention (Berninger, Garcia, & Abbott, 2009). EF have been found to reliably
43 predict the development of the processes involved in children's writing (e.g., transcription
44 and text generation; Berninger & Richards, 2012; Bourke, Davies, Sumner, & Green, 2014;
45 Drijbooms et al., 2015, 2017). The relationship between EF and transcription is more likely to
46 be stronger in the early stages (Drijbooms et al., 2015). Fluent handwriting increases the
47 availability of cognitive resources to support linguistic processes, at word, sentence and text
48 level, affecting the quantity, complexity, and content of what is written (e.g., spelling,
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1 grammar and narrative skills; Sumner, Connelly, & Barnett, 2014). Thus, providing a rationale
2 for why phonological working memory (updating) becomes increasingly important as writers
3 develop their skills (Bourke & Adams, 2003; 2010). Although less reported in the
4 developmental literature, linguistic attention shifting processes were found to be
5 independent predictors of individual differences in the holistic quality of narratives written
6 by children who are typically developing, aged 7 years (Key Stage 1, UK Curriculum, DfE, 2017)
7 (Bourke & Adams, 2003). For slightly older children (aged 9-11 years), when a heavier
8 emphasis is placed on the ability to incorporate structural elements into stories (King,
9 Dockrell, & Stuart, 2014) and writing (Key Stage 2, UK Curriculum, DfE, 2017), a direct and
10 unique longitudinal link with response inhibition was found for the number of words written
11 and syntactic complexity but not narrative content (number of ideas) (Drijbooms et al., 2015,
12 2017). Alternatively, research in autism has drawn attention to the importance of including
13 the hot affective processes underpinning cold EF, as well as assessment of wider elements of
14 structural coherence in written narratives and, has consequently directed the focus of the
15 current study.

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40 Narrative coherence is defined as the global representation of story meaning, and is
41 linked to the temporal order of events, encompassing actions, perspectives, and emotions of
42 characters (Karmiloff-Smith, 1985; Porter Abbott, 2008) as well as being closely related to
43 imagination, and divergent thinking (Crespi et al., 2016). Research comparing the two
44 developmental groups of children in the area of narrative writing is limited, and findings are
45 mixed. For instance, children with and without autism showed no differences in narrative
46 writing when using computer assisted technology to develop and prompt writing skills (Dillon
47 & Underwood, 2012). In contrast, alternative empirical data found that when children with
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1 autism wrote fiction it lacked overall coherence, social-emotional content, and fantasy
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3 (Barnes & Baron-Cohen, 2012; Crespi et al., 2016), and the stories were shorter when
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5 compared to typically developing peers (Zajic et al., 2018). Therefore, writing performance is
6
7 dependent both on the individual and the nature of the task (Berninger & Richards, 2012).
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9 Accordingly, one of the aims of the current study was to include an open-ended narrative task
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11 to help children develop their own ideas. In contrast to standardised measures of writing
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13 (e.g., Wechsler Individual Achievement Test, 2017), in the present study, we used an
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15 assessment based on three dimensions, that encompassed basic and episodic macro-level
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17 competences of the representational challenges children face when producing coherent
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19 written narratives: (1) *structure* (i.e., story beginning, setting, character description, action
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21 and story ending); (2) *plot* (goal, problem and resolution); and (3) *enrichment* (dialogue for
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23 effect, internal responses of characters, mood and atmosphere) (Bourke & Adams, 2003;
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25 Karmiloff-Smith, 1995; Shapiro & Hudson, 1991).
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35 **The Present Study**

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38 The main purpose of the research was to establish the extent to which the interplay
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40 between autism characteristics and EF effected the ability to develop coherence in story
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42 writing. Research question (1) examined the effect of developmental group on the scores
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44 obtained for the measures of executive functions, emotion regulation strategy, and writing
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46 skills. Based on experimental protocols widely used in autism research for the measurement
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48 of cold EF (Adams & Jarrold, 2012; Eylon et al., 2015), we predicted (1a) that children with
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50 autism would perform less well on tasks measuring inhibition of distractor information and
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52 the ability to shift attention between task-relevant incoming information, relative to typically
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54 developing peers. Further differences were expected (1b) between the children in the
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1 strategies used for managing emotions (Cai et al., 2018; Mazefsky et al., 2012). In comparison
2 to children with autism, typically developing children were expected to report a greater
3 degree of engagement in adaptive emotion regulation strategies. We predicted (1c) group
4 differences between the children on the elaboration of macro-level story writing factors (i.e.,
5 structure, plot, and enrichment of text) (Crespi et al., 2016). Once the nature of the
6 differences between the two groups of children were established, research question (2)
7 measured the extent to which executive functions and developmental group independently
8 accounted for individual differences in story writing ability. Since children with autism are
9 substantially compromised in their ability to empathise (Barnes & Baron-Cohen, 2012), it was
10 likely that the impact would be greater for the enrichment of narrative text, because of its
11 links to understanding of affect. The final research question (3) explored how far the
12 interaction between the developmental group the children belonged to and executive
13 functions, predicted the ability to imaginatively enrich the written texts (Zajic et al., 2018).
14 We expected this to be a significant factor based on the alignment between the EF
15 characteristics of autism and those that are required for good story-writing.
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41 **Method**

42 **Participants**

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52 Sixty-one children were recruited from mainstream primary schools and an autism
53 support group for families. They were attending Year 3-6 classes ($M_{age} = 9$ years 7 months, SD
54 = 14 months, 18 female, 43 male). A selected group of children who had been recognised
55 with autism characteristics, and were being cared for by the local autism spectrum disorder
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1 pathway multidisciplinary team (i.e., identification, referral, assessment, diagnosis,
2 management) (National Institute for Health and Care Excellence, 2019) ($N = 26$, $M_{age} = 9$ years
3 5 months, $SD = 16$ months, 4 female and 22 male, $N = 10$ diagnosed with autism and $N = 16$
4 autism pathway), and an age-matched group of typically developing children ($N = 35$, $M_{age} = 9$
5 years 8 months, $SD = 12$ months, 14 female and 21 male) participated in the study. Both
6 groups of participants attended the same mainstream schools, and there was Local Education
7 Authority statemented special educational support in school based on the needs associated
8 with autism for those children in the selected group. There were no significant differences in
9 age between the two groups of children $t(59) = 1.042$, $p = .302$, Hedges $g = 0.264$.

