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Long-term Analysis of Competing Stimuli in the Treatment of Automatically Maintained Problem Behavior

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Meline Pogosjana
M.A., California State University, Northridge, 2013

Dissertation
Submitted to the Department of Psychology
and the College of Arts and Sciences at
Western New England University in partial
fulfillment of the requirements for the
Degree of Doctor of Philosophy

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Abstract

Competing stimulus assessments (CSAs) are used as pretreatment assessments to identify stimuli that, when made freely available, reduce problem behavior. Although CSAs have demonstrated broad utility across various topographies and classes of problem behavior, the extent to which improvements noted during the CSA persist over time is unknown. We conducted initial CSAs and long-term analyses for participants with automatically maintained problem behavior. High-competition stimuli were identified during the initial CSA for all participants. When the effects of leisure stimuli were evaluated over the course of 12 weeks, the outcomes remained relatively unchanged for four of the six participants. These findings suggest that stimuli identified via a CSA are likely to retain their efficacy over time, particularly for individuals who do not require modifications to identify competing stimuli.

Long-Term Analysis of Competing Stimuli in the Treatment of Automatically Maintained Problem Behavior

The term automatic reinforcement is used to describe a response-reinforcer relation that is not socially mediated (Vaughan & Michael, 1982). Automatically maintained problem behavior can pose a unique assessment and treatment challenge because reinforcers maintaining the behavior cannot be directly identified nor easily controlled (Vollmer, 1994). The inability to specify variables maintaining automatically reinforced challenging behavior may limit a clinician's precision when attempting to arrange contingencies to withhold reinforcers for problem behavior or deliver the reinforcers maintaining problem behavior contingent upon appropriate alternatives. This uncertainty in specifying variables maintaining automatically maintained behavior seems most pertinent when considering treatment outcomes. For example, in a summary of functional analysis (FA) and treatment outcomes of self-injurious behavior (SIB), Iwata et al. (1994) reported differential treatment outcomes for individuals whose SIB was automatically maintained when compared to those with socially reinforced SIB, with fewer successful applications of both differential reinforcement and noncontingent reinforcement reported for the former (65% and 90%, respectively). Similarly, treatment outcomes summarized in Hagopian et al. (2015, 2017) support the notion that at least some forms of automatically maintained SIB are more treatment resistant and less amenable to reinforcement-alone treatment options.

Despite these unique treatment challenges, there is a sizable amount of research evaluating various behavior-analytic approaches in treating automatically maintained problem behavior. Treatments evaluated have included differential reinforcement of alternative behavior combined with other procedures to treat chronic hand mouthing (Roscoe, et al., 2013), response interruption and redirection to treat vocal stereotypy (Ahearn et al., 2007), punishment for treatment of SIB (Lerman et al., 1997), and the use of protective equipment for treatment of SIB (Roscoe et al.,1998). In addition, many treatments for automatically maintained challenging behavior, self-injurious and otherwise, rely on arranging noncontingent access to stimuli that provide access to alternative sources of reinforcement (e.g., Gover et al., 2019). In fact, Rooker and colleagues (2018) found that noncontingent reinforcement (NCR) was the most frequently evaluated treatment procedure (either alone or in combination with another procedure) for the treatment of automatically maintained SIB. Rooker et al. also found that NCR was the most effective reinforcement-alone based treatment for automatically maintained SIB and that stimuli selected for inclusion in NCR treatments were most often selected via a competing stimulus assessment (CSA).

Competing stimulus assessments (CSAs) are pretreatment assessments designed to identify stimuli that are associated with reductions in challenging behavior. A CSA generally involves systematically evaluating the extent to which stimuli freely available during test trials reduce or compete with problem behavior, relative to a no-stimulus control trial. Rates of challenging behavior and duration of engagement are measured across all control and test trials. The extent to which each stimulus is associated with reductions in problem behavior, presumably via reinforcer competition or substitution (Hagopian et al., 2005; Shore et al., 1997), is determined by calculating the percentage reduction in problem behavior while the stimulus is present, relative to a no-stimulus control trial. Stimuli associated with meaningful reductions in problem behavior—typically 80% or more reduction from no-stimulus control trial—are considered high-competition stimuli. High-competition stimuli identified during the CSA are then freely, or noncontingently, made available during treatment (e.g., Piazza et al., 1996; Piazza et al., 1998)

Recent reviews summarizing treatments for automatically maintained problem behavior indicate that stimuli identified for inclusion in NCR treatments are selected via a CSA result in greater reductions in problem behavior than when stimuli are selected via a preference assessment (e.g., Rooker et al., 2018). In one illustrative case, Groskreutz et al. (2011) evaluated preferences for a set of stimuli using a paired-stimulus preference assessment (Fisher et al., 1992) and then assessed the extent to which these same stimuli competed with stereotypy using a CSA. They then compared the reductive effects of high-competition stimuli from the CSA to high-preference stimuli from the preference assessment. The outcomes of high-preference stimuli did not correspond with those of the high-competition stimuli. The authors found that high-competition stimuli not only reduced stereotypy to a greater extent than the high-preference stimuli but also maintained these reductions across subsequent sessions. These findings suggest that not all high-preference stimuli compete effectively with reinforcement maintaining challenging behavior. The notion that stimulus preference and stimulus competition describe different stimulus-behavior relations is consistent with the results of a recent review on CSAs conducted by Haddock and Hagopian (2020). Haddock and Hagopian found a limited relation between high-competition and high-preference items, suggesting that stimuli to be included in treatment should be selected based on their reductive effects rather than levels of engagement or preference. Together, these results suggest that CSAs are better suited for identifying competing stimuli in the treatment of automatically maintained behavior and further support their frequent use.

