Implications of capacity in the classroom: simplifying tasks for autistic children may not be the answer.

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Abstract

Background: Research has demonstrated evidence for increased perceptual capacity in autism: autistic people can process more information at any given time than neurotypical individuals. The implications of this for educating autistic pupils have not been investigated. For example, this ability to process more information at any given time may explain why autistic children sometimes process more peripheral task-irrelevant information than neurotypical individuals (e.g. in background classroom wall-displays).

Aims: The current study assessed the impact of different types of background information on autistic and non-autistic children's ability to perform a learning task.

Methods and Procedures: Autistic (N=23) and non-autistic (N=50) children took part in a computer-based task designed to simulate a lesson. They watched three videos of a teacher telling a story, each with a different background condition: blank, relevant images, or irrelevant images.

Outcomes and Results: When the visual display contained story-relevant information, both groups recalled background information *in addition* to the central story. When the background displays were irrelevant to the story, autistic children recalled more background information than their neurotypical peers, yet maintained their ability to recall information from the central story.

Conclusion and Implications: The current study suggests that pupils' perceptual capacity– including those on the autistic spectrum - can indeed be capitalised on to support learning in the classroom. To do so, however, we must ensure that the child can use their capacity for task-relevant processing, rather than irrelevant distractions.

What this paper adds: This paper is the first to take a practical approach to the question of autistic children's increased perceptual capacity in the classroom. The findings are the first to show that, at least in some situations, an increased amount of task-relevant information does not undermine learning for autistic (and typically developing) children. This challenges the prevailing view that classroom environments should be made as simple as possible for those on the autistic spectrum. Instead, careful consideration should be given to the type of information presented, and how an increased capacity may be harnessed. Given the risk of sensory over-arousal for autistic people, care must certainly be taken that a child is not overwhelmed by too much information. However, when we simplify a task for a young person with increased perceptual capacity, they may be at greater risk of distraction due to the additional spare capacity that remains after reducing the amount of relevant information in a task.

Keywords: autism; attention; perception; learning; perceptual capacity; classroom.

1. Introduction

In many educational settings, learning tasks are simplified for those with special educational needs due to challenges accessing the standard learning materials (Goodman & Williams, 2007). One such group of children, are those with a diagnosis of autism, a developmental condition typically characterized by difficulties with social communication and interaction, the presence of rigid, repetitive behaviors, and atypical sensory processing (American Psychiatric Association, 2013). For those educating autistic children, reports that the condition may involve increased distractibility due to a deficient filtering mechanism (Marco, Hinkley, Hill, & Nagarajan, 2011) has led some to argue that removing background information may help the child focus attention on specific learning tasks. Currently one tactic used to deal with this distraction is to reduce the amount of external detail in the classroom: "As these students are easily distracted by extraneous noises and sights, they may benefit from having their own workstations screened off from other students" (Specialist Schools and Academies Trust, 2017). The reasoning here would be that if a child is attending to background information this must have an adverse effect on learning.

However, recent autism research suggests that individuals with autism in fact have an increased perceptual capacity, meaning that they can process more information than neurotypicals at any one time (Remington, Swettenham, Campbell, & Coleman, 2009; Remington, Swettenham, & Lavie, 2012). This is in line with the growing awareness of a range of skills that accompany the condition. For example, we see superior spatial abilities (Caron, Mottron, Rainville, & Chouinard, 2004), reduced susceptibility to change blindness (Smith & Milne, 2009), advantages on visual search paradigms (O'Riordan, 2004; O'Riordan, Plaisted, Driver, & Baron-

Cohen, 2001) and better pitch discrimination (Bonnel et al., 2003). Our own research suggests that many of these observations may be underpinned by an increased perceptual capacity in autism (compared to non-autistic people), where autistic people can process more information at any given time (Remington et al 2009; Remington et al., 2012; Swettenham et al, 2014). We hypothesise that it is this increase in capacity – rather than a filtering deficit – which may result in distraction under certain situations for autistic individuals. If so, the aetiology of this distraction must be reframed, and a revised approach taken towards potential interventions.

