AGE TRENDS IN STIMULUS OVERSELECTIVITY

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Stimulus overselectivity refers to the phenomenon whereby stimulus control over behavior is exerted only by a limited subset of the total number of stimuli present during discrimination learning. It often is displayed by individuals with autistic spectrum disorders or learning disabilities, but is not exclusive to those groups. The present studies investigated the impact of aging on stimulus control and overselectivity. Three age groups—18–22, 47–55, and 70–80 year olds—were studied in two experiments. All participants were trained on a simple discrimination task, randomly assigned to one of two conditions (either with or without a distractor task), and then tested for the emergence of overselectivity (Experiment 1). In Experiment 2 responding controlled by the overselected stimulus elements was reduced by introducing a verbal punisher. In subsequent tests, control of behavior by the previously underselected elements from Experiment 1 was enhanced across the two younger age groups but not the oldest group of participants. The results are discussed in relation to the attention-deficit and overshadowing accounts of overselectivity.

Key words: stimulus overselectivity, simple discrimination task, verbal reinforcer, verbal punisher, young adults, middle-aged adults, older adults

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Stimulus overselectivity refers to the phenomenon whereby control over behavior is exerted only by a limited subset of the total number of stimuli present during discrimination learning (see Dube & McIlvane, 1999; Lovaas & Schriebman, 1971). It is often displayed by individuals diagnosed with autistic spectrum disorders (ASD) or learning disabilities, can result in limited learning in terms of the range or number of stimulus features that come to control behavior, and may retard the acquisition of certain behaviors. Although the majority of the research in this area has been conducted with persons diagnosed with ASD (Lovaas & Schriebman), a new body of research has begun to explore this phenomenon in normally developing adults (Reed & Gibson, 2005).

There are two major reasons for the study of overselectivity: firstly, it gives insight into the processes of stimulus control of behavior; and secondly, it examines the role overselectivity plays in impeding the formation of complex concepts (Cumming & Berryman, 1965). According to Lovaas (1980), stimulus overselectivity could cause many of the behavioral problems commonly found in autism. For example, the understanding of speech involves a number of cues, including hearing what the other person is saying, watching lip movements and facial expressions, etc. In the extreme case, stimulus overselectivity may cause an individual to focus on only one of these cues. In turn, this may disrupt the development of an understanding of language or, indeed, the ability to use language in a meaningful way (Lovaas, Schreibman, Koegel, & Rehm, 1971; Schreibman & Lovaas, 1973).

The overselectivity effect bears on issues fundamental to understanding the circumstances under which stimulus control will occur. Explanations proposed for stimulus overselectivity have been based on the assumption that the problem is due to the failure of stimulus elements to be learned during initial training. For example, an attention deficit can be considered equivalent to the absence of stimulus control and has been proposed to account for overselectivity in autistic individuals (see Koegel & Schreibman, 1977). Analysis of the eye movements of retarded children who display overselectivity when confronted with a complex stimulus appears to corroborate this view. Such individuals do not appear to examine all the stimuli elements present in the complex stimulus (Dube et al., 1999). Hence, these unattended elements do not control behavior in subsequent test trials. (A cautionary note here is that eye movements are imperfectly correlated with attention; Remington, 1980.)

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doi: 10.1901/jeab.2007.88-369

An alternative argument is that all stimulus elements are attended to during training and learned, but that only a subset of these elements comes to control behavior. When a stimulus is presented by itself, it may exert strong control over behavior. However, previous research indicates that, if that stimulus is accompanied by another stimulus, then control by the former stimulus may be reduced or eliminated by the presence of the latter (see Mackintosh, 1975). This effect is more commonly known in the animal conditioning literature as overshadowing (see Trabasso & Bower, 1968). Recent research has suggested overshadowing as a model for overselectivity (Gibson & Reed, 2005).

