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ORIGINAL PAPER

Extinction of Over-selected Stimuli Causes Emergence of Under-selected Cues in Higher-functioning Children with Autistic Spectrum Disorders

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Abstract Two experiments examined whether over-selectivity is the product of a post-acquisition performance deficit, rather than an attention problem. In both experiments, children with Autistic Spectrum Disorder were presented with a trial-and-error discrimination task using two, two-element stimuli and over-selected in both studies. After behavioral control by the previously over-selected stimulus was extinguished, behavioral control by the previously under-selected cue emerged without direct training. However, this effect was only found in higher-functioning children, and not with more severely impaired children. These findings suggest that over-selectivity is not simply due to a failure to attend to all of the stimuli presented. They also suggest that extinction of over-selected stimuli may be a fruitful line of intervention for clinical intervention for some individuals.

Keywords Over-selectivity · Behavioral control · Extinction · Comparator deficit · Attentional deficit

Introduction

'Stimulus over-selectivity' refers to the phenomenon whereby control over behavior is exerted only by a limited subset of the total number of stimuli present in the environment (e.g., Lovaas et al. 1979; Schreibman 1997). It is a widely acknowledged problem in individuals with Autistic Spectrum Disorders (e.g., Allen and Fuqua 1985; Dube and McIlvane 1997; Dube and McIlvane 1999; Huguenin1997; Litrownik et al. 1978; Lovaas and Schreibman 1971; Meisel 1981; Schneider and Salzberg 1982; Stromer et al. 1993; Wilhelm and Lovaas 1976). The phenomenon is also observed in a many other populations, including individuals with general learning disabilities (Dickson et al. 2006), acquired neurological damage (Wayland and Taplin 1985), and the elderly (McHugh and Reed 2007). Stimulus over-selectivity has also been induced in rats who were trained to respond to compound stimuli under trace learning conditions (Gibson and Reed 2005), and in adults with no learning disability under increased task demands (Reed 2006; Reed and Gibson 2005).

Stimulus over-selectivity can have a considerable negative impact on an individual's functioning because it presents a serious problem for information processing in situations consisting of complex and multiple cues. Lovaas et al. (1971) suggested that this type of restricted responding could severely impair learning, and critically interfere with language acquisition. Indeed, research demonstrates that deficits in language and communication skills could be caused, in part, by over-selectivity to either the auditory or visual components of language (e.g., Birnie-Selwyn and Guerin 1997; Koegel et al. 1979; Lovaas et al. 1971; Lovaas et al 1966). Similarly, understanding social interactions involves attending to, and interpreting, a large array of complex stimuli, such as body posture, lip movements, facial expressions, voice intonation, etc. Individuals with ASD invariably notice a very limited number of these cues and, thus, may develop only limited social skills (see Schreibman and Lovaas 1973). Research has also suggested that stimulus over-selectivity can negatively impact overall quality of life. For example, LeBlanc

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et al. (2005) reported that individuals with ASD exhibit a limited ability to monitor external and internal cues simultaneously, which may potentially lead to problems such as incontinence.

Several theories of stimulus over-selectivity have been proposed, and many of these theories focus on deficits in attention (e.g., Dube and McIlvane 1999; Dube et al. 1999). Such theories suggest that over-selectivity is the result of a failure to attend to all the parts of a complex stimulus when it is first presented. If an individual attends to only a limited number of elements of a compound stimulus, only these elements, and not all elements, will acquire control over behavior. In support of such a suggestion, analysis of eye movements in children with learning disabilities, who also exhibit stimulus over-selectivity, reveal that these children do not scan all the stimuli present (Dube et al. 1999). Similar findings have been reported for populations with ASD (see Anderson et al. 2006; Van der Geest et al. 2002). However, it should be noted the literature has yielded some inconsistent results (cf. Kemner and Van Engeland 2006), and that analysis of eye movements is only imperfectly correlated with attention (Remington 1980).

