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FACTORS IMPACTING EMERGENCE OF BEHAVIORAL CONTROL BY UNDERSELECTED STIMULI IN HUMANS AFTER REDUCTION OF CONTROL BY OVERSELECTED STIMULI

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Stimulus overselectivity occurs when only one of potentially many aspects of the environment controls behavior. Adult participants were trained and tested on a trial-and-error discrimination learning task while engaging in a concurrent load task, and overselectivity emerged. When responding to the overselected stimulus was reduced by reinforcing a novel stimulus in the presence of the previously overselected stimulus in a second trial-and-error discrimination task, behavioral control by the underselected stimulus became stronger. However, this result was only found under certain circumstances: when there was substantial overselectivity in the first training phase; when control by the underselected stimulus in the first phase was particularly low; and when there was effective reduction in the behavioral control exerted by the previously overselected stimuli. The emergence of behavioral control by the underselected stimulus suggests that overselectivity is not simply due to an attention deficit, because for the emergence to occur, the stimuli must have been attended to and learned about in the training phase; but that a range of additional learning factors may play a role.

Key words: overselectivity, re-emergence of control, discrimination learning, humans

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Stimulus overselectivity is the term used to describe the phenomenon whereby one aspect of the environment comes to control behavior at the expense of other equally salient events in the environment (Broomfield, McHugh, & Reed, 2008; Dube & McIlvane, 1999; Koegel & Schreibman, 1977; see Dube, 2009, for a review). Stimulus overselectivity promotes limited learning with respect to the range, breadth, or number of stimulus features that come to control behavior. It is a widely acknowledged problem in individuals with developmental disabilities and Autism Spectrum Disorders (ASD; see Bailey 1981; Dube & McIlvane, 1999; Lovaas & Schreibman, 1971; Reed, Broomfield, McHugh, McCausland, & Leader, 2009), although it is certainly not unique to this population (McHugh & Reed, 2007; Reed & Gibson, 2005). For example, Reed and Gibson found that stimulus overselectivity can be observed in human participants without disabilities when they are experiencing a higher task demand (e.g., a concurrent memory load).

One theory that accounts for the results of such stimulus overselectivity experiments suggests that the phenomenon is caused by an attention deficit; a failure to observe all of the salient or important elements of the environment (Lovaas & Schreibman, 1971). Individuals who display overselectivity are thought not to attend to (observe) all of the component elements of the stimulus. In support of this view, analysis of eye movements in children who display stimulus overselectivity shows that these individuals do not examine all the stimuli present and, therefore, the unattended stimuli cannot come to control behavior (e.g., Dube, Lombard, Farren, Flusser, Balsamo, & Fowler, 1999).

In contrast to the above attention-based suggestion, it is possible that all the stimuli presented during training are attended to and learned about, but that only a subset of these stimuli control behavior. A stimulus, when presented alone, may exert strong control over behavior. However, if that stimulus is accompanied by another stimulus, then control by the first stimulus may be reduced or eliminated by the presence of the second (see Mackintosh, 1975). This effect is sometimes referred to as overshadowing (see Trabasso & Bower 1968), and overshadowing has been proposed as an experimental preparation that

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can model some aspects of overselectivity (see Reed & Gibson, 2005).

Results from the animal conditioning literature have shown that overshadowed (i.e., underselected) stimuli may come subsequently to control behavior when the behavioral control exerted by the more salient stimulus is reduced (see Kaufman & Bolles, 1981; Matzel, Schachtman, & Miller, 1985). Similar revaluation effects have been noted using an overselectivity paradigm in individuals with ASD (Leader et al., 2009), and individuals lacking any form of disability (McHugh & Reed, 2007). In these latter demonstrations, participants initially were trained with two concurrent simultaneous discriminations (AB+ CD− and EF+ GH−). Once discrimination reached criterion for both discriminations, overselectivity was determined for both reinforced elements by pairing the reinforced and nonreinforced elements of the two discriminations individually, and examining choice (i.e. A vs. C, A vs.D, B vs. C, B vs. D, E vs. G, E vs. H, F vs. G, F vs. H). Choice for the stimuli from each of the reinforced compounds was examined to determine the most (overselected) and least (underselected) selected element at test (e.g., A > B, and E > F). One of the overselected stimuli (e.g., A but not E) was then revalued by pairing it with novel cues, and reinforcing the novel cues. A subsequent retest examined responding to the elements, and it was observed that responding to A had decreased (through revaluation), responding to B had increased, but responding to E and F remained unaltered.