In the animal conditioning literature, apparently overshadowed stimuli, or stimuli that do not strongly control behavior, can be established as controlling stimuli by extinguishing other, more powerful or salient cues (e.g., Kaufman & Bolles, 1981; Matzel, Schachtman, & Miller, 1985; Reed & Reilly, 1990). This effect was demonstrated by Wilkie and Masson (1976). They exposed pigeons to compound stimuli consisting of color and shape elements. Grain reinforcers were given in the presence of a specific compound stimulus consisting of one color element and one shape element (the S+). Once pecking was exclusively directed to the S+, the color and shape elements were presented individually without reinforcement. Each pigeon responded only to the color element and not to the shape element. In the next phase of training, pecking was reinforced when the shape (i.e., the overshadowed or underselected) element alone was present. Pecking in the presence of the shape element was acquired more rapidly by the pigeons that previously had been exposed to the shape element than by pigeons that previously had not been exposed to the shape element (i.e., there were savings in the relearning task). This finding suggests that, although the pigeons exposed to the compound stimuli had learned the shape element during training, this element had not controlled behavior when it was combined with the color element, that is, was not sufficient to control performance when the more salient stimulus was present simultaneously.

To date there are few demonstrations that an underselected stimulus demonstrates enhanced stimulus control following extinction of the overselected stimulus in humans (see Broomfield, McHugh, & Reed, in press). Most demonstrations of the overselectivity effect have been with clinical populations (e.g., ASD), which may raise questions about the generality of the processes at work, that is, it may be that clinical populations are influenced by different factors than nonclinical populations. Previous research by Reed and Gibson (2005) demonstrated that stimulus overselectivity can be observed in human participants without disabilities when they concurrently perform an additional task (e.g., a concurrent memory task). In those studies, participants were presented with a simultaneous discrimination task in which they had to learn through trial and error to select one 2-element compound in preference to another 2-element compound. Participants who were given a concurrent task subsequently responded to one element of the compound far more than to the other, suggesting an overselectivity effect. These findings led to further research on the basic processes involved in the phenomenon of overselectivity involving non-autistic adult participants.

The present study used a nonclinical sample to examine the overselectivity phenomenon and also compared the effects of age on overselectivity. Experiment 1 exposed young adults, middle-aged adults, and elderly adults to an overselectivity procedure, while manipulating the presence of a concurrent distractor task. If, for example, higher levels of overselectivity emerged for the oldest age group than for the other two, this result would demonstrate a relation between age, distraction, and overselectivity.

EXPERIMENT 1

A study by Reed and Gibson (2005) examined whether overselectivity occurred in human participants without disabilities in conditions where they were presented with a distracting task. As previously noted, participants were exposed to a simultaneous discrimination procedure in which they learned through trial and error to select one 2-element compound over a second 2-element compound. Participants were randomly assigned to one of two groups. One group was required to concurrently memorize a stimulus grid (the distracting task) while the other group was presented with the same grid but not required to memorize it. Participants with the distracting task subsequently responded to one element of the stimulus compound far more than to the other, thus demonstrating the overselectivity effect.

Experiment 1 extended the work carried out by Reed and Gibson (2005) by including three different age groups to explore whether overselectivity increased with age and, if so, whether that increase was related to the distractor task. Research has documented various declines in ability with age such as the ability to process complex cues (Ardle, Ferrer-Caja, Hamagami & Woodcock, 2002). One potential explanation for such declines might be overselectivity. Employing the overselectivity procedure previously used by Gibson and Reed (2005) may provide an effective procedure for determining whether overselectivity increases with age and is amplified further by a distractor task.

Method

Participants

Forty-eight participants, 16 in each of three age groups (18–22, mean 19.5 ± 1.2 – the standard deviation; 47–55, mean 50.1 ± 2.3; 70–80, mean 73.1 ± 2.7) participated. All participants were volunteers recruited through faculty board announcements and from personal acquaintances of the experimenters. The participants in each age group were randomly assigned to one of two experimental groups ($n = 8$). Participants did not receive any payment for participation.

Apparatus and Materials

The experiment was conducted in a room free of ordinary distractions. Participants were presented with white cards that measured 15 cm by 10 cm. Some of the cards contained two stimulus elements. These were the compound stimuli. The stimulus elements were characters obtained from various fonts available in Microsoft Word 2000. The fonts were Wingdings, Wingdings 2, and Symbol. Verbal reinforcement was given for selecting one pair of characters (here designated by letters) over another pair; for example, selecting A and B over C and D, and E and F over G and H. Additional cards of the same size depicted only one of the elements of the compound stimulus.