In fact, there are numerous other possible theories that may explain stimulus over-selectivity. The term 'comparator' refers to the comparison between potentially relevant stimuli at the time of performance (not at the time of learning), which selects the most appropriate stimulus for the individual to act upon (see Miller and Matzel 1988). A comparator theory of over-selectivity might suggest that *learning* about the elements of a compound stimulus is not differentially impaired in those with ASD, but that individuals with ASD have a comparator which is over-sensitive to slight differences in the importance of stimuli that have previously been learned about as predicting outcomes in particular contexts. As a consequence, at the time of test, when selection concerning which stimulus to respond to is made, behavior is much more likely to be controlled by only some of these elements, which are selected due to their apparent superiority to the other stimuli. With a less sensitive comparator, many more stimuli may be judged to be of 'similar' importance, and less over-selectivity would be noted.

The comparator theory of stimulus over-selectivity in ASD makes a unique prediction that is not inherent in other theories, in that it suggests that post-learning manipulations (i.e. extinction) of the previously over-selected cue should influence (enhance) subsequent control exerted by the under-selected cue, and, thus, aid more adaptive performance. If this is the case, it follows that the previously under-selected cue must have been attended to, and processed, initially, but that it did not come to acquire control over responding at a later point in time.

Research from the animal conditioning literature supports the notion that cues which do not appear to control behavior subsequently can demonstrate behavioral control if the cues that are controlling behavior are extinguished (e.g., Kaufman and Bolles 1981; Matzel et al. 1985; Reed and Reilly 1990; Reilly et al. 1996; Willkie and Masson 1976). For example, Kaufman and Bolles (1981) trained rats in a conditioned fear paradigm. Their results showed that the rats displayed negligible arousal to a noise stimulus when it was presented in conjunction with a light prior to an electric shock. Instead, significant levels of fear were noted to the light stimulus. However, after the light was extinguished, fear of the noise was revealed without further training. This finding suggests that although the rats had learned about the noise during training, it had not come to control behavior. This finding is especially noteworthy given the recent suggestion that such procedures can be used to model over-selectivity (Gibson and Reed 2005).

Similar post-acquisition emergence effects have been noted in a population of typically developing adults (Broomfield et al. 2008a). Individuals were presented with a match-to-sample task using two, three-element stimuli, and were trained to criterion. Subsequent investigation revealed that, under conditions of increased cognitive load, one of the three stimulus elements exerted greater stimulus control than the others (see also Reed and Gibson 2005). After extinction of this element, the remaining elements demonstrated elevated control over matching performance in the absence of any further training. However, although this post-acquisition emergence effect supports a comparator view of over-selectivity, such an effect has not been demonstrated in a sample with ASD. Additionally, neither has it been established whether such an effect would emerge with individuals with ASD who had both milder and more severe impairments. The investigation of such a basic effect, and its generality, is the aim of the current report.

Experiment 1

Experiment 1 aimed to explore whether over-selectivity could be found in a population with ASD using a simple discrimination task. This finding has been noted previously (see Koegel and Wilhelm 1973), but it was thought important to replicate the effect as there are few demonstrations of this effect in populations with ASD using such a procedure. The second aim was to extend the findings noted by Broomfield et al. (2008a), which demonstrated that previously under-selected stimuli can come to control behavior, when previously over-selected cues are extinguished. This would show that the results reported by Broomfield et al. (2008a), regarding extinction, could be generalized to a population with ASD. Should such a pattern of results be noted, it would suggest that over-selectivity is not simply the product of a deficit with initial attention (Lovaas et al. 1971), but could reflect a post-conditioning influence over behavior, such as suggested by a comparator theory (Miller and Matzel 1988).

Method

Participants

Fourteen participants with ASD participated in this study (12 males and 2 females). The participants were aged between 7 and 15 years, and were randomly assigned to either the experimental group (mean age = 9.1, SD = 2.9), or the control group (mean age = 9.9, SD = 2.4). All the participants had a diagnosis of autistic disorder (DSM-IV), which was made by a specialist pediatrician following referral from a general practitioner, both of whom were independent from this study. All participants had high functioning ASD, and all had the use of communicative speech, however, three of the children displayed echolalia. The mental age scores of the participants on the British Picture Vocabulary Scale ranged from 3.1 to 14.0 for the experimental group (mean = 8.1, SD = 4.0), and from 5.1 to 15.0 for the control group (mean = 8.5, SD = 3.9). These BPVS scores would give an approximate IQ of 88 for the experimental group, and 86 for the control group.