Such findings have been used to suggest that the overshadowing or blocking effects (and, indeed, the overselectivity effect, see Leader et al., 2009; McHugh & Reed, 2007) cannot be fully explained by an attention-based mechanism; for behavioral control by the overshadowed or underselected stimulus to emerge following treatment of the overselected stimulus, the former stimulus must have undergone some learning initially.

Despite the above demonstrations of retrospective revaluations, there are some contradictory findings in the literature, especially from nonhuman conditioning experiments. For example, Holland (1999) conducted a series of experiments, which differed from one another in design, stimuli, and amounts of conditioning and extinction, and found that responding to overshadowed cues was either unaffected, or actually reduced by extinction in rats. Similarly, Speers, Gillan, and Rescorla (1980) found that extinction of flavor aversion conditioning to one element reduced the amount of conditioned responding to the unextinguished element. These findings reported by Holland and Speers et al. are at odds with the previous retrospective revaluation findings (Kaufman & Bolles, 1981; Matzel et al., 1985; McHugh & Reed, 2007). The factors that produce the apparently discrepant results are unclear, and have received little investigation, although the effectiveness of the procedure used to reduce behavioral control by the initially overselected stimulus has been suggested as one factor to be investigated (cf. Holland, 1999).

Given the above considerations, the main aim of the current study was to replicate and extend the work of McHugh and Reed (2007), and Reed and Gibson (2005), in order to further validate the reliability of the revaluation effect in the overselectivity paradigm, in human subjects. However, as an additional aim the study also sought initially to explore the factors that may be responsible for the control of the emergence effect. For example, whether the degree of reduction of behavioral control by the overselected stimulus is related to the emergence of behavioral control by the underselected stimulus, as suggested by Holland (1999); the greater the reduction in control, the greater the predicted emergence in behavioral control in the underselected stimulus. In addition, the impact of the initial levels of overselectivity on the subsequent emergence of control by the underselected stimulus has not yet been examined, and may be important to examine based on the assumption that emergence should be more readily observable if initial levels of overselectivity are more pronounced. Finally, the patterns of behavioral control initially exhibited by the overselected and underselected stimuli were also examined.

Given the potential theoretical and practical importance of both the overselectivity finding and the methods by which it can be remediated, it would be useful to establish the circumstances in which an individual might be expected to show emergence of control by the underselected stimulus after treatment of the overselected stimulus. The further corroboration of the basic revaluation and emergence findings, as well as tentative study of the above factors, may well offer insights into the circumstances under which this effect might occur.

METHOD

Participants

One hundred and seven Psychology students from Swansea University participated. All participants received course credit in return for their participation. There were 90 females and 17 males, and they had an age range of 18 to 30 yr. None of the participants reported any form of developmental or learning disability. No participants scored over 32 on the Autism Quotient questionnaire (Baron-Cohen, Wheelwright, Skinner, Martin, & Clubley, 2001; which is the criterion for high functioning Asperger's Syndrome). The scores on the AQ scale ranged from 7 to 30 (mean = 14.36; SD = 5.33).

Apparatus and Materials

The experiment was conducted in a quiet room, free from distraction, located in the university. Participants were presented with white cards which measured 15 cm by 10 cm. Some of the cards contained two pictures; these were the compound stimuli. The pictures were taken from the British Picture Vocabulary Scale. Ten additional cards of the same size depicted one of the elements of the compound stimulus. The stimuli employed in the experiment were as follows: a hand, a cup and saucer, a swan, a toy, a baby, a shoe, a butterfly, a bed and a sock. An example of these stimuli is presented in Figure 1.

In this example, participants were either rewarded for picking the hand and teacup over the bed and butterfly, and the swan and shoe over the baby and toy *or* for selecting the bed and butterfly over the hand and teacup and the baby and toy over the swan and shoe. 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. 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).