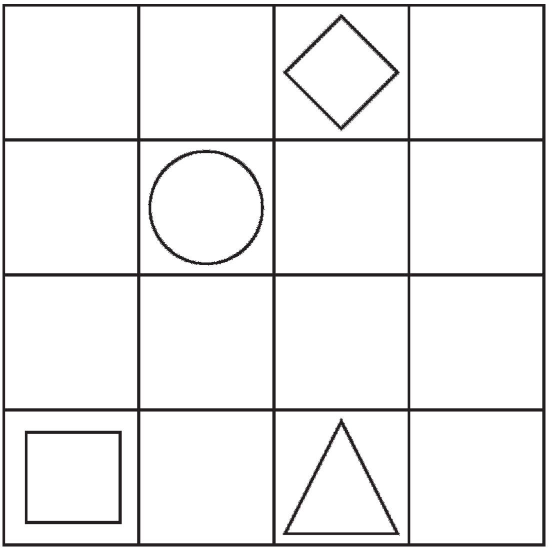

Fig. 1. The grid used in the distractor condition in Experiment 1.

The 4 × 4 grid with four different shapes that was used in the distractor task is presented in Figure 1 (see also Reed & Gibson, 2005).

Procedure

Distractor task. A distractor task was implemented as a between-subject variable. Half of the participants in each age group were randomly selected and first required to memorize the stimulus grid (Figure 1), which was presented for 20 s. Participants were presented with the distractor task individually. They were informed that they would be required to replicate the grid by drawing it on paper at the end of the experiment but that the grid was not relevant to the next part of the experiment. The other half of the participants in each group were shown the grid for the same length of time at the beginning of the experiment, but no instruction to replicate (or memorize) the grid was provided.

Training phase. Participants were trained individually. The experimenter sat directly opposite the participant throughout the experiment. The stimulus cards were placed at the center of the table between the participant and the experimenter. Participants were instructed as follows:

> *You will be shown two cards containing two symbols on each. Please select a card by pointing to that card. Point to the card rather than an individual symbol.*

You will be given feedback of "yes" for some cards and "no" for others. Your choices will be recorded.

Participants were presented with two cards simultaneously. Each card contained two stimulus elements. On any given trial, participants were presented with one compound stimulus card (e.g., here symbolized as AB or EF) that, if selected by the participant, resulted in verbal reinforcement in the form of the experimenter saying ''yes.'' In other words, that card became an S+. Selecting the other card (e.g., CD or GH) resulted in the experimenter saying ''no''; in this case, the card became an S−. The positions of the cards were systematically randomized, that is, on 50 percent of the trials the correct card was presented on the left and otherwise on the right. Each trial lasted until a response was made and each intertrial interval was approximately 5 s.

During the training phase, a specific S+ was always paired with a specific S−. There were two S+ and two S− stimuli. Participants were considered to have acquired the discrimination once they produced 10 consecutively correct responses. The stimulus elements used in the compounds were different for each participant in order to prevent an intrinsically more salient stimulus from always having the same role.

Test phase. The test phase followed the training phase. During the test phase of the experiment the participants were presented with two cards simultaneously, each containing only one character from the previous compound stimulus to which it belonged during the training phase. That is, one card contained an element of a previous S+ and the other an element of a previous S−. Specifically, A or B elements were presented with C or D elements, and E or F elements were presented with G or H elements, respectively. There were five trials for each combination of elements for a total of 40 trials. No feedback was provided during these trials. To ensure that the initial discriminations involving compound stimuli were maintained throughout testing, each pair of compound stimulus cards (S+ and S−) also was presented 10 times during probe trials in the test phase for a total of 20 probe trials. No feedback was provided during probe trials. The order of presentation of the compound stimulus and single stimulus cards was randomized over the total of 60 test trials. The training and test trials all took place within the same session.

Results

Trials to Criterion in the Training Phase

The mean numbers of trials to criterion for the three age groups in the no-distractor condition were: 15.88 (s.d. ± 3.3), 17.38 (s.d. ± 3.9), and 21.75 (s.d. ± 6.4) for the 18–22, 40–55, and 70–80 year-old groups, respectively. The means for the three age groups in the distractor condition were: 18.06 (s.d. ± 4.23), 20.31 (s.d. ± 5.55), and 28.13 (s.d. ± 8.16), respectively. Thus, fewer trials were required when there was no distractor. Also, the number of trials to criterion increased as a function of age, irrespective of the presence or absence of the distractor, with the fastest acquisition demonstrated by the youngest group and slowest acquisition by the oldest group.