CSAs have been used to identify competing stimuli to be included in treatments of automatically maintained behavior such as pica (e.g., Saini et al., 2016), self-injury (e.g., Rooker et al., 2018), and saliva play (Piazza et al., 2000). However, CSAs are not universally effective at identifying high-competition stimuli (Haddock & Hagopian, 2020). This could be because some individuals lack the skills to engage with leisure items or engage exclusively in problem behavior. If so, strategies to promote engagement and disrupt problem behavior during the CSA itself may help improve CSA outcomes. Thus, some researchers have examined modifications to CSA procedures to improve the probability of identifying high-competition stimuli (e.g., Hagopian et al., 2020; Jennett et al., 2011; Leif et al., 2020).

Jennett et al. (2011) reported on a case with automatically maintained SIB for which no stimuli were associated with reductions in problem behavior during the initial CSA. When test stimuli were freely available, SIB persisted at high rates and levels of engagement remained low. The authors then evaluated two additional series of the CSA with modifications. In the first modified condition of the CSA, the therapist re-presented a test stimulus if the participant stopped interaction with the stimulus. In the second modified condition of the CSA, re-presentation was combined with response blocking. The authors found that high-competition stimuli were identified only when both supplemental procedures were in place. Outcomes from this study suggest that temporary use of procedures to promote engagement and disrupt problem behavior can solve challenges related to identifying competing stimuli. That said, it is difficult to discern if the reductive effects of high-competition stimuli would persist in the absence of response promotion and disruption tactics.

Hagopian et al. (2020) replicated and extended the modifications proposed by Jennett et al. (2011) by repeating the free-access condition after conducting the modified CSA for six consecutively encountered cases with treatment-resistant subtypes of automatically maintained problem behavior. When test stimuli were made freely available, the number of competing stimuli identified for each case ranged from zero to one. Prompting and response blocking were implemented in succession to promote engagement with stimuli and disrupt problem behavior. In the prompted engagement condition, the number of competing stimuli increased for one of the six participants. In the prompted engagement plus blocking condition, the number of competing stimuli increased for five of the six participants. When these tactics were withdrawn and the free-access condition was repeated, at least one competing stimulus was identified for all six cases.

Leif et al. (2020) also evaluated the effects of various response-promotion tactics for identifying high-competition stimuli (i.e., stimuli associated with 80% or more reductions in problem behavior) in the context of a CSA. The CSA progressed in a manner similar to that described in Hagopian et al. (2020), except that if high-competition stimuli were not identified in the prompting-alone condition, prompting was combined with differential reinforcement of alternative behavior (DRA). In the DRA condition, a preferred edible was delivered contingent upon 10 s of continuous leisure engagement. Prompting combined with DRA resulted in increases in the number of high-competition stimuli and levels of engagement for all participants. Treatment outcomes were maintained when prompting and DRA schedules were thinned during a generality analysis.

Together, findings from these studies suggest that modified CSA methodologies can be used not only to identify high-competition stimuli but also to establish them. That said, Hagopian et al. (2020) conducted the repeated free-access condition only once following the modified CSA; as such, it is unclear if improvements in problem behavior and levels of engagement would persist across repeated series. It is possible that improvements observed during the repeated free-access condition were a function of a participant's recent exposure to prompting and blocking and that repeated series without exposure to these interventions could result in decrements in problem behavior and engagement. Results from Leif et al. (2020) provide initial evidence that outcomes of high-competition stimuli are durable when treatment components are faded; however, whether these findings would hold true if contingencies arranged for engagement were withdrawn and high-competition stimuli were incorporated into NCR-alone treatments remains unknown.

The purpose of conducting a CSA is to identify high-competition stimuli for inclusion in subsequent NCR treatment sessions. The effectiveness of NCR treatment hinges on the use of these high-competition stimuli to produce consistent and reliable outcomes. However, when the effects of high-competition stimuli are evaluated during subsequent treatment sessions, they are often assessed in combination with other intervention components (e.g., Falligant et al., 2021; Schmidt et al., 2021), which limits our understanding of the isolated, long-term outcomes of high-competition stimuli. A long-term analysis of high-competition stimuli, evaluated under conditions that resemble those used in the CSA prior to their inclusion in treatment packages, can enhance our understanding of the durability of competing stimulus effects and subsequently improve NCR treatments for automatically maintained problem behavior. Therefore, the purpose of the current study was to examine the long-term outcomes of competing stimuli using conditions that are identical to those of the CSA.

Method

Participants

All six participants were enrolled in a school serving individuals with autism spectrum disorder (ASD) and developmental disabilities and were receiving behavior-analytic educational and clinical services in either a residential or day-program setting. Participants were eligible for the study if their clinician suspected they engaged in automatically maintained problem behavior and were nominated for enrollment by a clinical team member if reducing problem behavior was identified as a goal by stakeholders. Clinicians who sought assistance in addressing the target behavior did so either because it was an emerging problem or because previous treatments had failed or were not durable.

Ava was an 18-year-old individual diagnosed with ASD and OCD who communicated vocally in one-to-three-word utterances, had a limited leisure repertoire, and was referred to the study because she engaged in saliva play. Ava’s team reported that her saliva play was difficult to interrupt and raised health and hygiene concerns for her and others. Julian was an 18-year-old individual diagnosed with ASD who engaged in skin picking that was reported to produce tissue damage. Julian communicated via a communication book with icons and had a limited leisure repertoire. Otis was a 9-year-old individual diagnosed with ASD who engaged in eye pressing that his team reported interfered with acquisition of new skills and had the potential to produce tissue damage. Otis communicated using vocal verbal approximations and a communication board with icons. Amelia was an 18-year-old individual diagnosed with ASD who engaged in thread picking. Amelia communicated predominantly using gestures and had a limited leisure repertoire. Amelia's team reported that her thread picking not only interfered with teaching but also the completion of various daily life skills. Thread picking also frequently damaged her clothing, and episodes of thread picking often ended with disrobing, which occasionally limited her access to shared environments due to potential for exposure. Simon was a 15-year-old individual diagnosed with ASD who engaged in object mouthing that posed a health and safety concern and interfered with acquisition of new skills. Simon communicated using an AAC device and had limited leisure skills. Oliver was a 16-year-old individual diagnosed with ASD who engaged in motor stereotypy in the form of tapping and communicated using an AAC device. Oliver's team reported that the frequency of his stereotypy interfered with participation in educational programming as well as completion of daily living skills.

