Removal of negative feedback enhances WCST performance for individuals with
Asperger’s Syndrome

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Highlights

• Negative feedback led to perseveration in individuals with AS on the WCST

• Performance on WCST by AS individuals was enhanced when negative feedback was removed.

• These results suggest negative feedback may impair learning in persons with AS.
Abstract

Negative feedback was explored as a potential mechanism that may exacerbate perseverative behaviours in individuals with Asperger’s syndrome (AS). The current study compared 50 individuals with AS and 50 typically developing (TD) individuals for their abilities to successfully complete the Wisconsin Card Sorting Task (WCST) in the presence or absence of negative feedback. The results revealed that negative feedback led to perseveration in individuals with AS. When negative feedback was removed from the WCST, performance by individuals with AS was enhanced, and was no different to that of the TD individuals under the same conditions. These results suggest negative feedback may impair learning in persons with AS, and prevent the development of more effective strategies in many life domains.

Keywords: Autism; Asperger’s syndrome; learning; perseveration; WCST; feedback.
Perseveration was first considered a key feature of autism by Kanner (1943), who observed that individuals with autism displayed behaviours that indicated a need for sameness, resistance to change, and stereotyped and ritualistic behaviours. These traits confer strengths to some degree on individuals with autism spectrum disorders (ASD); the ability to focus intently on aspects of their environment, to take in voluminous information, and to display great attention to detail (Happé & Frith, 2006). However, such perseverative traits may also explain why individuals with ASD have difficulty in regulatory functions; shifting focus of attention, modifying behaviour appropriately, or inhibiting familiar, over-learnt responses, once engaged in an activity (Ozonoff, 1995). This pervasive cognitive and behavioural rigidity across functional domains has become a diagnostic feature of Autism (Geurts, Cobert, & Solomon, 2009).

One task used to assess perseveration is the Wisconsin card sorting task (WCST; Grant & Berg, 1948; Heaton, Chelune, Talley, Kay, & Curtiss, 1993; Hill, 2004; Liss et al., 2001; Ozonoff, 1995; 1997). The task represents a test of concept formation in which the participant must identify the clandestine rule determining the correct response. This is achieved over successive trials with verbal feedback from the experimenter, where the rule is subject to arbitrary modification without warning. These sudden and unprepared changes of clandestine rule challenge the participant’s executive function, as they require the participant to change their response strategy (Anonkhin, Golosheykin, Grant, & Heath, 2010; Hendry, 2006; Pennington & Ozonoff, 1996; Ozonoff, 1997; Poljac et al., 2010). This tests the ability to develop and maintain appropriate problem-solving strategies and attention across changing stimulus conditions, while inhibiting inappropriate responses (Poljac et al., 2010).

Cognitive inflexibility on the WCST is commonly measured through two key perseverance scores; perseverative responses (PR) and perseverative errors (PE; Grattan & Eslinger, 1989). Perseverative errors measure the number of times a participant persists in
responding to a stimulus characteristic that is incorrect. Perseverative response is measured when a participant persists in responding to a stimulus characteristic and may include incorrect and correct responses (Heaton et al., 1993).

Performance on the WCST by individuals with ASD highlights their perseveration particularly when their performance on the WCST is compared to that of other groups. For example, individuals with ASD have been shown to persevere longer in their sorting strategy than typically developing (TD) individuals (Minshew, Myer, & Goldstein, 2002; Pascualvaca, Fantie, Papegeorgiou, & Mirsky, 1998; Prior & Hoffman, 1990; Ozonoff & Jensen, 1999; Rumsey, 1985; Shu, Lung, Tien, & Chen, 2001). Individuals with ASD were also been found to persevere longer than other groups, such as those with learning disabilities (Bennetto, Pennington, & Rogers, 1996; Hughes, Russel, & Robbins, 1994; Liss et al., 2001; Ozonoff, Pennington, & Rogers, 1991; Rumsey & Hamburger, 1990), individuals with ADHD (Geurts, Verté, Oosterlaan, Roeyers, & Sergeant, 2004; Ozonoff & Jensen, 1999; Tsuchiya, Oki, Yahara, & Fujieda, 2005; Yang, Zhou, Yao, Su, & McWhinnie, 2009), and Tourette’s Syndrome (Ozonoff & Jensen, 1999). Even when control participants and persons with ASD are matched on full scale intelligence quotient (IQ), nonverbal age, and socio-economic status (Liss et al., 2001), age, IQ, socio-economic status and gender (Minshew et al., 2002), and verbal or performance mental age (Pascualvaca et al., 1998), individuals with ASD have been shown to persevere for significantly longer times. These results suggest perseveration is a direct consequence of autistic symptomology rather than a consequence of co-morbid deficits in other areas.