Apparatus and Materials

The British Picture Vocabulary Scale (Dunn et al. 1982) was administered prior to testing in order to attain a measure of the children's mental age. This test is standardized for use on children in the UK between 3 and 17 years old. It has an internal reliability of 0.93, and correlates at 0.59 with the Reynell Comprehension Scale (Dunn et al. 1997). This method of assessment does not require the child to speak, write, or read, but, like the Peabody Picture Vocabulary Scale, from which it is derived, the child simply points to the picture cards as requested.

Stimulus cards measuring 15 cm by 10 cm were also employed. The picture stimuli that were used as the elements in the experiment were: 'a hand', 'a cup and saucer', 'a bed', and 'a butterfly'. Four additional cards, of the same size, depicted one of the elements of the compound stimulus, and four other cards contained novel stimuli. The novel stimuli pictures were: 'a bus', 'a packet of crayons', 'a sock', and 'a cat'.

Procedure

The experiment was conducted in a quiet class room free from distraction in the child's school. A classroom assistant familiar with the child was also present during testing.

Training Phase

In this phase, the participants were either rewarded for picking the 'hand and teacup' over the 'bed and butterfly', *or* for selecting the 'bed and butterfly' over the 'hand and teacup'. The rewarded stimuli were counterbalanced across participants to avoid any of the results being the product of some stimuli being intrinsically more salient than others. The stimuli were presented to the children, with a verbal instruction to pick a card. Verbal feedback in the form of the spoken word "*yes*" signaled to participants that they had responded appropriately (i.e., had pointed to the correct card). The positions of the cards were randomized, in that 50% of the time the correct card was presented on the left, and 50% of the time it was presented on the right. During the training phase, the reinforced compound 'AB' was always paired with the non-reinforced compound 'CD'. Participants were said to have acquired the training discrimination once they had responded correctly 10 times.

Test Phase

During the test phase of the experiment, participants were presented with two cards simultaneously, each one comprising of just one picture from the compound stimulus. The pictures were paired so that the participants had a choice of reinforced stimuli or non reinforced stimuli, so either stimulus 'A' or stimulus 'B' from the previously reinforced stimulus were paired with either stimulus 'C' or stimulus 'D' from the previously non-reinforced compound. There were five trials for each combination of previously positively reinforced and negatively reinforced components (i.e., 'A vs. C', 'A vs. D', 'B vs. C', 'B vs. D'). Altogether, there were 20 trials involving the components of the compound stimuli. No feedback was provided during test trials.

Extinction Phase

The card that was selected the most in the testing phase (i.e., the over-selected stimulus) was determined (i.e., 'A' or 'B'). During the extinction phase, for participants in the experimental group, further training trials were conducted involving the over-selected stimulus, and a previously unseen novel stimulus. The over-selected stimulus was paired with one of four novel stimuli. The over-selected stimulus was placed down simultaneously with the novel stimuli. Participants were rewarded for choosing the novel stimulus, and not the over-selected stimulus. This continued until the participants choose the novel stimuli 10 times consecutively. For the participants in the control group, the over-selected card was not determined. During this phase of the study, these participants were shown the novel stimuli paired together. Of the pairs, one of the cards was given feedback of "yes", while the other was given feedback "no". No card was extinguished.

Retesting Phase

The same test procedure was used as in the first testing phase.

Results and Discussion

The control participants on average took 22.9 (±10.4) trials during training to choose the 'positive' card 10 times consecutively, while the experimental group took 15.1 (±8.9) trials to reach criterion. This difference was not statistically significant, $p > 0.05$.

During the first test, the percentage of times that each element from the positive compound was chosen when presented along with an element from the negative compound was calculated. When comparing the most and least chosen stimuli from the reinforced card, there was a large difference between the most and least selected stimulus for both groups, with no discernable difference between the two groups. The participants that were to become the experimental group had a mean percentage for the most-selected stimuli of 75.7 (±20.7), and a mean for the least-selected stimuli of 47.1 (±27.5). The participants that went on to be the control group had a mean score of the most selected stimuli of 75.7 (±23.7), and a mean score of 61.4 (±26.7) for the least-selected stimuli.