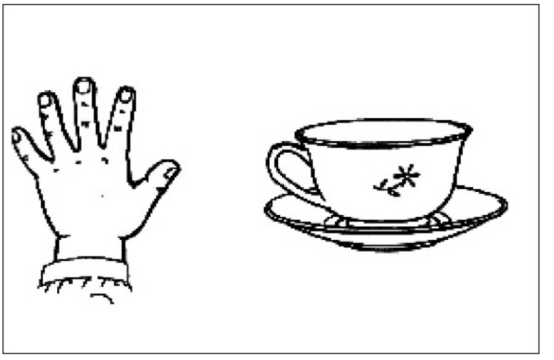

Fig. 1. An example of one of the compound cards presented to participants.

Procedure

Concurrent load. At the beginning of the experiment participants were given a five-digit number (e.g., 23,765) and were instructed to subtract 7 from the number continuously, out loud, throughout the experiment. If the participants went quiet they were prompted to continue with this concurrent task. The importance of this part of the study was explicitly stressed to the participants. This concurrent task was employed as it has been established previously that significant levels of overselectivity only occur in healthy participants when a concurrent task is used (e.g., Reed & Gibson, 2005).

Training phase. All participants were trained individually. The experimenter sat directly opposite the participant throughout the experiment. The cards (depicting the stimuli) were placed on the center of the table between the participant and the experimenter. Participants were instructed to select a card, rather than an individual picture, by means of pointing to the card. Participants were informed that they would be provided with corrective feedback on their card choices, and that all choices would be recorded by the experimenter. Participants were presented with two white cards simultaneously. Each card contained two stimulus elements (see Figure 1). On any given trial, participants were presented with one compound stimulus ('AB'), that, if selected by the participant (i.e., by means of pointing), resulted in positive feedback in the form of the experimenter saying ''yes''. Selecting the other card ('CD') resulted in negative feedback (i.e. the experimenter saying "no"). The positions of the elements on the cards (left/right) were randomly altered from trial to trial, and the position of the reinforced and nonreinforced cards (left/right) was systematically randomized, that is, 50% of the time the correct card was presented on the left, and 50% of the time it was presented on the right. Participants were said to have acquired the training discrimination once they produced 10 consecutively correct responses. The actual stimuli that were the elements (i.e. 'A', 'B', 'C', etc.) were different for each participant to reduce the possibility of overselectivity being caused by particular stimuli being intrinsically more salient than others.

Test phase. During the test phase of the experiment the participants were presented with two cards simultaneously, each one comprising one picture from a compound stimulus. The pictures were paired so that the participants had a choice between an element from a previously reinforced compound and an element from a previously punished compound. There were five trials for each combination of previously positively reinforced and punished components (i.e. A vs. C; A vs. D; B vs. C; B vs. D). The spatial position of the previously reinforced and nonreinforced elements (left/right) during the test was random from trial to trial (i.e. the previously reinforced element was not always presented on one side). Thus, there were 20 trials involving the components of the compound stimuli. No feedback was provided during test trials.

Treatment phase. The stimulus element that was selected the most during the test (i.e. the overselected stimulus) was determined (i.e., 'A' or 'B'). Further training trials were then conducted involving the overselected element (e.g., 'A'). On any given trial, participants were given a choice between the element from a previously reinforced compound (e.g., 'A'), and one of four novel stimuli. Which novel stimulus was presented varied from trial to trial, and all were presented roughly equally often as one another. The spatial position of the previously overselected stimulus and the novel elements (left/right) during the treatment phase was random from trial to trial (i.e. the previously overselected element was not always presented on one side). Participants were given positive feedback (rewarded) for choosing the novel stimuli, and were given negative feedback (punished) for choosing the previously overselected stimulus. This training continued until the participants choose the novel stimulus 10 times consecutively.

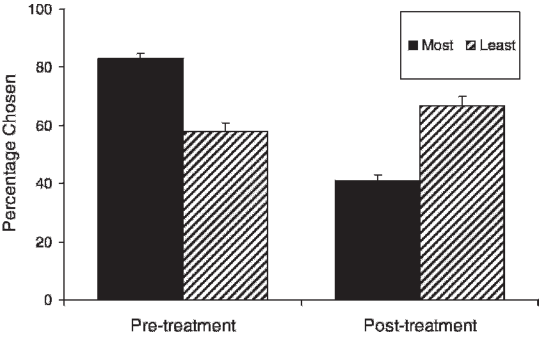

Fig. 2. The mean of the most and least chosen stimuli from the pretreatment and posttreatment phases (error bars = SEM).