However, there is a possible limitation regarding the learning style needed, which is inherent to the test itself that has not been previously considered, and that may be exacerbating this poor performance. The WCST relies upon trial and error learning, which is believed to be based upon operant conditioning. Operant conditioning works on the premise
that behaviour ‘operates’ in its environment and is maintained by its consequences (Keller & Schoenfeld, 1950). Among the elucidated principles of operant conditioning is the principle that behaviours associated with positive reinforcement, or the removal of negative reinforcement, are more likely to be repeated. Conversely, it is argued that when behaviour is punished, the likelihood of the behaviour reoccurring decreases (Candland & Campbell, 1961; Kelleher & Gollub, 1962). Importantly, however, what serves as a punishment or reinforcement is determined as a result of the actions of the individual (Candland & Campbell, 1961). For example, a child may have a tantrum to get his/her parent’s attention. If the parent gives the child lots of attention (by reprimanding the child), then the child is likely to engage in the same behaviour in the future in order to gain the parent’s attention. Thus, in this instance, the target action would increase, indicating that the behaviour was reinforced rather than punished (as the parents may have hoped). In the case of the WCST, the theoretical underpinnings assume participants will be reinforced by the word “correct” (which will increase or strengthen the desired response) and undesirable responses (such as incorrect sorting strategies) will be weakened by hearing “incorrect”, which serves as a punishment. It further assumes that participants will use this information to identify a new rule and change sorting strategies accordingly.

For TD individuals, there is a long history of research that has investigated the relative efficacy of positive and negative feedback (cf. Ashby & O’Brien, 2007) in tasks similar to the WCST. In studies that examine learning acquisition under reinforcement combinations (correct-incorrect vs. correct-blank; where blank represents no feedback in the place of incorrect) it was found that TD individuals learn more slowly under correct-blank conditions than correct-incorrect conditions (Buchwald 1959; Buss & Buss, 1956; Curry, 1960; Spence, 1964; 1966; Spence & Dunton, 1967; Spence, Lair, & Goodstein, 1963; Spence & Segner, 1967). This still holds even when verbal rewards are substituted for candy
and punishments are substituted with a loud noise (Spence & Dunton, 1967; Spence & Segner 1967). Further, Buss and Buss (1956) and Curry (1960) found that positive and negative feedback in combination was more effective for learning than positive feedback alone, when using a modified version of the WCST for TD individuals. These studies, and the current study, give support to the view that receiving both positive and negative feedback is a better learning aid than receiving positive feedback alone for TD individuals.

Individuals with ASD have also shown enhanced performance in the presence of positive feedback (Baltruschat et al., 2011a; 2011b; Demurie, Roeyers, Baeyens, & Sonuga-Barke, 2011; Freitag, 1970; Garretson, Fein, & Waterhouse, 1990). Baltruschat and colleagues (2011a; 2011b) examined the use of positive reinforcement for improving performance on working memory tasks - a common executive functioning deficit seen in individuals with ASD. The authors found considerable improvements in performance were obtained when the child received positive feedback (in the shape of an identified highly preferred toy or food item) for every correct response given. Furthermore, studies have shown that performance by autistic individuals on tasks can be improved with the introduction of social, and more so, tangible rewards during the task (Demurie et al., 2011; Garretson et al., 1990).