Setting and Materials

All sessions for a given participant were conducted in a single location. The session location varied across participants and took place in either their bedroom, a small common area of their residence, or a session room of their day school. Session materials were individualized for each participant (see Table 1 for a list of test stimuli for each participant). Stimuli selected for inclusion in each participant's CSA were based on the results of the Reinforcer Assessment for Individuals with Severe Disability (RAISD; Fisher et al., 1996) or were nominated for inclusion by the participant's clinical team.

Response Measurement and Interobserver Agreement

The primary dependent variables were automatically maintained problem behavior (topographies varied across participants) and stimulus engagement. Ava's automatically maintained problem behavior was *saliva play*, defined as any instance of expelling liquid from her mouth or nose onto a surface or her hands and/or any instance of her manipulating (e.g., rubbing spit on her clothes) liquid expelled from her mouth or nose and/or any instance of her placing her fingers in her mouth and manipulating liquid thereafter (i.e., rubbing spit between her fingers after placing fingers in her mouth). Julian's automatically maintained problem behavior was *skin picking*, defined as any instance of him putting his fingers in his mouth and biting on the skin and/or picking (i.e., pulling out) skin from his fingers. Otis' automatically maintained problem behavior included *eye pressing*, defined as any instance of him poking at or pressing into his eye and/or eyelids using any part of his hand, did not include rubbing his eyes. Amelia's automatically maintained problem behavior was *thread picking*, defined as any instance of her tearing, pulling, and/or removing threads from any part(s) of her clothing either with her hands or teeth. Simon's automatically maintained problem behavior was *mouthing*, defined as any contact between his lips, teeth, and/or mouth and any part of his body, clothing, or inedible object. Oliver's problem behavior was *stereotypy*, defined as any instance of flapping arms/hands, or tapping his hands and/or fingers two or more times in rapid succession.

Stimulus engagement was defined as any manipulation of the stimulus that was not destructive or harmful to the participant or others. An exception was made for Simon, whose problem behavior was mouthing. In his case, we excluded engagement if he placed the test stimulus in his mouth while manipulating it. Stimulus engagement was not scored during periods when participants were prompted to manipulate a test stimulus. Lastly, we broadened the definition of engagement when assessing stimuli that provided auditory stimulation. In these cases, engagement with stimuli was scored despite continued manipulation if the participant was oriented toward the item while it was producing auditory stimulation.

During the functional analysis (FA), CSA, and subsequent long-term analysis, observers collected frequency and duration data via video recordings of sessions by using handheld touch-screen devices equipped with the data-collection software Countee (Version 2.2.1; Peic Gavran & Hernandez, 2016). Data were collected on the frequency of Ava's saliva play, Julian's skin picking, Otis' eye pressing, and Oliver's stereotypy. All frequency measures were converted into responses per min by dividing the total frequency of the target behavior by the session duration. Data were collected on the duration of Amelia's thread picking, Simon's mouthing, and all participants' stimulus engagement. All duration measures were converted to a percentage of session time by dividing the total number of seconds recorded for the target behavior by the total number of seconds of the session and then converting this ratio to a percentage.

During the long-term analysis, the mean rate or duration of problem behavior (responses per min or % of session time) and stimulus engagement (% of session time) was calculated by obtaining means for each dependent measure across the last 3 series of the 12-week analysis. The percentage reduction in problem behavior per stimulus was calculated by subtracting mean responding during test trials (across the last three series of a condition) from mean responding from the respective control trials, divided by mean during control trials and multiplied by 100. This manner of summarizing treatment outcomes has been used by several studies involving single-case studies (see Hagopian et al., 1998; Rooker et al., 2013).

To determine the correspondence between initial CSA results to those of the last three series of the long-term analysis, the percentage reduction in problem behavior obtained during the last three series of the long-term analysis was subtracted from that obtained during the free-access condition (or repeated free-access condition, if applicable) of the initial CSA. Correspondence was defined as a difference of 10 or fewer percentage points, adapted from Haddock and Hagopian (2020).

Interobserver agreement was determined by having a second observer independently collect data for all primary dependent measures for minimally 30% of sessions across all phases of the study. Interobserver agreement coefficients were derived using the proportional agreement within intervals method (Mudford et al., 2009). Each session was first divided into 10-s bins and agreement was calculated by dividing the smaller number of responses (or duration) recorded within an interval by one observer by the larger number of responses (or duration) recorded by the other observer, generating a proportion for each interval. These proportions were then summed, divided by the total number of intervals, multiplied by 100.