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23 The research was carried out in accordance with ethical guidelines for investigations
24 involving vulnerable human participants. Participants' primary caregivers gave their written
25 consent for participation in the study.

26 27 28 29 30 31 **General Procedure**

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34 The participants completed the assessments over three sessions in a quiet location
35 within their school environment. Each session lasted approximately 30 minutes. The tasks
36 were counterbalanced within each session but presented in a fixed order across sessions.
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1 appreciation. The ASSQ is considered to be an effective screening tool with established
2 psychometric properties, rather than a clinical instrument to confirm diagnosis of autism (see
3 Posserud et al., 2008 for discussion of the reliability and validity of the questionnaire within a
4 clinical setting). It has been widely used in schools in the UK (Posserud, Lundervold, & Gillberg,
5 2009). The questionnaire consisted of 27 items which were rated on a three-point scale; 0
6 (not true), 1 (sometimes true) and 2 (certainly true) ($\alpha = 0.96$). It took into consideration a
7 wide range of symptoms related to, social interaction, verbal and non-verbal communication,
8 restricted and repetitive behaviours and motor coordination, and predictive of diagnosis of
9 autism. The recommended cut off score was ≥ 17 points for children displaying social and
10 behavioural characteristics associated with autism on the parent questionnaire, which
11 corresponds to an estimated sensitivity of 0.91 and specificity of 0.86 (see Posserud,
12 Lundervold, & Gillberg, 2009 for a fuller discussion of the validity of the ASSQ in a total
13 population sample of 7-9 year olds). The parents of children in the autism group rated their
14 children significantly higher on the questionnaire than the parents of the children in the
15 typically developing group $t(59) = -22.518, p < .001$, Hedges $g = 3.92$ (autism group $M = 24.87$,
16 $SD = 8.59$, range = 17-40; typical group $M = 1.81$, $SD = 2.35$, range = 0-8).

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Studies in autism and typical development (e.g., Adams & Jarrold, 2012; Boland et al.,
2018; Eylen et al., 2015; King et al., 2014) found that it was important to control for
differences between the groups in relation to, the gender of the participants, vocabulary
knowledge, general intelligence and perceptual processing, and the number of words written
in compositions when evaluating the relative contribution of underlying cognitive and
affective factors in literacy-based tasks.

Standardised tests

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3 The raw scores for all standardised tests were converted into scaled scores based on
4
5 the child's age at the time of testing. A scaled score of ≤ 7 represents below average
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7 performance. Table 1 refers to the range of scaled scores for each of the assessments
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9 described below.

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12 **Nonverbal cognitive ability.** WISC-IV (Wechsler, 2004) block design task. The
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14 experimenter presented a model construction to the child either in person or from a stimulus
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16 book who then had to reconstruct this within a given time limit. They were scored according
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18 to their completion time and accuracy. They received 0 points when the design did not match
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20 the model or picture, rotation of 30° or more, or when they exceeded the time limit. Internal
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22 consistency reliability for the task is reported as $r = .86$. Concurrent validity with the written
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24 expression subtest of the WIAT-II (Wechsler, 2006) is $r = .46$.

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31 **Verbal ability.** WISC-IV (Wechsler, 2004) vocabulary task. The children were required
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33 to provide definitions for words that were read aloud to them by the experimenter. Any
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35 recognised meaning of the word was determined to be acceptable. A child scored one point
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37 if their response was correct but was not elaborated upon and two points if the content was
38
39 more developed. For incorrect responses, 0 points were recorded. Internal consistency
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41 reliability for the task is reported as $r = .89$. Concurrent validity with the written expression
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43 subtest of the WIAT-II (Wechsler, 2006) is $r = .58$.

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51 **Perceptual processing speed.** WISC-IV (Wechsler, 2004) coding task. For this task, the
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53 children were asked to copy symbols that were paired with simple geometric shapes or
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55 numbers within a specified time limit using a key they were provided with. Children received
56
57 one point for each correctly drawn symbol. Internal consistency reliability for the task is

1 reported as $r = .85$. Concurrent validity with the written expression subtest of the WIAT-II
2 (Wechsler, 2006) is $r = .44$.
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4 **Executive function measures**

5 Cold EF measures were guided by, an extensive review of inhibition, sustained
6 attention and shifting attention in autism (Adams & Jarrold, 2012; Eylon et al., 2015), and
7 piloted before administration. The experimental protocols enabled the capturing of reaction
8 time data to support comparisons in error performance. Although less reliable in predicting
9 differences between age-matched children with autism and typically developing children, we
10 included a measure of prepotent response inhibition as this was found to be predictive of
11 typical development in writing (Drijbooms et al., 2017).
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25 ***Inhibition: Withholding Prepotent Response.*** Go-No-Go Task (Verbruggen & Logan,
26 2008). In this computer-based task, children were asked to inhibit their response when
27 presented with a triangle, but to press X when presented with a circle or square. Following
28 two training blocks consisting of 18 trials each (6 No-Go/12 Go), with feedback given after
29 each trial in the first block but not the second, they undertook a single block of 120
30 experiment trials (24 No-Go, triangle/96 Go trials, consisting of 24/circle and 72/square). All
31 shapes could appear in either a larger or small size, and be presented in red, green or blue
32 (on a white background). All combinations were presented equally and displayed in a random
33 order without replacement. After initial instructions, each trial consisted of, a 200 ms fixation
34 cross display, a target display for 1500 ms, followed by a 500 ms blank inter-trial interval after
35 response (or no response). On Go trials, if a response had not been registered by 1500 ms,
36 feedback was given indicating that the participant had been too slow. The experiment used
37 E-Prime 2 Professional.
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Sustained attention: Resistance to Distractor Information. The Flanker Task (Eriksen & Eriksen, 1974). This task required the participants to attend to a single arrow (either < or >) presented centrally while ignoring four flanking arrows (two left and two right). The trials could be compatible (<<<< or >>>>) or incompatible (<<><) or (>><>) and were presented as black print on a white background. Participants pressed the Z key for a left-facing centre arrow (<), or M for a right-facing centre arrow (>). A practice block of 20 trials was presented to the child followed by an experiment block of 120 trials. In both practice and experiment blocks, 50 % consisted of congruent trials, of which 50 % were left-facing. On incongruent trials, flanking arrows pointed in the opposite direction to the central arrow. Each trial consisted of, a 1000 ms fixation, a 3000 ms flanker display during which a response should be given, followed by an a 1000 ms feedback/inter-trial interval display ('Correct', 'Incorrect', or 'Too slow'). All trials in all blocks were randomly presented. The experiment used E-Prime 2 Professional.