Despite the research on positive feedback, to date, there has been little consideration given to the possibility that the reinforcement and motivational factors associated with negative feedback may not be as relevant or may be interpreted differently by individuals with ASD. There is a small, but growing body of evidence in the romantic attachment literature that suggests that perseverative behaviours in individuals with ASD may actually be reinforced by negative feedback they receive (Church, Alisanki & Amanullah, 2000; Green, Gilchrist, Burton & Cox, 2000; Stokes, Newton & Kaur, 2007); namely, that persistent behaviour is not discouraged in the presence of negative feedback. For example, Church et
al. (2000) and Green et al. (2000), reported that ASD individuals are overly persistent in their pursuit of a romantic target (e.g. intrusive following and stalking like behaviour), in spite of negative feedback (complaints) expressed by the targets. Moreover, Stokes et al. (2007) found that compared to TD individuals, individuals with high-functioning Autism reported they would persist longer in their pursuit of a romantic target of interest as the degree of resistance and negative feedback from the target increased. Further many researchers acknowledge the harassing and stalking behaviour displayed by individuals with an ASD despite negative feedback from the target that this behaviour is unwanted (cf. Berney, 2004; Haskins & Silva, 2006; Tay & Armstrong, 2009). It is possible, therefore, that negative feedback may distort the extent and nature of perseverance seen in individuals with an ASD. Consequently, we believe it is important to determine the impact negative feedback has on ASD populations in comparison to TD individuals.

The current study aimed to test the influence of negative feedback on perseveration, by examining the effect on WCST test scores, due to the presence or absence of negative feedback when an incorrect response is given. Feedback employed during the administration of the WCST was manipulated to create two conditions. The first condition gave feedback to participants in the manner prescribed by the WCST; positive feedback was given for correct responses and negative feedback for incorrect responses. This condition was designated as the traditional version of the WCST (TRAD WCST). In the second condition, no negative feedback was administered to participants for incorrect responses; only positive feedback was given for correct responses. This condition was designated as the modified version of the WCST (MOD WCST).

It was hypothesised based on previous literature (Buchwald 1959; Buss & Buss, 1956; Curry, 1960; Spence, 1964; 1966; Spence & Dunton, 1967; Spence et al., 1963; Spence & Segner, 1967) that TD individuals would have enhanced performance on the WCST in the
correct vs. incorrect reinforcement combination (TRAD WCST). On the other hand, based on limited literature (Church et al., 2000; Green et al., 2000; Stokes et al., 2007) it is hypothesised that negative feedback (punishment) will reinforce perseverative behaviour in individuals with ASD. Thus, performance by individuals with ASD will be enhanced under the correct vs. blank reinforcement combination.

2. Method

2.1 Participants

Participants used within the study included 50 high-functioning adolescents or adults with a diagnosis of Asperger’s syndrome (AS), and 50 typically developing adolescents or adults. Diagnosed participants were recruited from Australian Autism support networks and organisations. Participants with AS were required to have a prior diagnosis confirmed in writing by a registered clinical psychologist, psychiatrist, or paediatrician, and have a tested IQ above 70. TD Participants were recruited by word of mouth. All participants were selected on the criteria that they were aged between 14 and 70 years. It was assumed that TD individuals, not having a diagnosis that included an intellectual disability, had an IQ within the normal range, and thus were asked to participate.

Overall, the TD group had a mean age of 26.9 years (SD=8.78) and was comprised of 32 females and 18 males (see Table 1). The AS groups had a higher mean age of 39 years (SD=17.34) with 34 male and 16 female participants. An independent samples t-test revealed that this difference in age was significant ($t_{(98)}=4.41, p<.001, d=.88$). However, there was no significant differences between ages in the TRAD vs. MOD conditions for either the typically developing individuals $t_{(48)}=1.00, p = .321$, nor the individuals with AS $t_{(48)}=-.259, p = .797$. 
A Chi-square analysis indicated there was a significant difference between the number of males and females in each group by diagnosis $\chi^2(1) = 10.26, p < .01$. However, there was no significant difference between the number of males and females in the TRAD vs. MOD conditions for either the typically developing individuals $\chi^2(1) = .643, p = .557$, nor the individuals with AS $\chi^2(1) = .368, p = .762$.

Lastly, a significant difference in between the number of years of education in each group, $\chi^2(1) = 7.99, p < .05$, with the AS group having received less education and having more males than the TD group. However, as scoring of the WCST is standardised by the participant’s age and education (Heaton et al., 1993), the effect of these confounding variables would have been reduced, while gender has been shown unrelated to the WCST performance (Heaton et al., 1993).