According to load theory (Lavie, 2005) individuals will automatically process information until their capacity is reached, prioritising task-relevant information, but extending to task-irrelevant information if there is still spare capacity. As such, having an increased perceptual capacity can lead to a greater amount of task-irrelevant processing compared to the amount seen for those with a smaller capacity (whose resources are more readily exhausted by the task being performed). This task-irrelevant processing can lead not only to distraction from external stimuli, but also from internal thoughts (mind wandering, Forster & Lavie, 2009). A number of experiments in which the perceptual load of a primary task is varied have now demonstrated increased perceptual capacity in autistic adults and children. For example, in a dual task paradigms participants with autism, but not neurotypical controls, were able to detect occasionally presented peripheral stimuli even when the perceptual load of a primary task was increased (Remington et al 2012; Remington & Farnie, 2017; Tillmann & Swettenham, 2017). This extra capacity can have both positive and negative consequences, depending on whether the extra information is useful and of interest, or incongruous with the task (e.g. providing information which competes with an ongoing task). For example, when a task involves a great deal of information – such as checking lines of computer code – additional capacity allows the task to be completed more efficiently. Conversely, when a task is much simpler – such as listening to a conversation – additional capacity results in background noise also being processed, potentially leading to distraction. Increased perceptual capacity may have implications for tailoring educational environments and materials for autistic children, yet these have not yet been investigated. As a starting point we wondered whether providing extra visual information in background displays distracts autistic children in such a way that they disengage from a primary task, or whether such information is processed in addition to the central task, in order to fill any spare capacity.

The hypothesis we test here, based on the findings regarding increased perceptual capacity, is that for autistic children the presentation of additional background visuals will have no adverse effect on their ability to learn information from a verbally presented story. Further, they may even learn *more* information than their neurotypical peers from the “extra” background materials.

Perceptual capacity though, is not the only factor influencing selective attention in the classroom. Selective attention is also under voluntary control – i.e. individuals may choose to shift attention to non-primary task stimuli or may not have the cognitive control (often measured by working memory capacity) to maintain primary task attention (De-Fockert & Lavie 2004). And indeed there is some evidence that typically developing children in mainstream classrooms disengage from primary tasks and attend to complex visual background displays. For example Fisher, Godwin & Seltman (2014) recently showed that typically developing children spend more time engaging in off-task behaviour when their environment contains complex visual displays, than when in more sparse surroundings. Importantly for the current discussion, this impacted on their learning of a primary task. Barret, Davies, Zhang & Barrett (2015) also report that physical aspects of UK mainstream classrooms (e.g. complexity and colorfulness) accounted for 16% of the variance in academic progression of typically developing pupils over the course of one year, suggesting that complexity of wall displays could negatively affect a child's ability to pay attention in the classroom, impacting on their potential learning.

Our contention though, is that for autistic children the processing of background information may not necessarily come at the cost of processing a primary task. Although they may sometimes appear to have disengaged from a primary task, their engagement with background information may in fact be 'spill over' of spare capacity left over after primary task processing. If this is the case, our prediction is that this extra processing could take place without affecting learning on a primary task.

Of most relevance to the current study are two recent papers investigating how autistic pupils might be affected by complex visual background displays similar to those appearing in a classroom setting. In a multimodal task that emulated the visual and auditory stimuli experienced in a classroom, Falck-Ytter (2015) showed that while listening to a story being told, autistic children looked less at the experimenter's face (than non-autistic children) and more at the posters in the background. This is interesting in terms of understanding overt visual attention to faces, but does not really tell us about the ability to process the story and the background visuals. Story comprehension was not assessed in Falck-Ytter's paradigm, however children were asked to perform a cognitive test (digit span task) while listening to the story. The autistic children performed *better*, despite looking more at the background visuals (Falck-Ytter, Carlström, & Johansson, 2015). It is also worth reiterating that the increased capacity effect in autism appears to work across modalities (not just within) - that is, increased perceptual load in one modality affects processing in another (Tillman & Swettenham, 2017). Hanley et al (2017) also asked autistic and non-autistic children to watch videos of teachers telling stories, however in their experiment they also asked participants to answer questions about the content of the stories (similar to short 'lessons'). The background behind the teacher in the video differed, such that it was either blank or filled with posters and drawings (unrelated to the story being told). The eye-tracking results from this study showed that autistic children looked more at background displays than typically developing children. Typically developing children looked more at the teacher regardless of whether visual displays were present. In contrast to Falck-Ytter (2015), the autistic children scored marginally lower than typically developing children on the primary story-learning task when the complex visual displays were present. This finding is contrary to the prediction we make here – that extra visual background information should not affect primary task learning unless it specifically competes with the task in hand (i.e. conflicting, rather than irrelevant information). We note, however, that the difference between the groups in learning scores only reached significance when non-verbal ability was controlled for across the participants. In addition, neither of these prior studies investigated the impact of task-relevant information on the primary learning outcomes. This is a crucial next step in order to understand the positive practical application of perceptual capacity in the classroom.