To determine whether these trends were statistically significant, a 2×3 mixed-model analysis of variance (ANOVA) was conducted, with distractor versus no distractor and age group (18–22, 47–55, 70–80) as the between-subject variables and trials to criterion as the dependent measure. The analysis revealed that there was a significant main effect for distraction [$F(1,45) = 88.88$, $p < 0.0001$], indicating that the use of the distractor increased the number of trials to criterion, a statistically significant main effect for age group [$F(2,45) = 9.76$, $p < 0.0001$], indicating that the age groups differed in the number of trials required to meet the criterion, and a significant interaction effect for distractor task by age group [$F(2,45) = 10.05$, $p < 0.0001$].

To investigate where the significant effects for age group emerged for trials to criterion in the distractor versus no-distractor conditions, simple-effects analyses were conducted. They showed that there was a significant difference between the 18- to 22-year-old groups [$F(1,45) = 9.65$; $p < .05$], the 47- to 55-year-old groups [$F(1,45) = 96.52$; $p < .05$], and the oldest groups [$F(1,45) = 769.17$; $p < .05$]. That is, the inclusion of the distractor task increased the number of trials to criterion in all three age groups.

The differences between the numbers of trials to criterion between the age groups also were compared using independent *t*-tests. The results revealed that the youngest age group required significantly fewer trials to criterion than the oldest group in both the no-distractor condition [$t(30) = 3.26$, $p < .01$] and distractor condition [$t(30) = 4.38$, $p < .001$]. The same pattern also emerged between the middle-aged group and the older-age group in both the no-distractor condition [$t(30) = 2.33$, $p < .05$] and the distractor condition [$t(30) = 3.17$, $p < .01$]. There was no significant difference between the youngest and middle-aged groups in number of trials to criterion for either the distractor ($p > .05$) or no-distractor conditions ($p > .05$). The significant differences that emerged between the groups suggested a developmental trend in terms of trials to criterion, with the two younger groups of participants meeting the criterion more rapidly than the oldest group in both the distractor and nondistractor conditions.

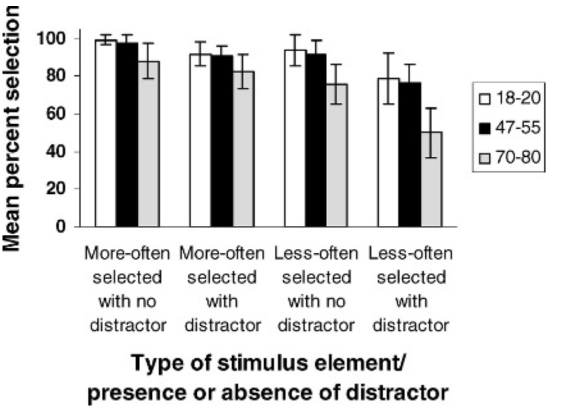

Fig. 2. Mean percentage and standard error of selection in the test phase of the less-often-selected and more-often-selected stimulus elements in both the distractor and no-distractor conditions for the three age groups in Experiment 1.

More-Often- versus Less-Often-Selected Elements in the Test Phase

Correct responding on probe trials in the test phase was consistently above 80%, indicating that the initial discriminations were maintained throughout testing. The mean number of times that each of the elements of the S+ stimuli was selected during the test phase was calculated in order that the pair of more-often-selected elements and the pair of less-often-selected elements could be identified. The results from the distractor and no-distractor conditions are shown in Figure 2 for each group.

Inspection of these data indicates that in the distractor condition, there was a larger difference between the percentage of times the more-often- and less-often-selected elements were chosen than in the no-distractor condition. A 2×2×3 mixed-model ANOVA was performed with element type (more-often-selected versus less-often-selected) as the within-subjects variable, distraction (distractor versus no distractor) and age group (18–22, 47–55, and 70–80) as the between-subjects variables, and percentage of times the more-often- or less-often-selected elements were selected as the dependent measure. This analysis showed that there was a significant main effect for more-often-selected versus less-often-selected elements [$F(1,45) = 124$, $p < 0.0001$], a significant main effect for distraction [$F(1,45) = 90.74$, $p < 0.0001$], and a significant interaction effect for the two variables [$F(1,45) = 33.29$, $p < 0.0001$]. There was also a significant effect for age group [$F(2,45) = 48.97$, $p < 0.0001$], a significant interaction between age group and the selected elements [$F(2,45) = 11.63$, $p < 0.0001$], and a significant three-way interaction between the three variables [$F(2,45) = 3.6$, $p < 0.05$].