2.2 Measures

2.2.1 The Wisconsin Card Sorting Task

The WCST (Grant & Berg, 1948) requires participants to develop and maintain an appropriate problem-solving strategy and attention across changing stimulus conditions, while inhibiting inappropriate responses, to achieve a specific goal. The WCST consists of four stimulus cards and 128 response cards that depict various symbols (crosses, circles, triangles, or stars), in different colours (red, blue, yellow, or green) and numbers of figures displayed (one, two, three, or four).
2.3 Procedure

Approval from the Deakin University Human Research Ethics Committee (DUHREC; EC13-2007) was obtained for this study. Participants with AS were recruited from within a 500 km (360 miles) radius of Deakin University. All participants were tested in their homes or neighbourhood libraries. Testing was conducted over a single session.

Participants were seated at a table and informed about the WCST. Participants were randomly allocated to one of two conditions: TRAD WCST and MOD WCST. In the TRAD WCST condition, positive feedback in the form of “correct” was given for correct responses by participants while negative feedback in the form of “incorrect” was given for incorrect responses. In the MOD WCST condition, participants received only positive feedback “correct” for correct sorting strategies, in the same manner as participants in the TRAD WCST. No feedback was given if a participant in the MOD WCST condition gave an incorrect response. In order to succeed, the participant had to make ten consecutive correct matches to the predetermined sorting principle. For example, if the covert predetermined sorting principle was colour, the participant had to match the response card in the deck to the stimulus cards of the same colour, in order to get a correct match. Once the participant made 10 consecutive correct matches to the sorting principle, the sorting principle was changed (i.e., from colour to form, from form to number, etc.) without warning, requiring the participant to use the examiner’s feedback to determine the new sorting principle.

There were six predetermined sorting principles in the order of colour, form, number, colour, form, number. The participants were not aware the sorting strategy would change throughout testing. A participant completed the task when all six correct sorting principles were made with 10 correct consecutive matches (in the order of colour, form, number, colour, form, number) or when all 128 response cards in the deck had been used by the participant.
Before the participant began, they were read out loud the following standardised instructions:

“This test is a little unusual because I am not allowed to tell you much about how to do it. You will be asked to match each of the cards in these decks (point to response card decks) to one of these four key cards (point to each of the stimulus cards in succession, beginning with the red triangle). You must always take the top card from the deck and place it below the key cards that you think it matches. I cannot tell you how to match the cards, (the following is different for each condition)

*Traditional approach (TRAD WCST): “but I will tell you whether you are right or wrong”*  
*Modified approach (MOD WCST): “but I will tell you whether you are right”*. If you are wrong, simply leave the card where you have placed it and try to get the next card correct. There is no time limit on this test. Are you ready? Let’s begin”

The test was scored as per the WCST manual (Heaton et al., 1993). As a result, all measures were standardised according to age and education, and several measures were reverse scored.

2.4 Design and Analysis

Using a between-subjects design, participants were randomly allocated to one of two conditions: TRAD WCST or MOD WCST. This gave a two-way design: *feedback type by diagnosis*. Diagnosis included two levels: AS and TD individuals. Feedback type also included two levels: positive and negative feedback (TRAD WCST) versus positive feedback only (MOD WCST). Three univariate repeated measures analyses of variance (ANOVA) were conducted on the key measures of the WCST; error responses (ER), perseverative errors
(PE; the number of times a participant persists in responding to a stimulus characteristic that is incorrect) and perseverative responses (PR; the number of times a participant persists in responding to a stimulus characteristic and may include incorrect and correct responses).

3. Results

There were no missing values, univariate outliers, or normality issues. Jaeger and Halliday (1998) argue that when a study is exploratory in nature (as is the present study), controlling for Type 2 error (supporting the null hypothesis when it is false) is more important for knowledge development than controlling for Type 1 error alone. By retaining the .05 alpha criterion, the present retains more power than either FWE or FDR approaches to detect a significant effect. Confidence intervals will be reported along with effects to give the reader a better impression about the stability of obtained effects. However, replication will be the true test of error rates for effects found in the present study.

A summary of results is presented in Table 2. As revealed in Table 2, TD participants in both conditions had similar scores, approximately a 5-point difference, but always scored higher in the TRAD WCST condition. Conversely, participants with AS scored similarly in both conditions, but with an approximate 10-point difference, that always favoured the MOD WCST.

In order to assess the significance of these results, and establish whether the absence of negative feedback resulted in improved performance by individuals with AS and reduced performance by TD individuals, we compared the TRAD WCST condition using a two-way repeated measures ANOVA. Significant diagnosis by feedback effects were evident for all
three dependent variables: ER, PE, and PR. No significant main effects for diagnosis or feedback were found (cf. Table 3).