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Cognitive flexibility: Attention shifting. In this computer-based task (Vandierendonck, Liefoghe, & Verbruggen, 2010). The participants were required to press Z or M in response to two plain blue shapes (triangle = Z or square = M) or a number of vertically aligned dots that appeared within the same shapes (2 = M or 3 = Z). White dots always appeared within one of the two shapes equally often. The experiment consisted of four blocks. After initial instructions and examples of all of the six possible stimuli (i.e., square, triangle, square with two dots, square with three dots, triangle with two dots, triangle with three dots), participants took part in a practice block of 12 trials that included two instances of each possible stimulus. This was followed by a shape-only block of 40 trials, with the triangle and square being equally probable, and a dot-plus-shape block of 40 trials, where each combination of shape and number of dots was equally likely. A final block contained a mixed

1 set of shapes and dots-plus-shapes, so that participants needed to switch between tasks
2 depending upon the stimulus presented, incurring increased effort through the process of
3 shifting attention between them. This block of 60 trials contained 10 trials each for every
4 possible stimulus/response type. Each trial, in each block, started with a 250 ms fixation,
5 which was followed by the target display that appeared until response, and this was followed
6 by a 250 ms blank inter-trial interval. All trials in all blocks were randomly presented and the
7 experiment used E-Prime 2 Professional.

17 **Emotion regulation.** A shortened version of the Cognitive Emotion Regulation
18 Questionnaire (CERQ-Sk) (Orgilés, Morales, Fernández-Martínez, Melero, & Espada, 2019)
19 was administered. The questionnaire included 18 items representing nine conceptually
20 distinct subscales divided between maladaptive (self-blame, rumination, catastrophising and
21 other blame) and adaptive (positive acceptance, refocusing, planning, positive reappraisal,
22 putting into perspective) strategies for emotion regulation. Items were measured on a 5-
23 point Likert scale ranging from 1 (*almost never*) to 5 (*almost always*) ($\alpha = .65$; subscale range
24 $\alpha = .35 - .90$). The researcher read the items aloud and answered any questions the children
25 had. The scores for individual subscales were derived by summing up scores belonging to the
26 particular subscale. A higher score on a subscale indicated the more likely the children were
27 to suggest they used a specific cognitive strategy.

46 **Spontaneous story writing.** Rory's story cubes were used to assist the children in the
47 writing task. The game consisted of nine dice with a different image on each side, when they
48 rolled the dice whichever images they landed on, the children were encouraged to create a
49 story associated with the pictures. The cubes are produced as an aid for children's imagination
50 and encourages them to develop their own stories (Al-Shorachi, Sasasmit & Goncalves, 2015).
51 The children were introduced to the story cubes and asked to choose some and look at the

1 pictures on them to help them come up with ideas. They were then given a few minutes to
2 think about this from a total of 10-15 mins spent orientating them to the task. Once the
3 composing part of the session began the children were timed for 20 mins and prompted to
4 keep writing until the time was up.
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10 **Narrative coherence.** The writing was assessed based on a scoring procedure that was
11 developed from guidelines for story-telling used in previous research (e.g., Bourke & Adams,
12 2003; Losh & Gordon, 2014; Shapiro & Hudson, 1991), and assessment practices in school
13 (Oxford Writing Scale, Wilson, 2015). Narrative coherence was judged according to the
14 development of three separate factors; *structure* (actions, character description, setting,
15 story beginning and end), *plot* (episodic components, causal language) and *enrichment of*
16 *narrative* (dialogue for effect, internal responses, mood and atmosphere, vocabulary for
17 impact). The latter factor elaborated on the structure and plot, and consequently developed
18 imaginative content. A maximum of 12 points could be awarded for structure (total = 5
19 points), plot (total = 3 points), and narrative enrichment (total = 4 points). All were included
20 as separate dimensions in future analyses to enhance specificity of measurement of narrative
21 coherence. Two researchers who were former teachers and experienced in assessing and
22 moderating children's writing, rated all the samples of spontaneous writing together to
23 maintain consistency and reach agreement. There was reliable agreement by an independent
24 rater on the dimensions assessed (correlations ranging from $r = .86$ enrichment, $r = .90$ plot
25 to $r = .92$ structure).
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50 **Number of words written.** Child Language and Analysis (CLAN) (MacWhinney &
51 Spektor, 2018). In order to control for the number of words the children wrote in their
52 narratives they were transcribed into the CLAN programme and counted.
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Statistical analyses