In the current study we built on the findings of Hanley et al to explore whether *different types* of background information would be more likely to be processed by autistic children and whether this affects performance on a primary task. Specifically, we wanted to compare performance when background visual information was *relevant* to a primary task (e.g. pictures relating to a primary story task) in addition to assessing the impact of irrelevant background information. We modified the Hanley et al. (2017) task, presenting a central video of a "teacher" verbally delivering a story in three conditions (relevant background, irrelevant background and blank background). We asked participants questions about the primary story task, and also about the background visual displays (despite not having instructed them to attend to the background).

Crucially, this study does not aim to reveal increased capacity in autism. We are not exceeding a moderate level of load in any condition and therefore we expect all participants to have spare perceptual capacity when performing the task (we are not manipulating the complexity of the central task). Our aim is more practical: to examine whether, for both autistic and non-autistic children, the presentation of additional background information alongside a learning task will impact on performance. More specifically – and in a departure from the previous literature – we are interested in the impact of task-relevant information, rather than irrelevant distractors.

Our prediction was that both autistic and non-autistic children would recall information from the background displays, but that this would not come at any cost to recall of information from the primary story task. In the relevant condition, we predicted that the background information would result in additional knowledge about the topic. This finding would suggest that presenting the correct type of information could enable additional capacity to be used for task-relevant processing and to maximise learning potential.

2. Materials and Methods

2.1 Participants

75 children (7-14 years, 23 autistic, 52 neurotypical) were recruited via schools, personal contacts and advertisements (see Table 1 for summary information). All participants were verbal, and IQ (all >70) was assessed using the two subtest version of the Wechsler Abbreviated Scale for Intelligence (WASI; Wechsler, 2011). Groups were matched on age and IQ (using the Vocabulary and Matrix Reasoning subtests of the WASI) by removing five neurotypical children who scored higher on the verbal IQ subtest of the WASI than the maximum for the autism group (a standard score of 72). This resulted in a group of 23 autistic and 47 neurotypical children. The gender distribution was not significantly different across the two groups (see Table 1). Average age of the autistic participants was one year higher than that of the non-autistic participants, but the difference was not statistically significant. All participants in the autism group had previously received a clinical diagnosis of an autism spectrum condition from an independent clinician in accordance with the Diagnostic and Statistical Manual of Mental Disorders, Fourth or Fifth Edition (American Psychiatric, 1994, 2013). None of the participants had any other neurological condition (e.g. ADD/ADHD). Diagnosis of autistic participants was confirmed by the researchers using Module 4 of the Autism Diagnostic Observation Scale (ADOS; Lord, Rutter, DiLavore, & Risi, 2002) or, for three participants who could not return to perform the ADOS, the Social Communication Questionnaire (Rutter, Bailey, & Lord, 2003).

(Table 1 about here)