Analyses of simple main effects were then undertaken to examine the source of the interaction effects (cf. Table 2 for means and SDs). Simple main effects were assessed by independent sample t-tests (cf. Table 4). Only within the AS group was there an effect due to feedback type. Individuals with AS displayed fewer PE ($t_{(48)}=2.01, p<0.05, d=.57$; cf. Figure 1), fewer PR ($t_{(48)}=1.97, p<0.05, d=.56$), and had fewer ER ($t_{(48)}=2.41, p<0.05, d=.68$) when receiving only positive feedback compared to those who received both positive and negative feedback. However, feedback type had no effect for TD individuals on ER, PE and PR. Further, within both MOD WCST feedback and TRAD WCST feedback there were no differences over diagnosis for ER, PE and PR. As shown in Figure 1 individuals with AS have fewer PE in the MOD WCST condition than in the TRAD WCST (n.b. a higher score indicates less perseveration). There was no difference for TD individuals. Results for ER and PR were highly similar to Figure 1, and so are not repeated here.

The present study investigated perseveration in individuals with AS using the WCST. Feedback during the test was manipulated in order to determine the role of negative feedback in perseverative behaviour for persons with an AS. Investigation of differences into how
negative feedback is processed in the AS and TD groups was guided by one broad hypothesis; that when the correct vs. blank reinforcement combination was employed, the absence of negative feedback would result in improved performance by individuals with AS and reduced performance by TD individuals, compared the correct vs. incorrect condition. The results of the present study partially support this hypothesis.

Although the performance of TD individuals did not differ significantly via feedback type as predicted, it is noteworthy that TD individuals receiving the correct vs. incorrect reinforcement combination performed better than TD individuals in the correct vs. blank combination for each of the measures (ER, PE and PR). It seems likely that our results for TD individuals are consistent with the notion that task performance is enhanced by negative and positive feedback for TD individuals (Buchwald 1959; Buss & Buss, 1956; Curry, 1960; Spence, 1964; 1966; Spence & Dunton, 1967; Spence et al., 1963; Spence & Segner, 1967).

Remarkably, individuals with AS performed significantly better on perseveration indices, when negative feedback was absent (correct vs. blank combination) compared to when negative feedback was present (correct vs. incorrect combination). This suggests that individuals with AS in the present study have the ability to shift cognitive strategies in response to changing environmental contingencies, at least in the absence of negative feedback. This is consistent with the proposed notion that individuals with AS do not utilise feedback in the same way that TD individuals do, or that the mechanisms by which AS individuals learn are different to those of TD individuals. This has implications in the theoretical understandings of the WCST as well as how individuals with AS learn.

This is not to say that operant conditioning does not work for individuals with AS. However, for a stimulus to be a punishment, it must act to decrease the likelihood of the undesirable behaviour. If a punishment is inappropriate, however, it can have the opposite effect and produce the same consequences as reinforcement (Grivas, Down, & Carter, 2007).
It appears that for individuals with AS in this study, negative feedback does not serve as a punishment (decreasing or diminishing a response), as their perseveration actually increases, indicating that this form of feedback may be acting as positive reinforcement. Possible explanations include: 1) that their undesirable behaviour increases because the social interaction obtained while receiving a punishment (the word “incorrect”) may be in itself reinforcing; 2) that adaptive responses by individuals with AS may be blocked by negative feedback, as punishers do not give any extra information regarding how to change behaviour or; 3) as individuals with ASD are less skilled at interpreting facial cues, expressions, and gestures from other people (Baron-Cohen, Wheelwright, & Jolliffe, 1997; Celani, Battacchi, & Arcidiacono, 1999; Davis, Bishop, Manstead, & Tantum, 1994), performance by TD individual may be supplemented by these kinds of social cues, while individuals with ASD are not. These explanations may account for why performance by individuals with AS improves in the absence of negative feedback. Not only is the interference of negative feedback absent, but possibly the lack of personal interaction with the experimenter provides negative consequences for AS individuals and thus serves as a punishment sufficient to diminish their response.