A two-way, mixed-model analysis of variance (ANOVA), with stimulus type (most versus least) as a within-subjects factor, and group (experimental versus control) as the between-subject factor, revealed that stimulus type was statistically significant, $F(1,12) = 10.43$, $p < 0.01$, but neither the main effect of group, nor the interaction of the two factors, were statistically significant, $F\text{s} < 1$. Thus, the participants showed a significant degree of over-selectivity, which replicates previous demonstrations of stimulus over-selectivity in children with ASD (Koegel and Wilhelm 1973; Dickson et al. 2006).

Figure 1 displays the mean difference between the pre- and post-extinction scores for the most-selected and least-selected stimuli in both groups. In the experimental group, the previously over-selected, and now extinguished, stimulus was chosen less, and the previously under-selected stimulus was chosen more, in the retest phase than in the initial test phase. This was not the case in the control group. A two-way, mixed-model ANOVA (stimulus type and group) showed that the main effect of stimulus type was not statistically significant, $p > 0.05$, nor was the main effect of group, $F < 1$. However, the interaction between group and stimulus type was statistically significant,

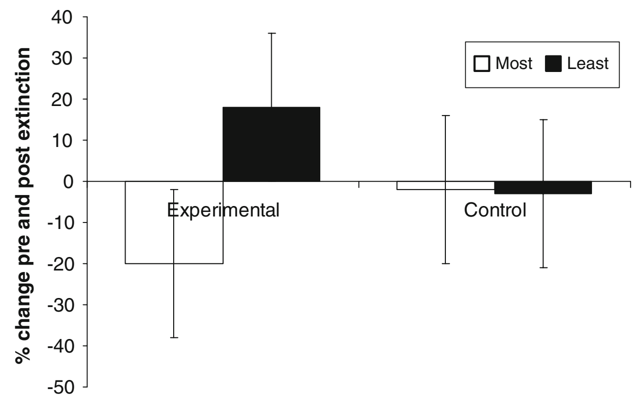

Fig. 1 Results from Experiment 1. Mean difference in pre- and post-extinction scores for the most and least chosen stimuli for the experimental group (most-selected stimulus extinguished), and control group (no extinction)

$F(1,12) = 4.65$, $p < 0.05$. Simple effect analyses revealed a statistically significant difference between the most and least stimuli for the experimental group, $F(1,12) = 8.99$, $p < 0.05$. For the control group, the difference between the most and least selected stimuli was not significant, $F < 1$. The emergence of the previously under-selected stimulus, in the experimental group, when tested against zero, was statistically significant, $t(6) = 4.26$, $p < 0.005$, but for the control group the emergence effect was not significantly different from zero, $t < 1$.

Thus, the main novel finding to emerge from Experiment 1 was that behavioral control exerted by previously under-selected stimuli emerged after extinction of the previously over-selected stimuli in a population with ASD. Following the extinction phase for the experimental group, behavioral control exerted by the under-selected cue was noted to emerge. In the control group, there was no emergence of control by the under-selected stimulus. These results show that the removal of control by the more salient cue can facilitate an initially less powerful stimulus element to control behavior. This finding mirrors those noted in a non-clinical population (Broomfield et al. 2008a), the animal literature (e.g., Kaufman and Bolles 1981), and also from the human retrospective revaluation literature (e.g., Dickinson and Burke 1996). Such results suggest that under-selected cues do not fail to control behavior because they are not learnt about during training. If the deficit were purely attentional, then there would be no emergence of behavioral control. Thus, over-selectivity cannot simply be attributed to an inability to attend to more than one stimulus.

Experiment 2

Experiment 1 extended the findings reported by Broomfield et al. (2008a); that is, previously under-selected cues come to control behavior when previously over-selected cues are extinguished. However, Experiment 1 used a clinically relevant population, whereas previous demonstrations of this type of effect have been with typically developing individuals (Broomfield et al. 2008a; Dickinson and Burke 1996). The aim of the second experiment was to further explore this effect in an ASD population. In particular, it aimed to explore whether this finding could be obtained using both children with ASD who were higher functioning (as in Experiment 1), and those who were lower functioning.

In fact, there is reason to be cautious about assuming that the current post-conditioning procedure will be universally effective in restoring control by the previously under-selected stimuli. For example, McHugh and Reed (2007) noted that with a very elderly, non-clinical, population there was no emergence following extinction of an over-selected cue, whereas, emergence did occur for younger and more cognitively high-functioning group. Reed (2006) suggested that while performance or memory factors may well be important, there were also suggestions that attentional aspects may play a role in over-selectivity, and it may be that lower functioning individuals would have deficits that would encompass both types of problem.