2.2 Experimental Stimuli

Stimuli were presented using Windows Media Player, and the OpenSesame software package (Mathôt, Schreij, & Theeuwes, 2012) on a 15" Dell laptop. The experimental stimuli were five-minute videos that aimed to simulate classroom lesson experiences (modified versions of those used by Hanley et al., 2017). Each video featured a 'teacher', looking directly at the camera, telling a story about a myth or legend (1) Androcles and the Lion, 2) Oisin and the Land of Youth, 3) The Salmon of Knowledge, all taken from the Irish primary school curriculum and used in Hanley et al., 2017). For each video, three different visual conditions were created: Blank and Irrelevant (similar to Hanley et al, 2017) plus the addition of a Relevant condition. These varied in the amount and types of visual information they contained in addition to the central auditory story. In the baseline "Blank" condition, the video had a plain cream background. In the "Relevant" condition, there were drawings of scenes that were related to the story in the video (See Figure 1). The images were either adapted from Irish primary school workbooks, or were found online. In the "Irrelevant" condition, the background contained images that were not related to the story, but could also be reasonably expected to appear in classrooms. The images were in the categories "Maths and Science" (for example, posters showing times tables, or how to build a computer), "Nature" (e.g. a poster of insects) and "Art" (e.g. a painting of a rainbow). For consistency, the images covered approximately the same amount of the background in both the Relevant and Irrelevant condition. The teacher's verbal telling of the lessons remained constant across background conditions, as the teacher was filmed against a green screen and the visual information added afterwards (the same teacher was used in all visual conditions and for all stories). In addition, each story could have each background condition (nine videos in total) and the combination of stories and background conditions were counterbalanced across participants. See Hanley et al (2017) for further information on the lessons and stimuli preparation.

(Figure 1 about here)

A set of 14 questions was created for each story, consisting of the following sections:

1) Story Questions: questions relating to the verbal narrative, comprised of:
    a) Four ‘Sentence Match’ questions where participants were presented, on screen, with the first half of a sentence from the verbal narrative, and three multiple-choice options to complete it. Each question had a correct answer, a possible/likely but incorrect answer, and an unlikely/unrelated answer. Answers were indicated with a key-press.
    b) Four ‘Recognition’ questions about the verbal content of the story (but not directly spoken in the video), presented on screen, with three multiple-choice answer options. Answers were indicated with a key-press.
    c) Two ‘Comprehension’ questions, which tested the participant’s understanding of the story. The experimenter read the question aloud, and the participant responded verbally whilst the experimenter recorded their free response on an answer sheet. If a “Yes/No” answer to the questions was given, the experimenter neutrally probed for more explanation.
2) Relevant background questions: four questions relating to the relevant visual pictures (e.g. what colour cape did Oisin wear?). The experimenter read the question aloud, and the participant responded verbally whilst the experimenter recorded their free response on an answer sheet. Participants were not told that

these questions related to the background pictures, and this was not obviously the case because the topic was the same as for the associated verbal story.

3) Irrelevant background questions: four questions relating to the irrelevant visual stimuli, such as the science and maths posters (e.g. what was underneath the picture of the rainbow?). They were included as an additional assessment of how much additional information children in each group were processing during the task (even though the information did not relate to the story the participant was required to learn). To ensure that these questions did not cue the participants to focus more on the background than they otherwise would in subsequent conditions, the Irrelevant condition was always presented last, while the order of the Blank and Relevant conditions was counterbalanced.

As each of the 3 lessons consisted of 10 questions, plus four additional questions in the Relevant and Irrelevant condition, the total number of questions was 38 (see Table 2 for a complete example for one story).

(Table 2 about here)

2.3 Procedure

The participants performed the task individually with an experimenter in a quiet room at the university or at their homes, depending on their preference. Each participant was shown three videos about myths and legends, and were told they would be asked some questions about the stories. Crucially, the emphasis was on the story, and no explicit mention was made about the background. To ensure they were motivated to perform the task to the best of their ability, they were told that they would be rewarded with tokens if they performed well enough on each set of questions. Depending on the age, and the apparent reading ability of the participant, the participant either read the Match and Recognition questions themselves on the screen, or they were read to them by the experimenter. Participants could choose to respond themselves, or tell the experimenter who pressed the keys for them. All comprehension questions were read out loud by the experimenter and the verbal responses recorded by hand. At the end of each block of questions, participants were told they had completed that "level" and tokens were awarded to participants regardless of their score, before progressing to the next "level". No feedback was provided after each question, although the experimenter did provide encouragement based on effort. They were then asked to continue to the next stage whenever they were ready to. This procedure was repeated twice more for the remaining stories. Every participant was presented with each of the three stories: one in each background condition. Each story (Androcles, Oisin, Salmon of Knowledge) was presented equally frequently overall, and was presented in each position (first, second and third) and with each background an equal number of times. The experimental task took around 30 minutes to complete. All procedures were approved by the institutional research committee and were in accordance with the ethical standards of the 1964 Helsinki declaration and its later amendments or comparable ethical standards. Informed consent was obtained from all individual participants included in the study.