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5 The first research question was answered by conducting separate multivariate
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7 analyses (MANOVA) that explored the effect of developmental group on the scores for
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9 measures associated with each of the three constructs being measured (i.e., cold EF /
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11 response inhibition, sustained attention, cognitive flexibility; hot EF / emotion regulation
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13 strategy; and narrative coherence / structure, plot and enrichment). Follow-up ANOVAS were
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15 conducted on variables within significant models to determine the strength of individual
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17 effects.
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23 With regard to the second research question (i.e., the extent to which EF and
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25 developmental group contributed to individual differences in story writing ability), first we
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27 ran correlational analyses between the measures of writing performance and variables within
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29 EF constructs found to be significant at the previous stage of analysis. The significant *r*
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31 coefficient for response inhibition and attention shifting was moderate ($r = .44$) indicating
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33 they were distinct constructs. To limit the number of variables entered into the hierarchical
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35 regression analyses, partial correlations were explored first, controlling for variables (i.e.,
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37 nonverbal ability, verbal ability, perceptual processing speed, number of words written) that
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39 could potentially account for the relationship between EF and writing quality. The measures
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41 of narrative coherence that continued to bear a significant association with EF skills were
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43 included in Step 1 of a hierarchical regression analysis model, which controlled for the gender
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45 of the participants.
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54 The third research question, to what extent does developmental group interact with
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56 individual differences in EF to predict narrative coherence, was explored in Step 2 of the
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58 hierarchical regression analysis.
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Results

Insert Table 1

Descriptive statistics for all measures are reported in Table 1. The distributions of the observed values were explored and the skewness statistic was within an acceptable range for all variables (Field, 2013).

Standardised tests

A series of independent *t* tests examined group differences in measures of cognitive ability and the number of words children wrote. Significant differences were found for all factors (*nonverbal ability* $t(59) = 2.262, p = .027$, Hedges $g = .58$, *verbal ability* $t(59) = 2.401, p = .019, g = .63$, *perceptual processing speed* $t(59) = 2.790, p = .007$, Hedges $g = .72$ and *number of words written* $t(59) = 3.259, p = .002$, Hedges $g = .84$). The children with autism scored significantly lower on all four measures. Potential confounds were controlled for in later analyses (partial correlations) exploring the relationships between the main significant variables associated with group differences in EF and the compositional quality of the children's writing, before conducting Steps 1 and 2 of the hierarchical analyses. This approach was taken rather than excluding any of the children based on guidelines for age-related average performance on the vocabulary task, the implications of which are discussed later. We took note that our study, at this stage, was exploratory as there had been limited previous research, which included clinical samples and measurements of executive functioning, and writing. In which case, based on two further factors: 1) all the children in the study wrote to a narrative prompt, and 2) nonverbal cognitive ability (measure of general intellectual

1 functioning) was above the standardised score for average performance, we decided that
2 there were not sufficient grounds on which to remove children from the study. As important
3 was all children attended mainstream schools, where practices of inclusion were paramount.
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5 Further to this, we looked at three children who obtained a standardised score of 1 on the
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7 vocabulary task in the autism sample in more detail, at this point and in later analyses¹. A
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9 standardised score of 1, represented scores of 4, 8 and 13 words correct for those children.
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11 The child who correctly identified the meaning of 4 words, had a standardised score of 10 on
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13 the nonverbal ability task, 2 on the perceptual processing speed task, and wrote 32 words;
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15 the child who scored 8, also achieved a standardised score of 10 on the nonverbal ability task,
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17 10 on the perceptual processing speed task, and wrote 15 words, which was relatively low by
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19 comparison to other children; and the third child who identified 13 words correctly, had a
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21 standardised score of 12 on the nonverbal ability task, 7 on the perceptual processing task,
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23 and they wrote 103 words. The variability is illustrative of the complexity of the interplay
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25 between differences in developmental groups and the linguistic, cognitive, and writing factors
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27 (Berninger & Winn, 2006), that we have begun to address in our research. It was expected
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29 that within the spectrum of communication difficulties associated with autism characteristics,
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31 that there would be some children who were challenged on tasks that required verbal
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33 production of language and this was controlled for in later analyses, as indicated previously.
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56 ¹ Later analyses were conducted after removing the children with a standard score of 1 on
57 the WISC-IV Vocabulary Scale, and there were no significant differences found to the
58 outcomes of the findings.
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Group differences

The first MANOVA examined differences in error rates for cold EF tasks (research question 1a) (Go-No-Go, Flanker, attention shifting). As predicted the cognitive cost of inhibiting and shifting attention between stimuli was found to be a significant factor in determining differences in cognitive control for the two groups of children, Wilks $\Lambda = .856$, $F(3, 57) = 3.204$, $p = .030$, $\eta^2_p = .14$. The subsequent follow up one-way analyses of variance (ANOVA) indicated that performances on the Flanker, $F(1, 59) = 5.072$, $p = .028$, $\eta^2_p = .08$ and attention shifting, $F(1, 59) = 8.004$, $p = .006$, $\eta^2_p = .12$, tasks were significantly more error prone for the children with autism. Performance on the attention shifting task accounted for the greater percentage of the variance between the two groups (12 %). No significant difference was found between the groups for the Go-No-Go task, measuring inhibition to prepotent responses ($p = .213$). Therefore, only the measures of inhibition to distractor information and cognitive flexibility were included in later analyses. Further, there was no significant main effect for RT in the second MANOVA for cold EF tasks, Wilks $\Lambda = .950$, $F(3, 57) = 1.004$, $p = .398$, $\eta^2_p = .05$.