If it were the case that individuals with ASD who were relatively higher functioning display over-selectivity due to a performance deficit, then they should replicate the extinction-induced post-conditioning recovery in behavioral control exerted by the previously under-selected stimulus shown in Experiment 1. However, if lower functioning individuals display an initial pre-conditioning attentional deficit, then such an extinction-induced recovery would not be seen (there being no suppressed learning about the under-selected stimulus to reveal by extinction of the over-selected stimulus).

Method

Participants

Eighteen participants with ASD participated in this study. All the participants had a diagnosis of an ASD (autistic disorder, DSM-IV), which was made by a specialist pediatrician following referral from a general practitioner, both of whom were independent from this study. The study employed a between-subjects design, with nine participants (all male) in the higher functioning ASD group, and nine participants (nine male and one female) in the lower functioning ASD group.

The mean chronological age for the higher functioning group was 11 years (range 9–13). The mean BPVS score for the children in the high functioning group was 8.5 ($\pm$2.19, IQ = 77). All participants had very similar characteristics to those described in Experiment 1. The mean chronological age for the lower functioning group was 11 years (range 7–17). The mean BPVS score for the children in the lower functioning group was 3.3 ($\pm$1.4, IQ = 29). Generally, the children in this group had moderate to severe autistic symptoms, and displayed problems attending to environmental and social cues. The majority of the children had not formed any friendships with other children in the school, and did not imitate other children at play. All of the children had some speech, but one child used at least 15 but fewer than 30 spontaneous phrases daily to communicate. Four children used five or less words per day to spontaneously communicate wants or needs.

Apparatus and Procedure

The materials used, and the procedure of the study, were an exact replication of Experiment 1. All of the participants were presented with the training, testing, extinction, and re-testing phases described in Experiment 1.

Results and Discussion

The participants in the higher functioning group took an average of 19.7 ($\pm$12.7) trials during training to choose the positive card 10 times consecutively. The lower functioning group took 25.8 ($\pm$13.8) trials to reach criterion. Although, as might be expected, there was numerically more training needed to reach criterion for the lower functioning group, there was no statistically significant difference between these scores, $t < 1$.

During the first test, when comparing the most and least chosen stimuli from the reinforced card, there was a large difference between the most and least selected stimulus for both groups, there were few differences between the two groups. The higher functioning group had a mean percentage chosen score for the most-selected stimuli of 76.7 ($\pm$15.7), and a mean for the least-selected stimuli of 57.8 ($\pm$17.3). The lower functioning group had a mean score of the most selected stimuli of 78.1 ($\pm$12.1), and a mean score of 41.7 ($\pm$20.8) for the least-selected stimuli. A two-way, mixed-model ANOVA (stimulus type and group), revealed that stimulus type was statistically significant, $F(1,16) = 18.72$, $p < 0.01$, but neither the main effect of group, nor the interaction of the two factors, were statistically significant, $F\text{s} < 1$. Thus, all participants showed a significant degree of over-selectivity, irrespective of their ASD severity. This corroborates and extends the findings from Experiment 1, as well as replicating previous demonstrations of stimulus over-selectivity in children with ASD (Koegel and Wilhelm 1973; Dickson et al. 2006).

It may also be worthy of note that the current findings suggest that intellectual functioning in itself is not strongly predictive of the emergence of over-selectivity, as the two groups were not reliably different in the degree of over-selectivity that they exhibited. In this finding the current report supports those of Frankel et al. (1984) who found no correlation between IQ and over-selectivity. However, caution must be attached to any such conclusion, especially given that there was a numeric difference toward greater over-selectivity in the lower functioning group, which may have revealed statistical significance with a greater sample size (see Schover and Newsom 1976; Wilhelm and Lovaas 1976).

The mean percentage change from the test to the retest phase was calculated for both groups by taking the test score from the retest score, and these difference scores are shown in Fig. 2. Inspection of Fig. 2 shows that, for the higher functioning group, the most chosen stimulus was chosen less in the retest phase than in the test phase, and there was an increase in the control exerted by the previously under-selected stimulus. In contrast, for the lower functioning group, while there was a reduction in the control exerted by the previously over-selected, and now extinguished, stimulus, there was no corresponding increase in control exerted by the previously under-selected stimulus.