In order to determine where the significant differences emerged between the more-often- and less-often-selected elements across the three age groups, a 2×2 repeated measures ANOVA was conducted for each age group with distraction as the between-subjects variable, element type as the within-subjects variable, and percentage of times the elements were selected as the dependent measure. The analysis for the 18- to 22-year-old group revealed a significant effect for distraction [$F(1,15) = 39.19$; $p < .0001$] and stimulus element type [$F(1,15) = 23.6$; $p < .0001$] and a significant interaction between the two variables [$F(1,15) = 4.36$; $p < .05$]. For the 40- to 55-year-old group, the analysis revealed a significant effect for distraction [$F(1,15) = 34.71$; $p < .0001$] and for element type [$F(1,15) = 40$; $p < .0001$] and a significant interaction [$F(1,15) = 15.64$; $p < .001$]. For the 70- to 80-year-olds, distraction was significant [$F(1,15) = 29.39$; $p < .0001$], as was element type [$F(1,15) = 63.95$; $p < .0001$], and there was a significant interaction between the two [$F(1,15) = 18.46$; $p < .001$].

A series of planned comparisons between the more-often- and less-often-selected elements was conducted comparing the distractor and no-distractor conditions in terms of the mean percentages of selection of the two types of stimulus element for each age group. For the youngest group of participants there was a significant difference between the more-often-selected elements in the distractor condition and those in the no-distractor condition [$t(15) = 4.39$; $p < 0.001$] and a significant difference between the less-often-selected elements in the two conditions [$t(15) = 4.74$, $p < 0.001$]. The same pattern emerged for the middle-aged group [$t(15) = 3.48$, $p < .01$ and $t(15) = 6.48$, $p < 0.001$]. However, there was no significant difference between the more-often-selected elements for the older group when compared across the two conditions [$t(15) = 1.95$, $p < 0.07$]. This indicated that the elderly participants overselected in both conditions. However, there was a significant difference between the conditions for the less-often-selected elements at the same age level [$t(15) = 5.86$, $p < 0.001$].

To summarize, there appeared to be a clear trend in overselectivity: It increased with age and with the use of the distractor task. Additionally, the effect of the distractor increased with age.

Individual Participants' Data.

The individual participants' data are presented in Appendix 1. As can be seen in the no-distractor condition, there is a distinct difference in percentage of selection between the more-often-selected element and the less-often-selected element. This distinction becomes more pronounced in the distractor condition.

The numbers of participants who exhibited a difference of 20% or greater in their selection between the two types of stimulus elements were 2, 1, and 7, for the young, middle-aged, and elderly groups, respectively, in the no-distractor condition, and 5, 7, and 14, respectively, in the distractor condition. A chi-squared analysis compared whether the number of participants meeting this criterion differed across the age groups. Overall, 21.9% of the participants in the 18- to 22-year-old group met the criterion, 25% in the 47- to 55-year-old group did so, and 65.6% of the 70- to 80-year-old group. The chi-squared analysis indicated a significant difference between the 18- to 22-year-olds and 70- to 80-year-old group [$\chi^2(1) = 12.44$, $p < .001$, $\Phi = .44$] and between the 47- to 55-year-old and 70- to 80-year-old groups [$\chi^2(1) = 10.65$, $p < .001$, $\Phi = .41$], suggesting a significantly higher level of overselectivity in the oldest group.

To summarize, the distractor task increased the level of overselectivity, and the level of overselectivity increased as a function of age. Specifically, the participants in the oldest age group displayed higher levels of overselectivity than those in the two younger groups. The results replicate the previous findings of Reed and Gibson (2005), who showed that adult participants were more likely to overselect when a distractor was used.

Discussion

Previous work by Broomfield et al. (in press) explored whether underselected elements would control behavior after a verbal punisher was administered following the selection of the overselected elements. In fact, responding to the previously underselected elements was enhanced. This was the first demonstration of enhanced behavioral control by underselected elements as a consequence of punishing the selection of the overselected elements. These results have implications for the remediation of overselectivity in populations where it may inhibit learning. To date, however, no study has attempted to enhance control by underselected elements using participants from a normal adult population who demonstrated higher levels of overselectivity. Experiment 2 was designed to explore whether the enhancement of stimulus control by underselected elements could be facilitated in participants who demonstrated the highest levels of overselectivity in Experiment 1, namely, the older adults.