3. Results

3.1 Scoring

For the Story questions, participants were awarded one point for a correct answer and zero points for an incorrect answer, and given a 'Story Score' out of 10 in each condition. For the Relevant Background questions some ambiguities in answers emerged (after coding an initial subsection of the data). Three of the four questions were coded in the standard way (correct answers were given one point, incorrect answers given zero points). For one Background question in each story, however, the initial phrasing of the question was found to enable a reasonable answer to be given based on the verbal story alone (a fuller answer could be given using the background images). As we were interested in how much the children processed the background images, two points were awarded if the participant answered fully, based on the image, whereas 1 point was given if they answered correctly using the story (they scored 0 if they answered incorrectly). This scoring system meant that in the Relevant condition, participants could score a total of five for the Background questions. In the Irrelevant condition, the additional background questions were scored as one point for each correct answer (a maximum of four), (see Table 3).

(Table 3 about here)

3.2 Story Questions Accuracy

To examine whether the amount recalled from the verbal story differed between groups and conditions, a repeated-measures Analysis of Variance (ANOVA) was conducted on the Story Scores, with background (blank, relevant, irrelevant) as the within-subject factor, and group (autistic, non-autistic) as the between-subject factor. There were no significant main effects or interactions: accuracy rates were high overall (above 85% throughout), and did not differ between groups, or across conditions (all p values > .4). This confirms that any background information present was not interfering with recollection of the story details.

3.3 Relevant Background Learning Score

A Mann-Whitney U test (due to non-normal distribution of scores) was conducted on the accuracy rates for the questions that were based on the background images related to the stories being told. There was no main effect of group: U(68) = 522, p = .817, *r* = .028, with both autistic and neurotypical children performing at a similar level on questions related to the relevant background images (accuracy rates of 49% and 50% respectively).

3.4 Irrelevant Background Score

The accuracy levels on questions about the irrelevant wall items were also compared across the groups, using a Mann-Whitney U test (due to non-normal distribution of scores). On this measure, the autistic group scored significantly higher than the non-autistic group, recalling more information about the irrelevant background items: U(68) = 688, p = .045, *r* = .24). Chi squared tests did not indicate that this difference was driven by autistic children's performance on one particular question compared to that of the non-autistic children (all p values > .1). There was, however, a systematic pattern of correct answers for both groups (autistic group: χ^2 =20.23, p < .001; non-autistic group χ^2 =46.47, p < .001). Inspection of the correct answers suggests that the information that all children most frequently recalled was 1) what was on the maths poster (a times tables chart), and 2) what item was labeled on a poster (a computer). The colour of the hexagon (green) and what was under the rainbow (butterfly) were less well recalled.

4. Discussion

Using a computer-based task to simulate a classroom environment, the current study assessed the impact of different types of background information on autistic and non-autistic children's ability to perform a learning task. Both groups performed equally well on the story task regardless of the visual background. Scores did not suggest participants were at ceiling, but were high enough for us to be confident they were attending to, and learning, the story material.

When the visual background contained images relevant to the central story, both groups showed evidence that they had attended to the background and learned this extra material to an equal degree. Further, both groups achieved similar learning scores on the verbal story in the blank and relevant background conditions, indicating that participants were not being distracted by the presence of the visual information.

For the typically developing children, this was not unexpected: many children are used to having picture book stories read to them, and so the finding that visual material can be processed with no cost to the ability to learn the verbally-presented story is not surprising. Of note, however, was that a similar pattern was observed for the autistic group: the ability to process both background and verbal information simultaneously. This resulted in the relevant condition providing more opportunity to learn about the topic in question (the myth/legend) than the blank condition did. This may counter prior views that, for autistic children, reducing the amount of background information is necessary to avoid distraction. Indeed, neutral background stimuli – or even increasing task components (though we do not explicitly test this here) - may have a beneficial effect on task performance by decreasing the capacity available for processing information that might compete with the task, thereby resulting in *less* distraction. In preliminary support of this, Forster & Lavie (2007) found that increasing the load of the task was useful in preventing distraction for those more susceptible to it. On a low load task, they found that participants who scored highly on the Cognitive Failures Task (CTF, Broadbent, Cooper, FitzGerald, & Parkes, 1982 a measure of everyday distractibility) showed more distractor interference than those who scored lower on the CFT. However, when the perceptual load of the task was increased, the impact of distractors was eliminated for both groups. This increase in load can be considered similar to the addition of background information in the relevant and irrelevant conditions of our paradigm.