A two-factor, mixed-model ANOVA (stimulus type × group) revealed that stimulus type was statistically significant, $F(1,16) = 26.06$, $p < 0.0001$. Group was not statistically significant, $p > 0.05$, and that there was a statistically significant interaction between the factors, $F(1,16) = 3.99$, $p < 0.05$. Simple effect analyses revealed a statistically significant difference between the most and least stimuli for both groups, smallest $F(1,16) = 7.37$, $p < 0.05$. The emergence of the previously under-selected stimulus, in the higher functioning group, when tested against zero, was statistically significant, $t(8) = 7.26$, $p < 0.005$, but for the lower functioning group the emergence effect was not significantly different from zero, $t < 1$.

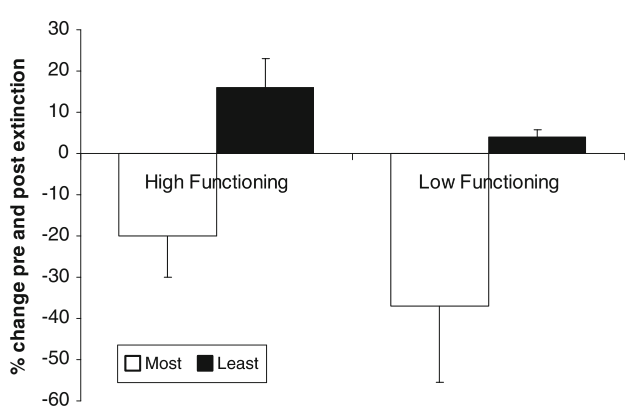

Fig. 2 Results from Experiment 2. Mean difference in pre- and post-extinction scores for the most and least chosen stimuli for the high functioning group, and low functioning group

These data corroborate, on the one hand, that extinction of a previously over-selected stimulus will lead, not only to a reduction in the behavioral control exerted by that stimulus, but also to a subsequent emergence of behavioral control by a previously under-selected stimulus. This emergence of behavioral control occurred in the absence of direct training for the under-selected stimulus, and supports previous demonstrations of such effects (Dickinson and Burke 1996; present Experiment 1). These findings support a comparator view of these effects, rather than a purely attentional-deficit view (e.g., Dube and McIlvane 1999). On the other hand, these results also suggest a limitation to the generality of this finding, in that no such emergence of behavioral control was noted in a lower functioning ASD sample. This was despite the extinction effect being at least as pronounced in this lower functioning group as in the higher functioning group. Although such a finding regarding the limitations of this generalization will require corroboration, it would appear to have some face validity. The greater the degree of severity of impairment, the less likely initial learning about all cues will be to occur. Consequently, even if the over-selected stimulus were extinguished, there would be no learning about the previously under-selected stimulus to emerge. That many attentional-deficit findings have been noted using children with learning disabilities, rather than children with ASD, especially for eye-tracking deficits (e.g., Dube et al. 1999; Dube and McIlvane 1999) would tend to support this conclusion.

General Discussion

The present experiments demonstrated that there was a significant degree of over-selectivity found in populations with ASD, using the current simple discrimination task. This finding replicates those reported by Koegel and Wilhelm (1973), and by Dickson et al. (2006), and they also validate earlier results from model populations (Gibson and Reed 2005; Reed and Gibson 2005). The results from Experiment 1 reinforce those reported by Broomfield et al. (2008a), that, under some conditions, post-learning manipulation of one stimulus can impact on the behavioral control exerted by the other stimulus in a compound. However, the current findings from Experiment 2 also suggest that some caution is warranted in the use of extinction with individuals who are severely impaired.

In terms of their theoretical relevance, these results suggest that over-selectivity may be the result of a performance deficit, or retrieval failure, rather than an acquisition failure, or attention deficit. As the previously under-selected cues came to control behavior after the extinction of the previously over-selected cues, it would suggest that higher-functioning children with ASD do not over-select merely because they do not attend to all the stimuli present (Lovaas et al. 1971). In fact, the current results for high-functioning children with ASD support the work of both Plaisted et al. (1998), who found that children with ASD performed better at visual search tasks that required them to switch their attention, and Pascualvaca et al. (1998), who found that participants with ASD performed as well as control participants on a computer task that required successive comparisons. That the current finding is limited to children with ASD who were higher functioning, and not those who were lower functioning, may also explain the apparent discrepancies in the existing literature on attention, in that different samples may well display different patterns of attention-switching deficit (cf. Treisman 1969).