When examining hot EF (research question 1b), significant differences were found in the use of maladaptive emotion regulation strategies (self-blame, rumination, catastrophizing, and other-blame), Wilks $\Lambda = .719$, $F(4, 56) = 5.468$, $p = .001$. The multivariate η^2_p based on the Wilks Λ was strong indicating that 28 % of the variance of the dependent variables was explained by the group factor. The children demonstrating characteristics associated with autism were, on average, more likely to suggest that these were their preferred strategies for dealing with life events. The univariate ANOVA for *other-blame* was the only statistically significant factor accounting for the differences in the children's use of maladaptive strategies, and the group the children were assigned to $F(1, 59) = 15.887$, $p <$

1 .001, $\eta^2_p = .21$. Consequently, *other-blame* was included in subsequent analyses. However, in
2 contrast to the use of maladaptive strategies, no significant differences were found for the
3 multiple dependent variables associated with adaptive strategies for emotion regulation,
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5 Wilks $\Lambda = .966$, $F(5, 55) = .383$, $p = .858$. Therefore, these sub-scales were excluded from
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7 further analyses.
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12 There was a main effect for the group the children were assigned to for the variables
13 associated with narrative coherence (research question 1c), Wilks $\Lambda = .326$, $F(3, 57) = 39.233$,
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15 $p < .001$, $\eta^2_p = .67$. Of particular note, this MANOVA had the strongest effect size. The finding
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17 was further emphasised in follow up ANOVAs, where all dependent variables were found to
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19 be significant [*structure* $F(1, 59) = 41.837$, $p < .001$, $\eta^2_p = .41$, *plot* $F(1, 59) = 20.535$, $p < .001$,
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21 $\eta^2_p = .26$ and *enrichment of text* $F(1, 59) = 76.068$, $p < .001$, $\eta^2_p = .56$]. The children with autism
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23 had significantly lower scores than the children who were typically developing. Enrichment of
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25 text was found to exert the strongest impact on the variance between the two groups of
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27 children, accounting for 56 %.
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38 **Correlation analyses**

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1 gender of the participants (boys = 43, girls = 17) was negatively associated with the Flanker
2 task, and the use of a maladaptive strategy for emotion regulation (*other-blame*). It was
3 positively associated with number of words the children wrote, and the plot and enrichment
4 of the narratives. On average, males were significantly more likely to demonstrate errors
5 when required to inhibit distractor information (sustained attention) and were significantly
6 more likely than females to use other-blame emotion regulation strategy. Females wrote
7 more, produced better plots and enriched the compositional quality of their writing to a
8 greater degree than the male participants. Significant associations were found between
9 nonverbal cognitive ability and sustained attention, structure and enrichment of the
10 narratives. Verbal ability was significantly associated with attention shifting, maladaptive
11 emotion regulation, structure and plot. However, it was not significantly related to the
12 number of words the children wrote or enrichment of the narratives. An additional factor
13 that supported a rationale for not excluding children from the study, on the basis of poorer
14 performance on the vocabulary task. Processing speed again varied in the pattern of
15 significant relationships between factors. It was significantly correlated with the number of
16 words written, attention shifting, structure and the enrichment of text. Unsurprisingly the
17 number of words the children wrote was significantly positively related to all measures of
18 quality of writing. Those participants who were able to minimise the errors they made in the
19 Flanker task, produced significantly better quality stories based on the enrichment measure.
20 Performance on the attention shifting task was significantly negatively associated with the
21 structure and enriched nature of the texts.

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Insert Table 3 here

1 To limit the number of variables entered into the hierarchical regression, Table 3
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3 refers to the partial correlations that controlled for the influence of significant differences
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5 between the groups in performance on the developmental variables, known to underpin
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7 progress children make in writing, first. Once the analysis had been conducted, plot and
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9 structure no longer bore a significant relationship to the two EF tasks; and attention shifting
10
11 alone continued to be significantly associated with the enrichment of the texts. Furthermore,
12
13 the relationship between attention shifting and enrichment remained significant after
14
15 controlling for the number of words the children wrote. Emotion regulation in the form of
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17 other-blame remained significantly negatively related to all three writing variables.
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19 Therefore, enrichment of text became the criterion variable, with attention shifting and
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21 other-blame (in addition to developmental group) the predictor variables of main interest in
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23 the study, after controlling for gender.
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32 **Hierarchical regression analysis**

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Insert Table 4 here

66 In Step 1 of the model (research question 2), gender of the participants was entered
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68 into the equation before the impact of the cognitive effort involved in attention shifting was
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70 added. The contribution to the variance in children’s writing performance made by emotion
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72 regulation strategy was assessed next. Finally, the developmental group the children were
73
74 assigned to was entered into the equation. Table 4 includes the beta weights and change in
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76 R^2 . Overall the model accounted for 65 % of the variance in the quality of the children’s

1 writing (adjusted $R^2 = .626, p < .001$). The beta values for developmental group and attention
2 shifting were significant. Whilst the gender of the participants and maladaptive emotion
3 regulation strategy failed to reach significance. The R^2 change for the group the children were
4 assigned to, indicated that this factor contributed to an additional 26 % of the variance in the
5 children's writing. Finally, in Step 2 of the model (research question 3), using centred
6 variables, Table 4 indicates a significant interaction between group status and attention
7 shifting in predicting narrative coherence. The model accounted for 69 % of the variance in
8 children's ability to enrich texts beyond their starting point (adjusted $R^2 = .657, p < .001$).
9 However, although significant, only 3.1 % of the observed variance related to the interaction
10 factor according to the adjusted R squared value. Figure 1 shows that children who were
11 typically developing and were less error prone in the attention shifting task, and thus
12 demonstrated higher levels of cognitive control, were able to benefit significantly more from
13 the protective factors provided when enriching the imaginative content of written narratives.
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34 **Discussion**