Moreover, if there is spare capacity available and no background information to attend to, it seems that attention turns inwards, resulting in distraction by internal thoughts ('mind wandering', Forster & Lavie 2007). Although we did not vary the perceptual load of our central task, it could be argued that in conditions where there was no background we may have denied autistic children the opportunity to easily "fill" their capacity, leading to more "mind wandering". While we did not have a direct test of this, anecdotally we noted that the autistic children seemed more engaged (sat more calmly, looked directly at the screen rather than around the room) in the conditions containing visual information (either relevant or irrelevant) compared to the blank condition. Further research should elicit the views of the child regarding their preferred condition, and their views on the task overall.

The findings from the irrelevant background condition were also informative. Here, autistic children learned more visual background information than typically developing children despite the there being no difference between the groups in the ability to answer questions about the verbal story. As both autistic and non-autistic participants' perceptual capacity appeared not to be exhausted by the auditory task (evident from additional visual processing in the relevant condition), the increase in autistic children's recall of irrelevant visual information may be due to an increased interest in the images presented in this condition. Indeed the items chosen (computer, mathematical tables) are considered to be ‘high-interest items’ for autistic individuals (Sasson, Elison, Turner-Brown, Dichter, & Bodfish, 2011).

This finding is consistent with Hanley et al (2017) who used eye tracking and showed that autistic children looked longer at the irrelevant visual images than their non-autistic peers (for whom attention was directed to the social / person information on screen). We did not find that this irrelevant processing was detrimental to task performance (amount learnt from the story), perhaps due to the brevity and ease of the central task (evident by high accuracy scores) and proximity of the visual information to the teacher telling the story. However, over a longer time period this tendency to spend longer looking at high-interest items may lead to more off-task behaviour and poorer outcomes even when there is increased perceptual capacity (Hanley et al., 2017). Increased perceptual capacity allows processing of additional information (which can be task relevant or irrelevant) whilst continuing to process the task. However, one possible outcome which is testable could be that processing additional information leads to a shift in attention away from the central task towards the additionally processed information. In relation to the stimuli used here, that would mean shifting attention away from the story to the background information. We did not find evidence of this here over the five-minute videos in terms of the effect on learning, but it remains an empirical question whether over longer periods of teaching and different background information could lead to attention shifting. The key measure in Hanley et al. (2017) was of overt visual attention to distractors whereas here we measured the processing of distractor information and learning. Hanley et al. (2017) showed a small effect of the presence of distractors on learning outcomes from the stories, but a much clearer effect of the presence of distractors on attentional allocation. Furthermore, time spent looking at distractors was the strongest predictor of learning. In order to more fully understand the effect of the presence of displays on learning and interactions with perceptual capacity relevant for the classroom, it will be important to test these issues on a longer-term larger-scale study.

We suggest a practical application of the findings. Our study shows that, at least in some situations, increasing the amount of task-relevant information presented does not undermine learning for autistic (and typically developing) children. This finding challenges the prevailing view that learning environments should be made as simple as possible for those on the autistic spectrum (Specialist Schools and Academies Trust, 2017). Given the risk of sensory over-arousal in autism (Pellicano, 2013), we must certainly take care not to bombard a child with too much information. However, when we simplify a task for a child with increased perceptual capacity, we may leave them at greater risk of distraction due to the additional spare capacity that remains after reducing the amount of relevant information in a task. Indeed this curvilinear relationship, where both too much and too little environmental complexity may hinder performance, was proposed by Barrett et al (2015). The findings presented here offer an intriguing suggestion: that for autistic children *increasing* the amount of information in an educational task leads to greater learning about a topic. Further, the additional information may help with resistance to distraction (as more of the child's perceptual capacity will be filled). For example, it may follow that a task with a greater number of components (i.e. maths task with visual and auditory aspects) will allow not only increased topic-learning, but also less effortful maintenance of on-task behaviour.