EXPERIMENT 2

As previously mentioned, possible causes of overselectivity have been suggested in the literature. Dube et al. (1999) suggested the possibility of an attentional deficit, that is, that not all the elements that compose a complex stimulus are learned. An alternative view is that, although all of the stimulus elements are learned, overshadowing may take place when relative stimulus control is tested with a simultaneous discrimination procedure. Also, the possibility that two separate processes affect stimulus control has been suggested by White and Ruske (2002). Experiment 2 aimed to assess whether the higher levels of overselectivity observed in the older-adult participants in Experiment 1 was an attentional deficit or the result of overshadowing. To this end, the previously overselected elements were punished verbally, and the previously underselected elements were then tested for any change in the stimulus control that they exerted when tested again against the elements from the previously nonreinforced compound. Experiment 2 also addressed the question of whether the enhancement of stimulus control by the underselected elements would differ across the three age groups (18–22, 47–55, and 70–80 year olds).

Method

Participants, Apparatus, and Materials

Twenty-four of the participants in Experiment 1 also participated in Experiment 2. Specifically, they were the 8 participants from each age group for whom the distractor condition was in place during the training phase of Experiment 1. The setting, apparatus, and materials were identical to those employed in Experiment 1 with the exception that novel stimulus elements were introduced in the training phase. No payment for participation was provided.

Procedure

Training phase. The elements that were selected more often in Experiment 1 (i.e., the overselected elements) were identified for each participant. Training trials were conducted in which one of the more often selected elements and a novel element were presented at the same time, each on a separate card. There were four novel elements, one of which was selected randomly for each of the participants. A verbal reinforcer (''yes'') followed selection of the novel element. A verbal punisher (''no'') followed selection of the previously overselected element. Training continued until the participants selected the novel element in 10 consecutive trials.

Test phase. The test phase followed the training phase. The test procedure involved the same 40 trials consisting of individual elements of S+ and S- that were included in the test phase of Experiment 1. Unlike Experiment 1, no probe trials containing the original compound stimuli were presented.

Results

The mean percentages of selection of the punished elements (i.e., the originally more-often-selected elements) and the mean percentages of selection of the originally less-often-selected elements from Experiment 1 (unpunished elements) were calculated for each age group and are presented in Figure 3. For purposes of comparison the percentages of selection of the originally underselected and overselected elements in Experiment 1 also are presented in the Figure 3.

The results from the test phase of Experiment 2 were compared to those from the test phase of Experiment 1 using the percentages of selection of the more-often-selected stimulus elements across the three age groups in the distractor condition. To that end, the mean percentage of selection of the originally more-selected stimulus elements from Experiment 1 was subtracted from the mean percentage of selection of these now punished (but previously more often selected) stimulus elements from Experiment 2. A negative difference indicates a lower percentage of selection in Experiment 2. The smallest difference emerged for the older-adult group [-28.75 (± 17.27)], compared to the two younger groups of participants [18–22: -31.25 (± 14.6); 47–55: -31.25 (± 9.9)]. The differences clearly show that stimulus control by the originally underselected stimulus elements emerged following punishment of the originally overselected elements.

A 2×3 mixed ANOVA was performed. Selection of the punished elements versus selection of the originally less-often-selected elements was the within-subjects variable, age group was the between-subjects variable, and mean percentages of selection of element type was the dependent measure. The analysis revealed a significant main effect for element selected [$F(1, 21) = 15.59$, $p < 0.001$], a significant main effect for age group [$F(1, 21) = 17.24$, $p < 0.0001$], and a significant interaction effect [$F(2, 21) = 5.934$, $p < 0.01$]. These results indicate that the use of the verbal punisher may have reversed the selection of the two types of stimulus element.