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40 The current study explored the impact EF and characteristics of autism had on
41 narrative coherence in writing. The children with autism and typically developing peers were
42 compared on a number of different executive functions ranging from, cold cognitive to hot
43 affective factors and assessed on three aspects of narrative coherence. In accordance with
44 previous research in autism, the findings indicated there were significant differences between
45 the children in the ability to sustain and shift attention between different sets of stimuli, and
46 on average the children were able to minimise the errors they made on the prepotent
47 response inhibition tasks equally well (e.g., Adams & Jarrold, 2012; Eylon et al., 2015). There
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1 were no significant differences between the children in the use of adaptive emotion
2 regulation strategies. However, there were significant differences found in the use of
3 maladaptive strategies, in particular, other blame. This strategy indicates a tendency to
4 consider other people or aspects of the environment at fault for the situation people find
5 themselves in (Garnesfski et al., 2007).
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12 After controlling for nonverbal cognitive ability, vocabulary, perceptual processing
13 speed, and the number of words the children wrote, attention shifting and other blame
14 continued to bear significant associations with writing skill (i.e., enrichment of narrative).
15 With regard to the main research question, after controlling for the gender of the
16 participants, the capacity of attention shifting and autism characteristics to predict
17 enrichment, was examined in more detail. Both the developmental group the children
18 belonged to and performance on the attention shifting task were able to account for
19 significant proportion of the variance in the ability to include different perspectives and
20 develop mood and atmosphere in writing. In assessing, the degree the interaction between
21 group and executive function predicted writing performance, we found the children who
22 were typically developing, were able to benefit more from efficient attention shifting skills
23 than the children with autism.
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44 The findings extend the role of executive control processes in writing highlighted in
45 previous research (Berninger and Richards, 2012; Bourke et al., 2014; Drijbooms et al., 2015;
46 2017; Kellogg et al., 2013) to children with autism. In particular, the effort to deploy cognitive
47 resources to shift attention across different sets of information, compromised children's
48 ability to simultaneously focus on, organising, sequencing, and prioritising the language
49 needed, to elaborate on ideas and convey the thoughts, and feelings of the narrator or
50 protagonist in written narratives. Cognitive flexibility is required to infer changing viewpoints
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1 and mental states of others (Bock et al., 2015), which distinguish a narrative from other
2 genres of writing (Crespi et al., 2016). It is possible for some, that once ideas are generated,
3 they are easily lost and/or expressed poorly resulting in minimal expression and simplistic
4 texts (Bourke & Adams, 2003). In contrast to research with typically developing children,
5 there was a significant association between EF and quality of the stories (Drijbooms et al.,
6 2015; 2017). This in part can be explained, by differences in the methods (e.g., experimental
7 stimuli vs standardised measures) and measurement of efficiency of executive functions (e.g.,
8 cognitive cost, measurement of errors and RT), a wider range of dimensions to capture
9 narrative coherence, and a comparison between developmental groups. All of which
10 dominate the contradictions in the area of EF and writing at present, even though there is
11 general agreement that the model used by Miyake et al., (2000) encapsulates the main
12 functions describing the cognitive resources underpinning writing development (Berninger &
13 Richards, 2012). Increased empirical evidence in the area and opportunities for replication of
14 findings will contribute to a more comprehensive explanation of the inconsistencies. The
15 decision for the measures of EF used in this study was based on the main perceptual
16 difficulties (i.e., filtering of visual information) associated with autism (Adams & Jarrold,
17 2012). The associated experimental paradigms afford an opportunity to manipulate and
18 contrast different domains of information processing, including emotion-based stimuli in
19 future research, so that a fuller account of the range of autism characteristics and EF is
20 developed. Previous research has also highlighted the role of updating in working memory as
21 central to the development of writing skills (Berninger & Richards, 2012; Bourke & Adams,
22 2003; Drijbooms, 2015, 2017), and should be included in future research in autism to explore
23 the role of wider EF in different processing domains (i.e., visuo-spatial and phonological;
24 Bourke et al., 2014; Dockrell et al., 2014).

Limitations of the current study

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5 In contrast to previous studies (e.g., Dillon & Underwood, 2012; Dockrell, Ricketts,
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7 Charman, & Lindsay, 2014) that considered differences in performance between children with
8
9 autism and typically developing peers, all the children in our current sample produced writing
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11 to the prompt they were given. We believed this and the finding that the link between
12
13 narrative coherence and receptive vocabulary was not significant in previous research, once
14
15 other factors had been taken into consideration (Bourke & Adams, 2003; 2010; Dockrell et
16
17 al., 2014), mitigated against any substantial reason to exclude children who were in
18
19 mainstream school, from participating in the study based on the measure of verbal ability we
20
21 used. Although all children were able to define some of the words in the task, it was very
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23 challenging for some with children with autism. This was because they tended to demonstrate
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25 more divergent (off tangent) thinking in their oral expression and took some time to develop
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27 the succinctness needed to encapsulate the defined meaning of the words, to optimise the
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29 points being awarded. Furthermore, the IQ profile in this domain was not generalised to
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31 other aspects of intellectual functioning measured in the study, which had accounted for
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33 individual differences in autism characteristics in previous research (Boland et al., 2018; Eylon
34
35 et al., 2015). Therefore, we decided to retain all children with autism characteristics
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37 irrespective of their oral language skills. In retrospect, even though performance on the
38
39 expressive verbal IQ measure used was not related to the number of words the children wrote
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41 and did not significantly alter the relationship between EF and narrative enrichment in the
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43 partial correlations, there is a substantial amount of unexplained variance between autism
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45 characteristics and writing performance that could be accounted for, in part, by sentence
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47 level skills (Dockrell et al., 2014). Importantly, sentence level skills are also significant in typical
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1 development (Drijbooms, 2015; 2017). Furthermore, we did not administer the Autism
2 Diagnostic Observational Schedule (ADOS-2) (Lord et al., 2012) or any other appropriate
3 diagnostic measures due to time constraints, and the number of assessments the children
4 needed to complete for the study within the context of other school-based activities. Only
5 autistic traits or symptoms were assessed in the current study. Despite this, in future studies,
6 the combination of standardised and semi-structured assessments of communication would
7 provide more detailed information regarding a child's expressive language level from which
8 to apply a more reliable and valid cut-off point for participation. In addition, it would offset
9 some of the potential for unaccounted for variability across children, depending where they
10 were located diagnostically, across the dimensions of functioning associated with autism.
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26 Emotion regulation was included in the study because of its links to supporting cold
27 EF skills (Zelazo, 2015) and the challenges people with autism encounter with emotional
28 awareness. The reliability of the questionnaire for the sample of children in this study was
29 low and did not match previous research (e.g., $\alpha = .80$, Orgilés et al., 2018). In future, it would
30 be useful to collect information regarding cognitive strategies for emotion regulation from
31 teachers and/or parents. Moreover, it is important to consider the relationship between
32 children's understanding of internal responses in others and themselves (and any discrepancy
33 between the two), including empathising (Sucksmith, Allison, Baron-Cohen, Chakrabati, &
34 Hoekstra, 2013). Current research in autism supports the importance of looking not only at
35 the strategies for emotion regulation, but the emotion goals people want to feel depending
36 on the context (López-Pérez, Ambrona, & Gummerum, 2018).
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Implications for education