Agreement for problem behavior during the FA averaged 92% (range, 87% to 94%) for Ava, 91 (range, 80% to 100%) for Julian, 95% (range, 93% to 98%) for Otis, 97% (range, 93% to 100%) for Amelia, 90% (range, 90% to 100%) for Simon, 98% (range, 93% to 100%) for Oliver. Stimulus engagement was not measured during the FA. Agreement for problem behavior during the CSA averaged 97% (range, 80% to 100%) for Ava, 98% (range, 94% to 100%) for Julian, 98% (range, 90% to 100%) for Otis, 99% (range, 93% to 100%) for Amelia, 93% (range, 81% to 100%) for Simon, 96% (range, 85% to 100%) for Oliver. Agreement for stimulus engagement during the CSA averaged 97% (range, 95% to 99%) for Ava, 98% (range, 91% to 100%) for Julian, 97% (range, 92% to 100%) for Otis, 99% (range, 97% to 100%) for Amelia, 93% (range, 82% to 100%) for Simon, 98% (range, 94% to 100%) for Oliver. Agreement for problem behavior during the long-term analysis averaged 98% (range, 83% to 100%) for Ava, 93% (range, 82% to 100%) for Julian, 93% (range, 82% to 100%) for Otis, 98% (range, 90% to 100%) for Amelia, 92% (range, 82% to 100%) for Simon, 98% (range, 89% to 100%) for Oliver. Agreement for stimulus engagement during the long-term analysis 94 % (range, 81% to 100%) for Ava, 95% (range, 80% to 100%) for Julian, 98% (range, 90% to 100%) for Otis, 98% (range, 91% to 100%) for Amelia, 92% (range, 84% to 100%) for Simon, 96% (range, 90% to 100%) for Oliver.

To minimize risk and maximize efficiency, rate of problem behavior during the ignore conditions of the functional analysis was used as a baseline for determining optimal trial durations (i.e., duration that would capture at least 10 occurrences of problem behavior), for each participant's CSA (Hagopian et al., 2020). For responses that were measured as frequency, trial duration was calculated by dividing 10 by the mean rate of problem behavior in the ignore condition and then rounding to the nearest minute. For responses measured using duration (summarized as percentage of session time), 100 was divided by the proportion of session with problem behavior during the ignore condition, then divided again by 60, and finally rounded to the nearest minute. Trial durations as well as total durations to complete the CSA for each participant are depicted in Table 1.

Procedure

Functional Analysis

A functional analysis (FA) was conducted to identify environmental determinants of each participant's problem behavior. All FA sessions were 5 min in duration. FA conditions were presented in a fixed pattern (ignore, attention, play, demand) and intersession periods ranged between 1–2 min. All conditions were evaluated in a multielement design and were similar to the procedures outlined by Iwata et al. (1982/1994).

In the no interaction condition, testing for automatic reinforcement, the participant did not have access to any positive reinforcers arranged by the experimenter and was asked to wait in their room. The therapist stood near the door, oriented away from the student, and did not initiate any interaction nor respond to bids for attention. If the participant engaged in problem behavior, the therapist did not attend to or orient toward the participant. In the attention condition, testing for social positive reinforcement, the therapist remained in proximity to the participant but did not initiate any interactions. If the participant engaged in problem behavior, the therapist delivered a brief reprimand (e.g., "Don't do that"). In the demand condition, testing for social negative reinforcement, the therapist approached the participant and delivered directives. If the participant did not cooperate with the directive within 5 s, the therapist redelivered the directive every 5 s along with successive model, and physical prompts until cooperation occurred. If the participant engaged in problem behavior at any point during the session, the therapist terminated the demand and removed any task materials for 30 s. Problem behavior during the escape interval was ignored. In the play condition, the therapist remained in proximity to the participant and initiated brief interactions at least every 30 s. The participant had access to two to three highly preferred (HP) leisure items (identified via a preference assessment) throughout the session and problem behavior was ignored.

FA results were interpreted using criteria described by Hagopian et al. (2015; 2017). Problem behavior was classified as automatically maintained if (a) levels of problem behavior in the no interaction condition were elevated in comparison to the control condition, or (b) levels of problem behavior were high across all conditions and greater than either 1.5 responses per min or 15% of session time in the no interaction condition. A functional analysis outcome indicating automatically maintained problem behavior was then subtyped using procedures described by Hagopian et al. (2023). We identified subtypes to investigate whether CSA outcomes varied across these subgroups. To generate a subtype, the experimenter calculated the level of differentiation (LOD) using data from the play condition and no-interaction conditions of the FA. The LOD refers to the mean proportional rates of responding in the no-interaction and play conditions of the FA. To obtain an LOD value (expressed as a percentage), we divided mean rate of problem behavior in the play condition by mean rate of problem behavior in the no-interaction condition. This quotient was then subtracted from 1 and then multiplied by 100. An LOD of 0% indicates that levels of problem behavior were identical across the play and no-interaction conditions, whereas an LOD of 50% indicates that levels of problem behavior were 50% lower in the play condition, relative to the no-interaction condition. Positive LOD values indicate that levels of problem behavior were lower in the play condition relative to the no-interaction condition. Negative LOD values indicate that levels of problem behavior were higher in the play condition relative to the no-interaction condition. Hagopian et al. (2023) used a receiver operating characteristic curve to identify an optimal cutoff point at which LOD most accurately corresponded to a subtype. As such, behavior was classified as Subtype 1 if the LOD value was equal to or above 62.5% and classified as Subtype 2 if the LOD value was below 62.5% (Hagopian et al., 2023).

Competing Stimulus Assessment

Prior to initiating the CSA, exposure trials were arranged to allow participants to sample each test stimulus. During exposure trials, the therapist demonstrated interaction with each test stimulus and then provided the participant with a brief opportunity to interact with the item. The item was removed after 5 s and the next item was presented. These procedures were repeated until all test stimuli were sampled once.

All participants started with the free-access condition and, if necessary, experienced three additional conditions: response promotion, response promotion with disruption, and repeated free access. Each condition consisted of three series, except for the repeated free-access condition, which consisted of one. Each CSA series consisted of a no-stimulus control trial followed by several isolated test trials. The no-stimulus trial served as a control for that series and was arranged identically to the no-interaction condition of the FA. During the test trials, each stimulus was presented individually in a randomized order without replacement. The number of test trials in a CSA series matched the number of test stimuli being evaluated for each participant. Participants never experienced more than a series in a day. Trial duration was 3 min for Ava and Julian, 5 min for Otis, 2 min for Amelia, 4 min for Simon, and 3 min for Oliver.