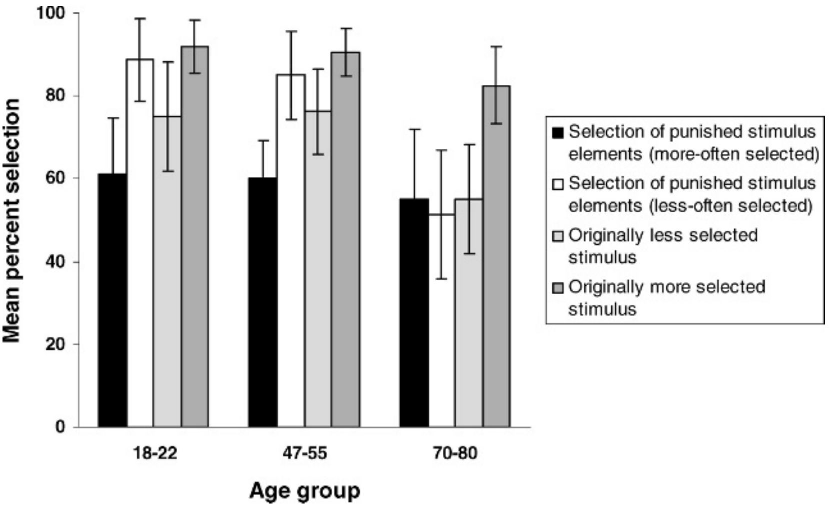

Fig. 3. Mean percentage and standard error of selection of the originally more-often-selected stimulus elements and the originally less-often-selected elements in the test phase for the three age groups in Experiment 2. The original percentages of selection also appear for comparison.

A series of planned comparisons was conducted to determine where the significant differences in element selection emerged with regard to age group. Simple-effects analysis revealed a significant difference for the 18- to 22-year-old-group [$F(1,4) = 26.71$; $p < 0.05$], for the 40- to 55-year-old group [$F(1,4) = 8.7$; $p < 0.05$], and for the 70- to 80-year-old group [$F(1,4) = 19.22$; $p < 0.05$], but the difference for the last group was in the opposite direction from that for the two other groups.

For the two younger age groups, the originally less-often-selected elements became more salient (that is, were selected more often) when the originally more-often-selected elements were punished. This did not occur in the older-adult group. That is, the enhancement of stimulus control by the originally less-often-selected elements occurred in the two younger groups but not in the older-adult group.

Individual Participants' Data

For each participant, Appendix 2 displays the percentages of selection of the element types in the two experiments. A negative difference indicates a larger percentage of selection in Experiment 1. There was a clear tendency in the younger two groups to prefer the originally less-often-selected element.

To further demonstrate the reversal that occurred in Experiment 2, a criterion of 20% or greater in the selection of the previously more-often-selected element and the previously less-often-selected element was imposed. Of the 8 participants in each group, 7 of the youngest group of participants and 6 of the middle-aged group of participants met the criterion, but only 3 of the elderly group of participants met it. A chi-squared analysis revealed a significant difference between the number of participants who met criterion between the youngest and oldest groups of participants [$\chi^2(1) = 4.27$; $p < .04$, $\Phi = .516$]. The difference between the middle-aged and oldest group was not significant [$\chi^2(1) = 2.29$; $p < .13$], nor was there a significant difference between the youngest and middle group of participants.[$\chi^2(1) = .41$; $p > .05$]. These results suggest that the use of the verbal punisher had the least impact on the oldest group of participants.

Discussion

The results from Experiment 2 demonstrated that the enhancement of stimulus control by underselected elements was facilitated in the two younger groups of participants. However, this effect was not observed in the oldest group of participants. These findings suggest that different processes may be involved in the overselectivity observed in the oldest group. Specifically, the emergence of the enhancement effect in the two younger groups supported the overshadowing rather than the attentional-deficit account of stimulus overselectivity, as the less-often-selected stimulus elements in Experiment 1 were, in fact, learned. That facilitation did not emerge in the oldest group of participants may lend support to the attentional-deficit account of stimulus overselectivity for that age group.

GENERAL DISCUSSION

The results from Experiment 1 demonstrated stimulus overselectivity in all three age groups of adult participants in a simple discrimination task. The effect was more pronounced when participants also were required to complete a distractor task. The effect was similar to that reported by Reed and Gibson (2005). In addition, a developmental trend in overselectivity emerged: Overselectivity was more likely to occur in later adulthood. In Experiment 2, participants in the two younger age groups demonstrated differentially greater stimulus control by the previously less-often-selected stimulus elements. This effect was not evident in the oldest group.

Two hypotheses were considered. The first is that overselectivity of stimulus elements represents the failure to attend to them in the first place (attentional deficit). The second is that one element overshadows the other (overshadowing). The results of Experiment 2 provide some support for the second hypothesis. The results for the two younger age groups of participants showed that the less-often-selected stimulus elements in Experiment 1 were learned.