This idea that the social demands of the WCST are influencing the performance of individuals with ASD is not a new idea, and research has been conducted on the effectiveness of removing the social components from this task (Ozonoff, 1995). The results thus far have been mixed. Some studies have shown that individuals with ASD have enhanced performance on the computerised version, with no significant differences in scores to TD individuals (Kaland, Smith, & Mortensen, 2008; Ozonoff, 1995; Pascualvaca et al., 1998), while other studies have shown that individuals with ASD still show deficits on scores of perseveration (Tsuchiya et al., 2005).
Those studies finding positive results suggest that it is possible that individuals with ASD perform more poorly on the manual format of the WCST (in comparison to the computerised version) because they are not as receptive to the social feedback given by the examiners as the TD individuals are (Ozonoff, 1995; Pascualvaca et al., 1998). Ozonoff (1995) further extended this argument by asserting that the computerised version of the WCST more accurately reflects executive function, as it relies less on the social demands of the traditional approach. While many studies have discussed the impact of social interaction in the manual format of the WCST, no studies to date have examined the impact of negative feedback, or negative feedback mediated by social interaction, on exacerbating this perseverative behaviour. It is possible that negative feedback is processed differently by persons with ASD, such that it may be rewarding at some level. This speculation could be assessed by functional neuroanatomical studies in reward and punishment situations.

While the current study did not provide an intervention to every day activity for individuals with AS (and thus did not provide a demonstration of clinical utility), the study did provide further support for the use of ABA therapy. Which understands the importance of choosing the correct reinforcers to behaviour – which are not those simply chosen by the researchers or practitioners - but those deemed desirable by the individual with ASD (Garfield, 2008; Naoi, 2009).

Lastly, it is important to acknowledge that participants in the current study were not matched on Full scale IQ or education; variables that could be expected to contribute to cognitive flexibility and perseveration in participants. While matching on full scale IQ would have been ideal, as it allows one to rule out IQ as the cause of poor performance among individuals with Autism (Jarrold & Brock, 2004), purposive sampling of individuals with Asperger’s Syndrome was used to ensure that all participants had (at least) normal
intellectual functioning. Thus it seems unlikely that the current findings can be attributed to recruitment of individuals with AS with lower than average cognitive abilities.

In summary, the present study suggests that individuals with AS are able to inhibit incorrect responses and are capable of shifting cognitive sets when they are not presented with negative feedback. The implication of this is that individuals with AS may be more successful when receiving positive reinforcement and this should be taken into account when individuals with AS are learning a new task. It is also possible that poor performance by individuals with AS on the WCST does not reflect a deficit in executive function, but an inability to attend to, and process, the verbal and social interaction demands of the task in the same way that this is performed by TD individuals. Further research is necessary to reproduce the findings from the current study, and because the task in the current study had social and communication demands it would be worthwhile to explore what role social interaction plays, if any, in perseverative behaviour of the ASD population.
5. References


Table 1
Participant descriptive data

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<tr>
<td></td>
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<tr>
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<tr>
<td>Females</td>
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<tr>
<td>Males</td>
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<tr>
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Table 2

Mean scores and SD of standardised Error Responses, standardised Perseverative Errors and standardised Perseverative Responses for individuals with AS and TD, receiving either TRAD WCST or the MOD WCST

<table>
<thead>
<tr>
<th></th>
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<th>Perseverative Errors</th>
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<td>TD</td>
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<tr>
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<td>TRAD WCST</td>
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<tr>
<td>MOD WCST</td>
<td>99.44 (14.00)</td>
<td>97.60 (17.77)</td>
<td>99.20 (17.55)</td>
<td>25</td>
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Note. Values are standardised scores, where a higher score indicates fewer errors. Scores are standardised for age and years of education.
**Table 3**

ANOVA of ER, PE and PR for individuals with AS and TD, receiving either TRAD WCST or the MOD WCST. (n.b. The lack of diagnosis effect is because the mean score within each group did not differ.)

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<th></th>
<th>$F$</th>
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<th>error df</th>
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<td>&gt;.99</td>
<td>.00</td>
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<td>.01</td>
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Table 4

Simple main effects for ER, PE and PR on TRAD WCST and MOD WCST using independent sample t-test

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* p < .05 (one-tailed)
Figure 1: Mean scores (±SE) on the number of perseverative errors (PE) for individuals with AS and TD receiving either the TRAD WCST or the MOD WCST. Note: Values are standardised scores, where a higher score indicates fewer errors.