A high-competition stimulus was defined as any stimulus that resulted in an 80% or greater reduction in problem behavior relative to the no-stimulus trial from that respective series. Stimuli associated with an 80% reduction in problem behavior in the response-promotion and disruption conditions were not classified as high-competition stimuli. This is because it was unclear whether the observed reduction in problem behavior was due to the specific tactics employed or the inherent properties of the stimuli themselves.

Free Access. Following the no-stimulus control trial, the therapist initiated a test trial by placing a single test stimulus on the table in front of the participant. During test trials, the test stimulus remained continuously and freely available to the participant and no consequences were arranged for engagement or problem behavior. If the participant threw the test stimulus, the experimenter placed the item back on the table. Any subsequent throwing was ignored, although the participant was free to pick up the item themselves. If at least three high-competition stimuli were not identified in the free-access condition, the experimenter implemented one of the modified conditions. Participants who demonstrated low levels of engagement and high levels of problem behavior next experienced the response-promotion condition. Participants who demonstrated high levels of both engagement and problem behavior in the free-access condition experienced the response-promotion and response-disruption conditions. The free-access condition was repeated if either the response-promotion or the response-promotion and disruption conditions resulted in the identification of competing stimuli. The arrangement of the repeated free-access condition was identical to that of the initial free-access condition.

Response Promotion. Procedures were identical to the free-access condition except that each test trial began with the therapist placing the stimulus in the participant's hands and prompting engagement (i.e., hand over hand guided manipulation for up to 5 s). Contingent on 10 s of disengagement, the clinician again prompted engagement with test stimuli. No contingencies were arranged for engagement or problem behavior. The response-promotion and response-disruption condition was conducted if the response-promotion condition did not result in identification of three or more competing stimuli.

Prompted Promotion and Response Disruption. Procedures were identical to response-promotion condition except that during each test trial the therapist blocked each instance of target problem behavior (e.g., to block mouthing the experimenter placed their arm between the leisure item and the participant's mouth) and redirected the participant to the test stimulus by placing it back in their hands and prompting engagement.

Long-Term Analysis. The long-term analysis was initiated one week after the last free-access or repeated free-access series. Participants experienced the long-term analysis if at least three high-competition stimuli were identified in the initial free-access condition, or if the number of high-competition stimuli increased during the repeated free-access condition. One series of the free-access condition was conducted each week. Consequently, over a 12-week period, each participant completed twelve series of the CSA.

Results

The results of the FA and the outcomes of the subtyping are displayed in Table 2. Using subtyping procedures described by Hagopian et al. (2023), each participant's problem behavior was classified as either Subtype 1 (Julian and Otis) or Subtype 2 (Ava, Amelia, Simon, and Oliver). Julian and Otis showed reduced levels of problem behavior (0 RPM and 0.13 PM, respectively) during the play condition compared to the no-interaction condition (3.5 RPM and 1.27 RPM), indicative of response patterns consistent with Subtype 1. In contrast, Ava, Amelia, Simon, and Oliver's rates of problem behavior in the play condition were more comparable to rates in the no-interaction condition, which is indicative of response patterns classified as Subtype 2.

Table 3 displays the total number of stimuli associated with an 80% reduction in target behavior relative to the respective no-stimulus control trial in each condition of the CSA. High-competition stimuli were identified for all participants. At least three high-competition stimuli were identified for four of the six participants in the free-access condition, and at least two high-competition stimuli were identified in the repeated free-access condition after participants experienced one or more of the modified CSA conditions.

Figure 1 depicts initial CSA outcomes for participants Ava, Julian, Otis, and Amelia, who did not experience response promotion or disruption tactics. In the free-access condition, six high-competition stimuli were identified for Ava, five for Amelia, and three for both Julian and Otis. That is, an 80% reduction in problem behavior was achieved with at least half of the stimuli evaluated for each participant. In fact, an 80% reduction in problem behavior was achieved with more than half of the stimuli evaluated for both Ava and Amelia (i.e., 11 of the 14 total stimuli evaluated). Additionally, stimulus engagement equaled or exceeded 80% for at least half of the stimuli evaluated for each participant. The percentage of high-competition stimuli that were also high-engagement stimuli was 65% for Ava, 100% for Julian, 67% for Otis, and 83% for Amelia.

Figure 2 depicts initial CSA data for Simon and Oliver, both of whom experienced at least one modification tactic followed by the repeated free-access condition. During the initial free-access condition, Simon's levels of mouthing remained elevated across all test stimuli, and engagement did not reach or exceed 80% for any of the stimuli. These data are depicted in the top left panel. Because none of the stimuli were associated with at least 80% reductions in mouthing during response promotion phase (middle left panel), the response promotion and disruption condition was evaluated next (bottom left panel). During this phase, all stimuli were associated with at least 80% reductions in mouthing and engagement exceeded 80% for all six stimuli. During the repeated free-access condition (top left panel), two stimuli (slinky and pop tubes) were associated with at least 80% reductions in mouthing. Stimulus engagement reached or exceeded 80% for half of the stimuli, including the slinky and pop tubes (i.e., the two high-competition stimuli).

During the initial free-access condition, Oliver's rates of stereotypy remained elevated across most test stimuli, but engagement reached or exceeded 80% for five of the six stimuli (top right panel). Because Oliver's levels of engagement were high across at least half of the test stimuli, the response promotion and disruption condition was evaluated next. During this phase, depicted in the bottom right panel, four stimuli were associated with at least 80% reductions in stereotypy, and engagement exceeded 80% for all six stimuli. During the repeated free-access condition (top right panel), the same four stimuli (i.e., pop tubes, light spin toy, squish ball, and scratch art) were associated with at least 80% reductions in stereotypy, and stimulus engagement reached or exceeded 80% for all stimuli.