Previously, Dube et al. (1999) used a measure of eye movement to assess overselectivity in individuals with mental retardation. Their findings suggested that participants who overselect failed to attend to all the relevant stimuli. If stimuli are not attended to, then they cannot control behavior. This finding is in line with learning theories of differential stimulus control (e.g., Mackintosh, 1975; Rescorla & Wagner, 1972; Sutherland & Mackintosh, 1971). However, the present study found that, for the two younger groups of participants, previously less-often-selected stimulus elements gained control of behavior when the previously more-often-selected elements were punished, a finding that strongly suggests the originally underselected elements did not go unattended. Still, the same effect was absent in the older-adult group of participants. Either overshadowing is less likely to occur in the elderly, or they may experience an attentional deficit. Deciding between these hypotheses is a matter for further research (see Reed, 2006). For example, future research might examine selectivity in participants with diagnosed attentional deficits (e.g., ADHD). Furthermore, the performance of such participants on the acquisition task involving compound stimuli could be compared with that of participants who ordinarily manifest stimulus overselectivity (e.g., those with ASD), thus possibly providing insights into the behavioral processes by which these two categories of disorder can be differentiated further.

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Received: September 27, 2006
Final acceptance: July 11, 2007

APPENDIX 1

Individual data for each group in Experiment 1. The data are the percentages of selection of the more-often-selected and less-often-selected stimulus elements in the distractor and no-distractor conditions in Experiment 1. Age group (in years) is denoted by number: 1 = 18–22; 2 = 47–55; 3 = 70–80.

Age Group	More-often-selected with no distractor	Less-often-selected with no distractor	More-often-selected with distractor	Less-often-selected with distractor
1	100	90	100	70
1	100	90	90	80
1	100	100	90	80
1	90	80	90	50
1	100	100	90	90
1	100	80	90	80
1	100	100	100	70
1	100	100	90	80
1	100	100	90	90
1	100	90	100	90
1	100	100	90	90
1	100	100	100	90
1	100	100	100	100
1	100	80	80	80
1	100	90	80	60
1	100	100	90	60
2	100	80	90	70
2	100	100	90	90
2	100	90	90	60
2	90	80	90	60
2	100	100	100	90
2	90	80	90	80
2	100	100	90	70
2	90	90	90	90
2	100	100	100	90
2	100	90	80	70
2	100	90	90	80
2	100	100	90	70
2	100	100	90	80
2	100	90	90	70
2	100	90	80	70
2	90	90	100	80
3	70	70	90	80
3	70	60	70	50
3	90	80	80	70
3	90	70	90	50
3	90	70	100	30
3	90	70	80	50
3	80	80	80	60
3	100	100	80	50
3	90	80	80	60
3	100	80	90	40
3	90	80	70	50
3	100	70	80	40
3	90	80	80	40
3	90	70	80	50
3	80	60	70	50
3	90	90	100	30

APPENDIX 2

Individual data for the percentages of selection of the punished stimulus elements (i.e., the originally more-often-selected; 1st column) and the originally less-often-selected (2nd column) stimulus elements in the test phase of Experiment 2. The 3rd and 4th columns show the differences in the percentages of selection of the two types of elements between Experiments 1 and 2 (specifically, % in Experiment 2 - % in Experiment 1). Age group (in years) is denoted by number: 1 = 18–22; 2 = 47–55; 3 = 70–80.

Age Group	% selection of punished stimulus elements (more)	% selection of unpunished stimulus elements (less)	Difference in % selection of the more-often-selected element	Difference in % selection of the less-often-selected element
1	60	90	−40	20
1	70	100	−20	20
1	50	80	−40	0
1	60	90	−30	40
1	50	70	−40	−20
1	90	90	0	10
1	60	90	−40	20
1	50	100	−40	20
2	50	90	−40	20
2	70	80	−20	−10
2	50	90	−40	30
2	70	100	−20	40
2	60	90	−40	0
2	60	70	−30	−10
2	50	70	−40	0
2	70	90	−20	0
3	50	70	−40	−10
3	50	50	−20	0
3	70	30	−10	−40
3	50	50	−40	0
3	70	60	−30	30
3	80	30	0	−20
3	30	70	−50	10
3	40	50	−40	0