It is important to note, however, that though the stimuli in the current study were set up to mimic a classroom environment, the experiment was conducted outside of a school setting. It will be interesting to take the next step towards ecological validity by translating the task into a classroom-based approach.

In conclusion, the current study suggests that pupils' perceptual capacity– including those on the autistic spectrum - can indeed be capitalised on to support learning in the classroom. To do so, however, we must ensure that the child can use their capacity for task-relevant processing, rather than irrelevant distractions.

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Table 1: Descriptive Statistics for each Group

		Age	WASI		
		(years:months)	Vocabulary subtest	Matrix reasoning	Full scale IQ (2 subtests)
AUTISM (n=23, 18 male, 5 female)	mean (SD)	10:1 (2:3)	54 (11)	55 (11)	107 (16)
	range	6 - 14	37 - 72	31-78	72-134
NEUROTYPICAL (n=47, 30 male, 17 female)	mean (SD)	9:0 (2:3)	59 (8)	55 (9)	112 (12)
	range	6 - 14	37-72	28-78	79-143
Difference between groups		p =.053	p = .086	p =.766	p = .195

Table 2: Full set of questions asked for the story *'Oisin and the land of youth'*

Sentence Match Questions
1. When Oisin and his father were hunting they saw: a. A woman on a snow-white horse ***Correct*** b. A woman on a snow-white deer c. A deer hiding behind a tree
2. Oisin and Niamh lived happily in the Land of Youth for almost three hundred years, although: a. It rained a lot. b. It felt like an eternity since he left home. c. It felt no longer than a few days to Oisin. ***Correct***
3. When Oisin returned to Ireland he found that everything: a. Was just as he remembered. b. Was now in ruins. ***Correct*** c. Was painted green.
4. When Oisin found no trace of his friends and family: a. He decided to keep searching for them. b. He decided to go on holiday. c. He decided to return to the land of youth. ***Correct***
Recognition Questions
1. What were Fionn and his son Oisin doing in the valley near the lakes of Killarney? a. Hunting with the Fianna ***Correct*** b. Hunting on their own c. Getting some exercise
2. Why did the beautiful princess ask Oisin to come with her to the 'land of youth'? a. Because she really liked him and wanted a friend in the land of youth b. Because she had fallen in love with him and wanted to be his wife in the land of youth ***Correct*** c. Because she wanted him to catch deer for her in the land of youth
3. What was the promise that Oisin made to Niamh before going back to visit Ireland from the land of youth? a. That he would never get off the white horse ***Correct*** b. That he wouldn't let anyone else on the white horse c. That he would not be long, because she would miss him

4. Why did Oisin get off the horse, even though he had promised Niamh that he wouldn't? a. Because he thought that nothing would happen and Niamh was just joking b. Because he had forgotten about their promise and wanted to help some men lift a heavy rock in a field c. He didn't mean to break his promise, it was an accident ***Correct***
Comprehension Questions
1. Why do you think Oisin couldn't find his father and friends when he came home after living in the Land of Youth? 2. Do you think it was a good idea for Oisin to come back to Ireland on the snow white horse? (Probe for explanation if "Yes/No")
Relevant Background Questions
1. What was the colour of the silk dress that Princess Niamh was wearing when she first met Oisin? 2. What colour cape did Oisin wear? 3. What was the name on the gravestone in Ireland? 4. How many men were trying to carry the rock before Oisin arrived?
Irrelevant Background Questions
1. What maths poster was on the wall? 2. What colour was the hexagon on the shape poster? 3. What had its parts labelled on one of the posters? 4. What was underneath the picture of the rainbow?

Table 3: Average accuracy scores (%) and Standard Deviations (SD) for each group under each condition.

	Blank Condition	**Relevant Condition**		**Irrelevant Condition**	
	Story Score	**Story Score**	**Background Score**	**Story Score**	**Wall Items**
Autism group	86 (13)	89 (12)	49 (30)	88 (12)	38 (28)
Neurotypical group	89 (13)	89 (11)	50 (22)	87 (12)	25 (22)

Figure Captions

Figure 1. Examples of Experimental Stimuli in (left to right) blank, relevant and irrelevant conditions.