The last column of Table 3 displays the number of high-competition stimuli identified in long-term analysis for all participants. All long-term outcomes are summarized using data from the last 3 series of the 12-week analysis. The number of high-competition stimuli identified in the long-term analysis exceeded the number identified in the initial free-access condition for Ava (Subtype 2) and Julian (Subtype 1). The number of high-competition stimuli identified for Otis (Subtype 1) decreased from the free-access condition to the long-term analysis. Lastly, the number of high-competition stimuli identified for Amelia (Subtype 2) remained the same. The number of high-competition stimuli identified in repeated free-access condition, relative to the free-access condition, increased for both Simon and Oliver, whose problem behavior was classified as Subtype 2. Compared to the repeated free-access condition, the number of high-competition stimuli identified in the long-term analysis decreased for both Simon and Oliver.

Figure 3 depicts long-term outcomes for participants Ava, Julian, Otis, and Amelia, who did not experience modification tactics. All six high-competition stimuli identified for Ava during the free-access condition retained their reductive effects in the long-term analysis. Additionally, two more stimuli (kinetic sand and slap bracelet) were identified as high-competition in the long-term analysis. Both items were associated with slight concomitant increases in engagement during the long-term analysis, relative to the levels of engagement observed during the free-access condition. All three high-competition stimuli identified for Julian in the initial CSA maintained their reductive effects in the long-term analysis. In fact, two additional stimuli (lacing boards and a puzzle) were identified as high competition stimuli in the long-term analysis. Both items were associated with concomitant increases in engagement levels compared to the free-access condition.

For Otis, the number of high-competition stimuli identified during the long-term analysis decreased compared to the free-access condition. An 80% reduction in eye pressing was achieved with only one previously non-high-competition stimulus (squish ball) during the long-term analysis. This indicates that all three high-competition stimuli identified during the free-access condition were no longer associated with 80% reductions in eye pressing. The number of high-competition stimuli identified for Amelia remained unchanged during the long-term analysis compared to the free-access condition. However, an 80% reduction in thread picking was achieved with a previously non-high-competition stimulus (iPad) during the long-term analysis. Additionally, one high-competition stimulus (sticker by letters) identified during the free-access condition was no longer associated with an 80% reduction in thread picking.

Stimulus engagement equaled or exceeded 80% for at least half of the stimuli evaluated during the long-term analysis for both Ava, Julian, and Amelia. Furthermore, improvements in engagement were observed with several stimuli during the long-term condition compared to the free-access condition for all three participants. Lastly, Otis' stimulus engagement worsened for two stimuli, improved for two stimuli, and remained unchanged for the remaining two.

Figure 4 depicts long-term outcomes for participants Simon (top panel) and Oliver (bottom panel), both with Subtype 2 automatically maintained problem behavior, who experienced modification tactics. Neither of the two high-competition stimuli identified for Simon during the repeated free-access condition continued to be associated with an 80% reduction in mouthing in the long-term analysis. In fact, during the second half of the 12-week analysis, three of the six stimuli evaluated were consistently associated with increases in mouthing relative to the no-stimulus trial. No test stimulus was regularly associated with an 80% reduction in mouthing or at least 80% engagement across the 12-week analysis. Stimulus engagement equaled or exceeded 80% for none of stimuli evaluated during the long-term analysis, a decrease from the repeated free-access condition. Three of the four high-competition stimuli identified for Oliver during the repeated free-access condition continued to be associated with at least an 80% reduction in stereotypy in the long-term analysis. Similarly, stimulus engagement remained at or above 80% for three of the four high-competition stimuli identified during the repeated free-access condition.

Figure 5 illustrates the percentage reduction in problem behavior associated with each stimulus in the free-access and long-term analysis conditions for Ava, Julian, Otis, and Amelia, who did not experience a modification tactic. Of the 26 stimuli evaluated, 17 were identified as high-competition stimuli during the free-access condition, and 19 during the long-term analysis. About half of the stimuli evaluated during the long-term analysis (denoted by closed circles) led to greater reductions in problem behavior compared to those observed in the initial CSA (denoted by open circles). Specifically, improvements in the percentage reduction in problem behavior were seen in 12 out of 26 stimuli evaluated (46%). Slight decreases in the percentage reduction in problem behavior were observed for 11 stimuli (42.3%) between the free-access and long-term analysis. Nevertheless, seven of these 11 stimuli still achieved 80% reductions in problem behavior. We also examined the correspondence between initial CSA results and those of the long-term analysis. Correspondence was defined as a difference of 10 or fewer percentage points in the percentage reductions in problem behavior. The correspondence between initial CSA results to those of the long-term analysis was 50% for Ava, Amelia, and Julian, and 0% for Otis. However, the lack of correspondence for all participants except Otis was due to improvements in problem behavior reductions during the long-term analysis. When considering the reliability of stimulus-specific outcomes, the percentage of stimuli identified as high-competition stimuli that continued to function as high-competition stimuli over time was 100% for Ava, 100% for Julian, 0% for Otis, and 80% for Amelia.

Figure 6 illustrates the percentage of reduction in problem behavior associated with each stimulus in the repeated free-access and long-term analysis conditions for Simon and Oliver, both of whom experienced at least one modification tactic. Of the 12 stimuli evaluated, 6 were identified as high-competition stimuli during the free-access condition, and 3 during the long-term analysis. More than half of stimuli evaluated during the long-term analysis (denoted by closed circles) showed a relative worsening in problem behavior compared to the reductions observed in the initial CSA (denoted by open circles). Improvements in the percentage reduction in problem behavior were not observed for any of the stimuli evaluated for Simon and Oliver. In fact, relative to the repeated free-access condition, decreases in the percentage reduction in problem behavior were observed for all stimuli. The correspondence between initial CSA results and those of the long-term analysis was 16% for Simon and 0% for Oliver. When considering the reliability of stimulus-specific outcomes, the percentage of stimuli identified as high-competition stimuli that continued to function as high-competition stimuli over time was 0% for Simon and 75% for Oliver.