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

RESULTS

Overselectivity and Emergence of Control of Underselected Stimulus

The percentage of times that the stimuli (most vs. least) were chosen in both pretreatment and posttreatment phases are shown in Figure 2. Inspection of these data shows that there was a large difference between the two stimuli in terms of their behavioral control in the pretreatment phase. In fact, of the 107 participants, 72 demonstrated some degree of overselective responding in the pretreatment phase. Of the 35 participants who did not show overselectivity, 20 responded at 100% to both; and 15 participants responded equally to both stimuli, but at less than 100% accuracy.

After the treatment, the previously overselected (treated) stimulus displayed less control over behavior than it had previously. Of the 107 participants, 84 showed a decrease in behavioral control exerted by this stimulus, 21 showed no change in control for this stimulus, and 2 showed an increase in behavioral control. Overall, there was less behavioral control exerted by the previously most picked stimulus than by the previously underselected (untreated) stimulus. Of the 107 participants, only 17 now showed greater control by the previously most picked stimulus, 22 showed no difference in control between the stimuli, but 68 now showed greater control by the previously least picked stimulus. In fact, the level of behavioral control exerted by the previously underselected stimulus had increased from the pretreatment phase despite no manipulation being conducted on this stimulus. Of the 107 participants, 55 showed an increase in behavioral control exerted by this stimulus, 29 no change in the control, and 23 showed a decrease in behavioral control.

These data were subject to a two-way, within-subject analysis of variance (ANOVA), with stimulus (most versus least) and phase (pretreatment versus posttreatment) as factors. This analysis revealed a statistically significant main effect of phase, $F(1,106) = 47.45$, $p < .001$, and a statistically significant interaction between stimulus and phase, $F(1,106) = 149.17$, $p < .001$. There was no statistically significant main effect of stimulus, $F < 1$. To further analyze these data, a series of simple effect analyses were conducted. These analyses revealed a statistically significant simple effect of stimulus (most versus least) during the pretreatment phase, $F(1,106) = 70.84$, $p < .001$, indicative of overselectivity. There was a statistically significant simple effect of stimulus (most versus least) during the posttreatment phase, $F(1,106) = 78.43$, $p < .001$, indicative of a reversal in the degree of behavioral control exerted by these stimuli compared to pretreatment. There was a statistically significant simple effect of treatment on the most-selected stimulus, $F(1,106) = 200.61$, $p < .001$, indicative of a reduction in behavioral control by that stimulus following the treatment. Finally, there was a statistically significant simple effect of treatment on the least selected stimulus, $F(1,106) = 9.66$, $p < .01$, indicative of an increase in the behavioral control exerted by that stimulus following treatment of the previously most selected stimulus (but not, it should be noted, of this stimulus).

The impact of the treatment on the choice for each stimulus can also be seen in Figure 3, which displays the change in the percentage that each stimulus was chosen after treatment of the initially most picked stimulus (posttreatment minus pretreatment). These data show that there was a large decrease in the percentage of times that the initially most chosen stimulus was picked after treatment,

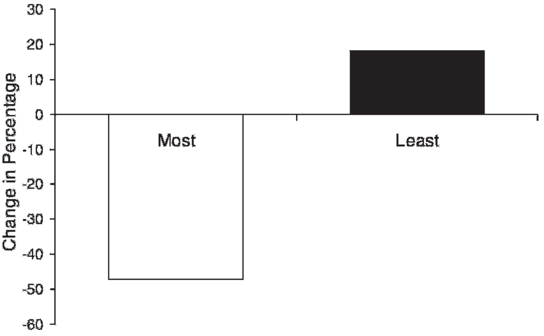

Fig. 3. The mean percentage change in choice for the most and least chosen stimuli, from pretreatment to posttreatment.

and an increase in the percentage of times that the initially least chosen stimulus was picked after treatment of the other stimulus. A paired-samples *t*-test revealed this difference to be statistically significant, $t(106) = 12.21$, $p < .001$. Additionally, paired sample *t*-tests, conducted against a zero baseline, showed that the reduction in responding for the initially most picked stimulus was statistically greater than chance, $t(106) = 12.40$, $p < .001$. Similarly, the increase in the percentage of times that the initially least picked stimulus was chosen was statistically significantly greater than chance, $t(106) = 3.13$, $p < .01$.