At least for higher-functioning children with ASD, the current findings suggest that cues initially exerting little stimulus control can subsequently come to control behavior with no further training than the removal of control from other cues. This replicates the findings from the animal literature (Kaufman and Bolles 1981), and the human conditioning literature (Dickinson and Burke 1996). These results could be explained in conjunction with the comparator hypothesis (Miller and Matzel 1988).

The procedure used for decreasing control by the previously over-selected stimulus has potential utility for remediating the negative effects of stimulus over-selectivity in individuals with ASD. In fact, this procedure (technically a differential reinforcement of alternative behavior schedule) represents a very simple technique for potentially increasing the number of cues that control the behavior of children with ASD. Traditionally, approaches to remediating over-selectivity have focused on administration of an observing response procedure (e.g., Constantine and Sidman 1975; Dube and McIlvane 1999; Stromer et al. 1993). The observing response procedure represents an intervention whereby the participant is brought in contact with all elements of the compound stimuli at the outset of training. It is, thus, assumed that the participant has attended completely to the compound stimulus, and over-selectivity of any one element at the expense of the others is reduced. Observing response procedures have been shown to reduce the effects of stimulus over-selectivity (e.g., Dube and McIlvane 1999), but the evidence suggests that the intervention effects are lost post-treatment (Broomfield et al. 2008b; Dube and McIlvane 1999). Thus, although there is evidence that the observing response procedure can reduce over-selectivity (e.g., Constantine and Sidman 1975; Stromer et al. 1993), this procedure may not promote long-term effects (see Dube and McIlvane 1999). Rather, the procedural benefits of an observing response intervention appear to be confined to the period of application of the intervention (Broomfield et al. 2008b). In contrast, the extinction procedure adopted by Broomfield et al. (2008a) would, be definition, offer a post-intervention benefit to the participants. Some caution may be needed, however, and certainly clinical studies are required. In the current study, the procedure resulted in the participants not selecting for the previously preferred stimulus card in favor of selecting for the previously less preferred stimulus card. This may be of benefit in some clinical circumstances, but not all. For example, if this is extrapolated to a stimulus array such as letters in words, or a countenance on the face of a social partner, it may mean that part of the information from the stimulus array (i.e., that which was extinguished) could be lost, and one might be substituting one over-selected stimulus, or set of stimuli, for another.

It may be worth noting in this context, that another procedure has been used to reduce over-selectivity in children with ASD, which involves the training of successive conditional discriminations (e.g., Koegel and Schreibman 1977; Schreibman et al. 1982). This procedure has been shown to reduce over-selectivity and, importantly, to directly impact learning situations wherein these children's over-selectivity has been reduced and, thus, allow for learning stimulus compounds the children previously had failed to learn.

However, both the theoretical and the practical implications of these findings need to be treated, at this point, with caution. The results reported in Experiment 2 for the lower functioning children were at odds with those reported in Experiments 1 and 2 for the higher-functioning children. Lower functioning children in Experiment 2 did not show this extinction-induced emergence effect. It is possible that the low-functioning participants in Experiment 2 had deficits in attention, as well as those concerning the function of the comparator system. Where learning problems may be an issue (such as for those with learning disabilities, as reflected by a low IQ score), this mechanism may be pronounced (see also McHugh and Reed 2007). Moreover, it is possible, as Treisman (1969) suggested that the deficit could be in switching attention for these participants. These findings suggest that extinction may be a useful tool in combating over-selectivity, but only in higher functioning people with ASD. Moreover, that the effect is not witnessed in lower functioning individuals may limit its generality as a potential clinical intervention.

In summary, the findings of the current report reinforce those of Broomfield et al. (2008a,b) showing that, when behavioral control by previously over-selected cues is removed, previously under-selected cues come to control behavior. This shows that extinction can be used in shifting behavioral control. However, this effect was only found to be significant in a higher functioning population. It is possible that lower functioning people autism do have problems attending to compound cues and this would need to be considered when thinking about the design of behavioral interventions.

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