Figure 7 illustrates the relation between levels of engagement and the percentage reduction in problem behavior for each participant across all stimuli evaluated during the initial CSA (depicted in the top panel) and long-term analysis (depicted in the bottom panel). Initial CSA data were extracted from the free-access condition for those who did not experience modification tactics and from the repeated free-access condition for those who did. A total of 38 stimuli were evaluated across 6 participants during the initial CSA. High-competition stimuli are denoted by data points above the dashed horizontal line, whereas non-high-competition stimuli are denoted by data points below the dashed horizontal line. Among all the stimuli tested, 23 (60.5%) were classified as high-competition stimuli. Moderate reductions in problem behavior (50%–79%) were obtained by 8 of the 38 stimuli tested (21.5%). One stimulus was associated with increases in challenging behavior relative to the no-stimulus control condition. For participants with Subtype 1 problem behavior, 6 stimuli (50%) were identified as high-competition stimuli. For participants with Subtype 2 problem behavior, 17 stimuli (65%) were identified as high-competition stimuli. Of the 38 stimuli tested, more than half (76.3%) were associated with at least 80% stimulus engagement. Stimuli with high engagement are denoted by data points to the right of the dashed vertical line. Data points to the left of the dashed vertical line denote stimuli associated with less than 80% engagement. Of the 29 stimuli associated with high engagement, 21 also functioned as high-competition stimuli, indicating that high engagement was associated with high response competition for 72.4% of the stimuli. The correlation between challenging behavior reduction and stimulus engagement was r = .51, p = .001, indicating a moderate positive correlation coefficient between challenging behavior reduction and stimulus engagement.

A total of 38 stimuli were evaluated across 6 participants during the long-term analysis (displayed in the bottom panel of Figure 7). Among all the stimuli tested, 22 (58%) were classified as high-competition stimuli. Moderate reductions in problem behavior (50%–79%) were obtained by 7 of the 38 stimuli tested (18%). Three stimuli were associated with increases in challenging behavior relative to the no-stimulus control condition. For participants with Subtype 1 problem behavior, 6 stimuli (50%) were identified as high-competition stimuli. For participants with Subtype 2 problem behavior, 16 stimuli (62%) were identified as high-competition stimuli. Of the 38 stimuli tested during the long-term analysis, more than half (58%) were associated with at least 80% stimulus engagement. Of the 22 stimuli associated with high engagement, 18 also functioned as high-competition stimuli, indicating that high engagement was associated with high response competition for 82% of the stimuli. The correlation between challenging behavior reduction and stimulus engagement was $r = .69$, $p = .0001$, indicating a moderate positive correlation coefficient between challenging behavior reduction and stimulus engagement.

Discussion

The current study replicated Hagopian et al. (2020) by further demonstrating the efficacy of CSAs in identifying high-competition stimuli and in establishing them using prompting and response blocking for automatically maintained behavior. We identified at least two high-competition stimuli for all six participants. High-competition stimuli were identified for four of the six participants in the free-access condition and for the remaining two participants after experiencing at least one modified CSA tactic. These findings align with previous research suggesting that modified tactics can be used to establish high-competition stimuli for automatically maintained SIB (Hagopian et al., 2020) and non-SIB (Falligant, 2021) in the context of a CSA. Although there are few published applications of the subtyping model to behavior other than SIB (e.g., Laureano et al., 2023; Wunderlich et al., 2022), our analysis found that high-competition stimuli were more likely to be identified in the initial free-access condition for those with Subtype 1 relative to Subtype 2 automatically maintained problem behavior. These findings approximate the CSA outcomes observed when targeting automatically maintained SIB (Hagopian et al., 2015, 2017, 2020) and support the notion that subtypes are differentially sensitive to reinforcement-based interventions.

This study extended the current literature on CSAs by examining the long-term outcomes of high-competition stimuli over a 12-week period. Specifically, we included long-term outcomes for all participants—both those who required modified CSA tactics to identify competing stimuli and those who did not—and evaluated all stimuli, both competing and non-competing. Overall, compared to the initial CSA, the number of high-competition stimuli and stimuli associated with at least 80% stimulus engagement remained relatively unchanged for four of the six participants. Long-term stimulus-specific outcomes were also consistent for these four participants, with more than three-quarters of the stimuli identified as high-competition during the CSA continuing to function as such over time. Recognizing that stimulus-specific outcomes may be reliable could allow clinicians to strategically use these stimuli throughout the day or when arranging therapeutic environments, leading to more predictable, stable results and potentially supporting sustained behavior change. For three of the six participants, at least two stimuli reliably competed with problem behavior over the 12-week period. Notably, we observed an increase in high-competition stimuli for both Ava and Julian, indicating that previously ineffective stimuli effectively competed with problem behavior during most weeks of the long-term analysis. This suggests that, for some participants, repeated exposure to stimuli may lead to increased stimulus engagement and subsequent improvements in problem behavior.

In contrast, Otis and Simon experienced less favorable long-term outcomes, with a decrease in both the number of high-competition stimuli and stimuli associated with at least an 80% stimulus engagement during the extended analysis. Additionally, none of the high-competition stimuli identified during the CSA retained its reductive effects over time. One possible explanation for Otis' outcomes could be the increase in the rate of problem behavior during no-stimulus control trials, which doubled over the course of the long-term analysis, relative to the CSA. This increase suggests that an establishing operation for automatic reinforcement of problem behavior may have come into effect, making it less likely that reinforcement produced from engagement could compete with reinforcement produced by problem behavior. Because Otis' problem behavior was not incompatible with stimulus engagement, it is possible he maximized overall reinforcement by engaging in problem behavior to obtain reinforcers for eye pressing, and then interacting with leisure stimuli to obtain reinforcers from engagement.