Effects of Level of Initial Overselectivity and Reduction in Control by Previously Most Selected Stimulus

To investigate the effects of initial levels of overselectivity, and revaluation levels, the participants were divided by splitting the sample at the mean for both the level of reduction of behavioral control for the initially most picked stimulus (mean reduction in percentage choice = 42.1 ± 35.2), and for the level of initial overselectivity (mean difference between most and least chosen stimuli = 25.1 ± 25.8). This created four groups (low reduction, low overselectivity, $n = 33$; low reduction, high overselectivity, $n = 23$; high reduction, low overselectivity, $n = 29$; and high reduction, high overselectivity, $n = 22$).

The data regarding the change in the number of times that each stimulus was chosen from the first to the second test are shown in Figure 4 for these four groups. Inspection of these data reveals that there was a strong emergence of control in both of the groups

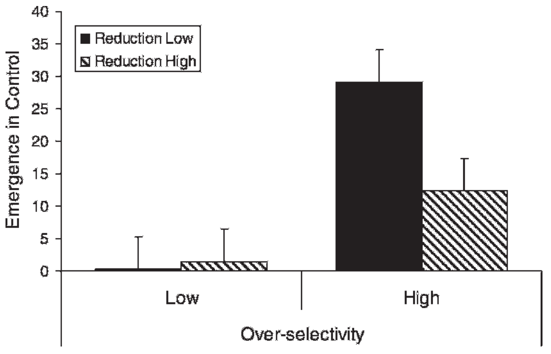

Fig. 4. The mean percentage change in choice for the most and least chosen stimuli from pretreatment to posttreatment for groups showing low and high initial levels of overselectivity and for low or high levels of reduction in control by the initially most picked stimulus.

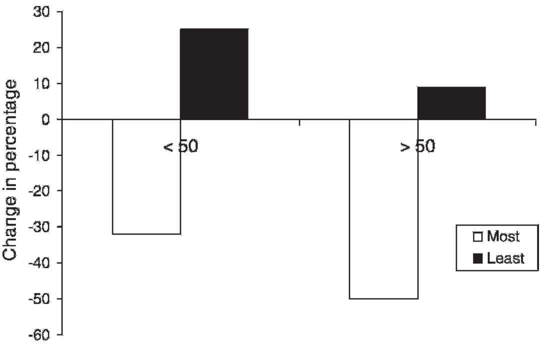

Fig. 5. The mean percentage change in choice for the most and least chosen stimuli from pretreatment to posttreatment for groups showing lower (< 50%) and higher (> 50%) initial levels of behavioral control by the initially least picked stimulus during pretreatment.

that showed a larger degree of initial overselectivity, compared to the groups with lower amounts of initial overselectivity. A two-factor ANOVA (reduction × overselectivity) conducted on these data revealed a statistically significant main effect of overselectivity, $F(1,103) = 12.35$, $p < .01$, but neither the main effect of extinction nor the interaction between the two factors were statistically significant, both *p*s > .10.

Role of Initial Degree of Behavioral Control

To explore the effects (i.e. the level of change in behavioral control) of the initial levels of behavioral control exerted by the underselected stimuli on the effects of the devaluation of the overselected stimuli, the sample was divided into two groups: one group for whom the behavioral control exerted by the initially least selected stimulus was 50% or greater ($n = 57$; excluding those participants who displayed ceiling effects, selecting each stimulus 100%), and another group for whom the behavioral control exerted by the initially least selected stimulus was less than 50% ($n = 31$).

Figure 5 shows the change in the percentage selection of the stimuli pretreatment to posttreatment. Inspection of these data reveals a very large increase in control by the initially underselected stimulus when its control was initially very weak (< 50%), and a smaller emergence when the control was initially stronger.