Competency in narrative coherence is a critical factor in academic achievement (Boudreau, 2008) and one way forward to enhance EF would be to introduce self-regulated strategy development (SRSD) into writing instruction, to improve the performance of the children with autism (Asaro-Saddler, 2016; Pennington & Delano, 2012). SRSD is a structured approach to the organisation of writing and provides tools for children to become active agents in their own learning and understand how to respond adaptively to internal responses that conflict with the goal they are trying to achieve (Asaro-Saddler, 2016). Studies have found success in mitigating performance in autism by using computer assisted instruction (CAI) and peer support to develop narrative coherence (Dillon & Underwood, 2012; Pennington & Delano, 2012). CAI can also be used as a motivational device to provide positive reinforcement to increase productivity and self-efficacy through mastery (Asaro-Saddler, 2016; Pennington & Delano, 2012). Modelling appropriate language to represent internal responses, vocabulary for impact and mood and atmosphere, through either computer presentation or cue cards would support current oral language skills, and alleviate the cognitive load associated with the writing task (Bourke & Adams, 2003; Mayer & Moreno, 2003; Pennington & Delano, 2012; Schlosser & Blischak, 2004). Furthermore, spoken language ability would be a significant barrier to self-talk (overt or subvocal) SRSD (Asaro-Saddler, 2016) unless it is addressed.

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3 **Conclusion**
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7 Children with autism encounter difficulties in developing creative imaginative content
8 in writing. This is the first study that has considered the direct impact of EF. Individual
9 differences in the ability to enrich a written narrative is accounted by the cognitive effort
10 involved in shifting attention between ideas. Narrative production is especially important
11 because it connects imagination with socially based creativity, mental imagery, memory
12 processes, and mentalising (e.g., cognition focused on the social world and the drive to
13 understand, infer, and share the thoughts feelings and intentions of other individuals), more
14 generally (Crespi et al., 2016). The current research also indicated that children with autism
15 differ cognitively and emotionally from one another as much as, or more so than children who
16 are typically developing. Although there are limitations to the present study, continued
17 research in the area would be beneficial to extend our understanding of the interplay
18 between social and communication experiences in the real world and the creative writing
19 process, and should include cognitive executive functions and oral language, underpinned by
20 an understanding of emotion and factors beyond. By knowing what factors sustain creative
21 writing we can better support children better in its development.
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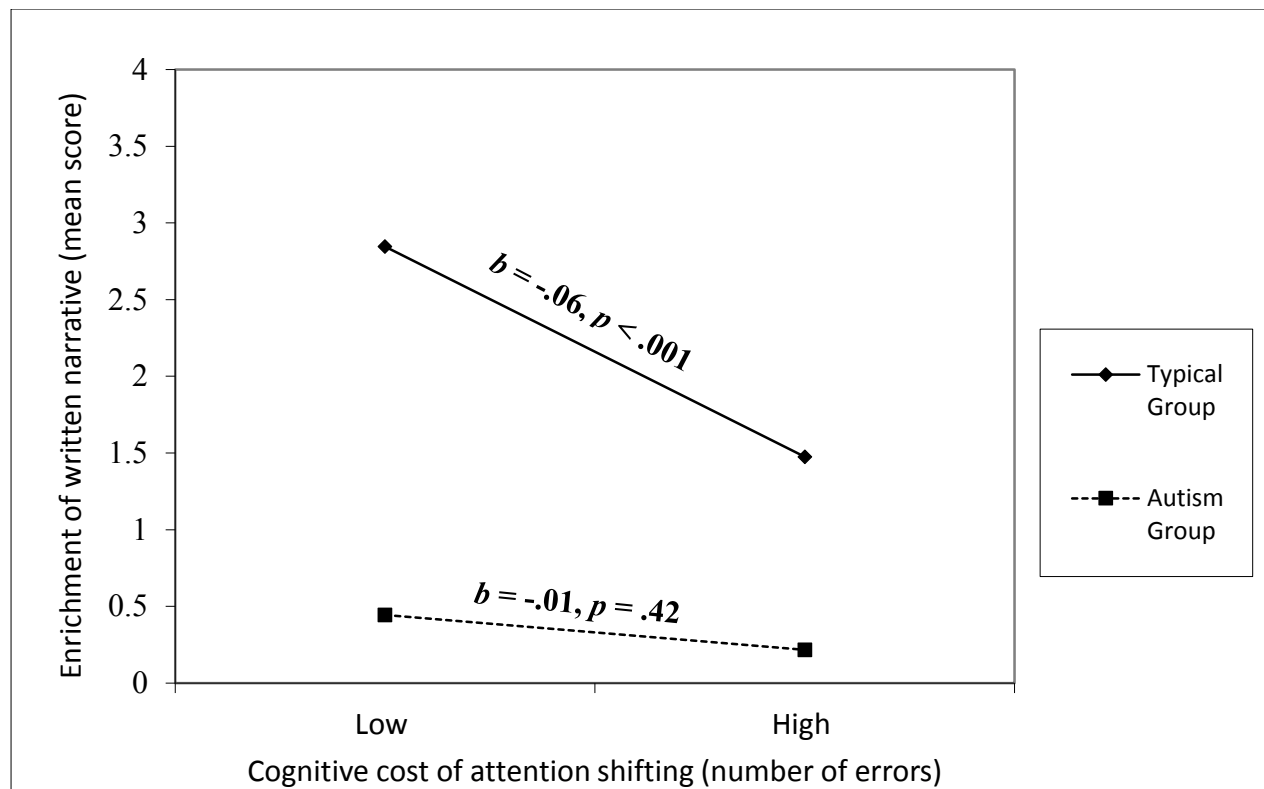