To examine the impact of this factor on levels of change in behavioral control, simple effect analyses were conducted on the levels of change in both stimuli separately, using the pooled error term from a two-factor ANOVA (group × stimulus), as recommended by Howell (1997). For the initially overselected stimulus, there was a statistically significant larger decrease in the level of reduction of behavioral control for the group with less control initially exerted by the underselected stimulus, $F(1,85) = 10.06$, $p < .001$. For the initially underselected stimulus, there was a statistically significant greater increase in the level of control by the initially underselected stimulus for the group with initially lower levels of behavioral control, $F(1,85) = 8.59$, $p < .001$.

Of course, it should be noted that the level of overselection (shown in Figure 4) and the level of initial control exerted by the underselected stimulus element (see Figure 5) are strongly correlated with one another ($r = -0.638$). Smaller levels of initial control by the underselected stimulus are associated with a larger difference between the overselected and underselected choices.

DISCUSSION

The present experiment had three main aims: to replicate the overselectivity effect in typically developing adults with the addition of a concurrent load task; to explore if a retrospective revaluation effect could be obtained in such an overselectivity/overshadowing procedure in humans; and to investigate the factors that contribute to the emergence of this effect. These results have implications for understanding the nature of the overselectivity effect, and when remediation by revaluation of the initially overselected stimulus might be a viable alternative.

The study found that stimulus overselectivity could be generated in adult participants who presented no form of learning disability. These results support previous finding of by McHugh and Reed (2007; Reed & Gibson, 2005), who found that such overselectivity could be generated by the addition of a concurrent load. One criticism raised concerning the study conducted by Reed and Gibson was that there was no screening for Asperger's Syndrome or high functioning autism, and thus, some of the participants may have scored highly on the autistic continuum, accounting for the results. The current study included a test for Asperger's and high-functioning autism (Baron-Cohen, Wheelwright, Skinner, Martin, & Clubley, 2001), ensuring that overselectivity that was observed was induced in participants without developmental disabilities.

The second aim of the current study was to explore whether retrospective revaluation effects could be obtained in humans using an overshadowing-like procedure (Matzel et al., 1985), as they have been found using backward blocking procedures with human participants (e.g., Van Hamme & Wasserman, 1994). Although the former procedure has demonstrated some retrospective revaluation effects in rats (Kaufman & Bolles, 1981; Matzel et al., 1995), these results are not always found (see Holland, 1999).

The present findings showing an emergence of behavioral control by a previously underselected stimulus following revaluation of the previously overselected stimulus reflect prior results reported for nonhumans by Kaufman and Bolles (1981), and Matzel et al. (1985), and in humans by McHugh and Reed (2007), and by Reed et al. (2009), but demonstrates the effect in adults with no developmental disabilities who were screened for ASD. However, it is difficult to make a strong comparison with findings from the literature using rats due to procedural as well as species differences. For example, the current procedure adopted a technique that employed both punishment of the previously selected stimulus, and reinforcement of a novel stimulus to reduce behavioral control. In contrast, studies employing nonhumans tend to use just extinction of the overshadowing stimulus. This difference remains to be explored further.

The present results also need to be interpreted in the light of previous demonstrations in order to rule out some potential trivial explanations of these data, such as regression to the mean. For example, the current study did not include a condition in which participants were taught the discrimination (AB+ versus CD−), were tested, then retested in the absence of any treatment phase. If no previous demonstrations of the effect had been presented, then it may well be the case that the present pattern of results could be attributed to regression to the mean effects. However, the fact that such controls have been used previously (e.g., see Broomfield et al., 2008; Reed et al., 2009), and have found no such regression to the mean effect, suggests that this is not a compelling argument. For example, Reed et al. compared an experimental group of children with ASD who received an initial discrimination training task, followed by a devaluation of the overselected stimulus phase, and then a retest, as described here, with a control group that received the same treatment without the devaluation phase. Only the experimental group displayed the revaluation and emergence effects as noted here. The control group showed no change in the levels of behavioral control exerted by the stimuli at the second test, suggesting that regression to the mean played little part in producing these effects (see also Broomfield et al., 2008). These previous demonstrations also suggest that it is necessary for emergence of control in the second test that the previously underselected stimulus is associated with the revalued previously overselected stimulus; in these studies there was no emergence of responding to the underselected stimulus from the compound from which the overselected element was not revalued.