Fig. 1. The interaction between cognitive cost of attention shifting by developmental group on imaginative writing ($p < .01$). Autism group (autism characteristics); Typical group (typical development profile)

Table 1 Descriptive statistics for standardised tests, measures of executive functions, narrative coherence, and number of words, written

Measure	Autism characteristics N= 26		Typical development N=35	
	Mean (SD)	Min-max	Mean (SD)	Min-max
Standardised tests				
Nonverbal ability*	11.57 (2.85)	9-17	13.62 (3.49)	6-19
Verbal ability*	6.07 (3.13)	1-12	8.57 (2.06)	8-12
Processing speed**	7.65 (3.36)	4-17	10.78 (3.95)	4-19
Cold executive function				
<i>Inhibition</i>				
Go/no go % errors	32.37 (22.75)	0-79.17	25.83 (17.49)	0-62.50
Go/no go RT (ms)	409 (164)	0-743	359 (183)	0-797
<i>Sustained attention</i>				
Flanker % errors*	18.58 (21.81)	0-66.67	9.06 (10.62)	0-36.67
Flanker RT (ms)	950 (258)	620-1774	860 (208)	516-1452
<i>Cognitive flexibility</i>				
Attention shifting % errors**	19.29 (12.08)	3.33-53.33	11.38 (9.05)	0-33.33
Attention shifting RT (ms)	1200 (318)	620-1874	1165 (388)	708-2538
Hot executive function				
<i>Maladaptive ER strategy</i>				
Self-blame	4.46 (1.96)	2-9	4.74 (1.55)	2-8
Rumination	6.34 (2.60)	2-10	5.57 (2.29)	2-10
Catastrophising	5.38 (3.11)	2-10	5.34 (2.72)	2-10

Other-blame***	6.96 (1.96)	3-10	5.14 (1.59)	2-8
<i>Adaptive ER strategy</i>				
Acceptance	6.57 (2.51)	2-10	6.71 (2.24)	2-10
Positive refocus	5.65 (2.81)	2-10	5.97 (2.34)	2-10
Planning	5.69 (2.94)	2-10	6.51 (2.41)	2-10
Positive reappraisal	5.38 (2.36)	2-10	5.77 (2.18)	2-10
Putting into perspective	5.38 (2.24)	2-10	5.94 (2.07)	2-10
Narrative coherence				
Structure***	3.61 (1.06)	1-5	4.85 (.35)	4-5
Plot ***	1.07 (.84)	0-3	2.02 (.78)	0-3
Enrichment ***	.65 (.84)	0-2	2.85 (1.06)	0-4
No. of words**	112.57 (59.59)	16-266	159.14 (51.71)	48-252

* $p < .05$, ** $p < .01$, *** $p < .001$ significant main effects between both groups of children on variables

Table 2 Correlation analyses between standardised tests, number of words written, executive functions, and narrative coherence

Measure	1	2	3	4	5	6	7	8	9	10
1 Gender										
2 Nonverbal IQ	.01									
3 Verbal IQ	.09	.35**								
4 Processing speed	.10	.26*	.31*							
5 No. of words	.32**	.12	.23	.31*						
6 Sustained attention	-.26*	-.27*	-.22	-.23	-.32**					
7 Attention shifting	-.21	-.21	-.26*	-.40***	-.11	.44***				
8 Other-Blame	-.32**	.09	.04	-.09	-.33**	.03	.11			
9 Structure	.19	.16*	.18	.41***	.44***	-.19	-.31*	-.41***	.	
10 Plot	.26*	.06	.32**	.19	.53***	-.22	-.24	-.27*	.57***	
11 Enrichment	.38**	.18	.46***	.41***	.54***	-.33**	-.49***	-.38**	.47***	.56***

* $p < .05$ ** $p < .01$ *** $p < .001$

Table 3 *Partial correlations between executive functions, narrative structure, plot and enrichment controlling for nonverbal IQ, verbal IQ, processing speed and the number of words written in the texts*

Control variable	Non-verbal IQ			Verbal IQ			Processing speed			Number of words		
	Structure	Plot	Enrichment	Structure	Plot	Enrichment	Structure	Plot	Enrichment	Structure	Plot	Enrichment
Narrative coherence												
Sustained attention	-.16	-.29*	-.29*	-.16	-.16	-.26*	-.11	-.18	-.26*	-.06	-.06	-.19
Attention shifting	-.29*	-.23	-.48***	-.28*	-.17	-.44***	-.17	-.18	-.39**	-.29*	-.21	-.52***
Other blame	-.43***	-.48***	-.41***	-.42***	-.30*	-.45***	-.41***	-.26*	-.38**	-.31*	-.12	-.26*

* $p < .05$, ** $p < .01$, *** $p < .001$

Table 4 Model 1 Hierarchical regression analysis for gender, attention shifting, emotion regulation strategy, and developmental group, predicting performance on enrichment criteria for writing

Predictor variables	Step 1 ($R^2 = .65$)		Step 2 ($R^2 = .69$)	
	$F(4, 56) = 26.15, p < .001$		$F_{change}(1, 55) = 6.03, p = .02$	
	$B(\beta)$	SE B	$B(\beta)$	SE B
1. Gender	.51 (.16)	.27	.38 (.12)	.27
2. Att_shifting	-.03 (-.25)**	.01	-.06 (-.50)***	.02
3. Emotion regulation	-.02 (-.02)	.07	-.01 (-.01)	.07
4. Dev_group	-1.80 (-.61)***	.28	-1.83 (-.62)***	.27
5. Att_shifting*Dev_group	–	–	.05 (.31)*	.02

Note. Gender (1 = Boys; 2 = Girls); Att_shifting = Attention Shifting; Dev_group (0 = typical group; 1 = autism group); B = unstandardized regression coefficient; β = standardized regression coefficient; SE = Standard Errors; * $p < .05$, ** $p < .01$, *** $p < .001$