There also is another possible consideration that deserves further exploration; this involves issues regarding the context of the test and retest phases, which are not identical to one another with respect to the histories of the stimuli present. In the initial test procedure, there is a choice between an element with a history of reinforcement (e.g., A or B) and an element with a history of nonreinforcement (e.g., C or D). However, in the second test, half of the choices involve two elements with at least some history of nonreinforcement (e.g., the revalued stimulus A and C or D). This difference may impact on the emergence of control by the previously underselected stimulus at the second test, and this deserves further exploration.

The current findings do suggest that overselectivity is not likely to be just the result of an attention-deficit problem (e.g., Dube & McIlvane, 1999). These retrospective revaluation effects could be explained by a number of models that do not suggest initial deficits in learning, for example, Dickinson and Burke's (1996) MSOP model, or the comparator hypothesis (Miller & Schachtman, 1985). Both of these theories explain overshadowing in humans, which has recently been proposed as a model for overselectivity in humans (see Reed & Gibson, 2005). These theories suggested that overshadowed (underselected) stimuli are learned about, but do not control behavior in the presence of stimuli with greater associative strength or salience. That is, the overshadowed or underselected cues do not fail to control behavior because they were not learned about (or attended to) during training. If this were the case they would not emerge as controlling stimuli when the overselected stimulus was extinguished.

That an emergence effect occurred most readily under particular circumstances has previously been suggested as likely in the literature (cf. Holland, 1999), but those circumstances have not received a great deal of attention. The current findings represent an initial attempt to establish whether any such factors could be identified. They suggest that such retrospective revaluation findings occur more readily if a strong overselectivity (overshadowing) was demonstrated initially. The extent of the reduction in behavioral control by the initially most picked stimulus was marginally related to the outcome (see Holland, 1999), but not to such an extent as the level of overselectivity. In particular, when the initial overselectivity was associated with low levels of behavioral control being exerted by the initially underselected stimulus, then the previously underselected stimulus came to control behavior most strongly after the devaluation of the previously overselected stimulus.

Prior to the discussion of the practical implications of such a finding, it is important to note that this finding may be related to the scope for showing such an effect; lower levels of initial behavioral control by the underselected stimulus may simply leave more room for a subsequent emergence of control by this stimulus. Future work will need to address this possibility, perhaps by adopting a procedure without a low ceiling for asymptotic behavioral control; that is, allowing scope for substantial increases in behavioral control, even when that behavioral control was strong relative to other underselected stimuli. One possibility is not to employ a forced choice procedure, but to adopt the procedure used initially by Lovaas, Schreibman, Koegel, and Rehm (1971) in which levels of behavioral control are assessed by response rate emitted in the presence of stimuli. This would remove a problem of an artificial ceiling on behavioral control, and go some way to overcome the above concerns. However, having acknowledged this fact, it should also be noted that the initial levels of control exerted by the underselected stimulus had an impact on the degree of reduction of control by the overselected stimulus. This finding cannot be related to a ceiling effect, and suggests that this factor may well be important in examining when a devaluation intervention would be beneficial.

The relationship of emergence to the level of initial overselectivity can be related to the finding that overselectivity is readily seen in individuals with ASD. If the compound cue is not broken down into its elements (it is learned as a configural cue), then any effect on one element of the compound would, indeed, generalize to the other element (as also suggested above). When there is a larger differentiation between the stimulus elements (i.e. a larger degree of overselectivity), the stimuli are more likely to have been treated elementally, and the underselected stimulus is seen to emerge after reduction in control by the initially most picked stimulus. Plaisted, O'Riordan, and Baron-Cohen (1998) have suggested that individuals with ASD show poor configural learning, which is why they are better at visual search tasks, and could also be why they are more prone to overselectivity effects.

The experiments reported herein support previous findings that underselected stimuli are learned about, and can come to control behavior when associatively stronger or more salient cues are weakened. This increase in control occurs when extinction of the overselected stimulus is successful, and when there is a higher degree of overselectivity. The findings do support the theory that underselected stimuli are attended to in learning but do not, however,come to control behavior until the extinction of more salient cues.

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