The reductive effects obtained with two of the stimuli during Simon's repeated free-access condition did not persist over time. In fact, Simon's rate of problem behavior and stimulus engagement worsened across most stimuli over the course of the 12 weeks. Simon's consistently low levels of stimulus engagement might explain the diminished reductive effects observed during the long-term analysis and may also account for why his results differed from Oliver's, who also experienced a modified CSA. Research shows that the availability of preferred positive reinforcers can effectively compete with automatically reinforced problem behavior (e.g., Ahearn, Clark, DeBar, & Florentino, 2005). However, for alternative stimulation to function as reinforcement and effectively compete with problem behavior, alternative responses must occur. In cases such as Simon's, supplementary procedures in which contingencies are arranged for leisure engagement, such as those evaluated by Leif et al. (2020), might be more effective and durable for teaching leisure skills. It is also possible that in the absence of procedures to suppress Simon's problem behavior, problem behavior occurred and produced more potent reinforcement than reinforcement produced from engaging with leisure items. Therefore, the lack of response competition observed during the long-term analysis may be attributable to the relative potency of reinforcers for engagement and/or an underdeveloped leisure repertoire.

The number of stimuli associated with at least 80% engagement slightly decreased in the long-term analysis compared to the initial CSA. Still, of the stimuli evaluated during the long-term analysis, more than half were associated with at least 80% engagement. Furthermore, high levels of engagement often corresponded with the identification of high-competition stimuli, as observed in 72% of cases in the initial CSA and 82% in the long-term analysis. This suggests that stimuli with high engagement, or highly preferred stimuli, were likely to result in at least an 80% reduction in problem behavior. These findings align with outcomes from some individual studies (e.g., Shore et al. 1997) but differ from recent CSA reviews conducted by Haddock and Hagopian (2020) and Laureano et al. (2023). These authors speculate that one reason for the limited relation between levels of engagement and reductions in problem behavior could be due to variations in definitions of engagement across studies (e.g., orienting towards the item versus touching the item), which was not the case in our study. They also suggested that some individuals might engage in behavior that is incompatible with the target response, such as stereotypy, resulting in reductions in problem behavior without high levels of stimulus engagement. Although we did not include tertiary measures, anecdotal evidence suggests that this was not a relevant variable in instances where we observed a limited relation between levels of engagement and reductions in problem behavior. Future research should continue to examine the relation between stimulus engagement and reductions in problem behavior, as this information is crucial for understanding the variables that impact CSA outcomes and for informing conceptual interpretations of the effects of competing stimuli.

Although we evaluated the effects of stimuli over a 12-week period, the exposure to each test stimulus was brief. It would be beneficial to determine if high-competition stimuli produce similar outcomes when incorporated into a treatment context and applied over longer durations. It may also be advantageous to examine the extent to which including multiple stimuli in a single test trial reduces problem behavior compared to a no-stimulus control condition, and whether these results are more robust in the long term compared to evaluating test stimuli individually. Lindberg et al. (2003) found that providing access to a range of preferred leisure items reduced the likelihood of satiation to a specific leisure item and extended the effectiveness of NCR. As such, making multiple stimuli concurrently available during treatment could be a particularly useful tactic to for individuals for whom engagement and reductions in problem behavior are closely related. The no-stimulus control trial always preceded test trials. It is possible that relatively high-rate emission of an automatically maintained response led to an abolishing operation for the automatic reinforcer, thereby decreasing response probabilities over time. Thus, it may be beneficial for future research to alternate the arrangement of control and test trials in each series. Lastly, our long-term analysis included data from only two participants who required a modified CSA to identify high-competition stimuli. Additional research is needed to determine if long-term outcomes differ for those whose high-competition stimuli are identified after a modified CSA.

The results of the current study support the following general recommendations for clinical practice, with the aim of enhancing the efficacy of treatments for automatically maintained problem behavior. First, we recommend that clinicians conduct several series of the repeated free-access condition following a modified CSA to ensure repeated measures. This will be particularly important if high-competition stimuli are to be included in an NCR-alone treatment. Second, we recommend that clinicians closely monitor stimulus engagement, as our study found it to be inversely related to problem behavior and indicative of long-term outcomes. Similarly, focusing on developing a leisure repertoire may be a beneficial next step for individuals for whom it may be challenging to identify high-competition stimuli. Lastly, our data suggest that clinicians can be confident that long-term outcomes of high-competition stimuli are consistent and durable, particularly when high-competition stimuli are also associated with high levels of engagement. Further research that replicates and expands upon these findings could enhance clinical practice and improve the efficacy and durability of treatments for automatically maintained problem behavior.

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Table 1

Stimuli Included, Trial Duration, and Total Time to Complete All Conditions of Competing Stimulus Assessment

Participant	Number of Stimuli Evaluated	Test Stimuli	Trial Duration (in min)	Total Duration to Complete the CSA (in min)
Ava	8	Bunchems, monkey noodles, pop tubes, keyboard, kinetic sand, slinky, slap bracelet, and abacus	3	72
Julian	6	Piano, legos®, lacing boards, puzzle, monkey noodles, lacing beads	3	63
Otis	6	Ribbons, handheld fan, squish stress ball, gyro wheels, light space wand, kaleidoscope	5	150
Amelia	6	iPad, mosaic sticker art, puzzle, sticker by letter, plush craft toy, dot paints	2	42
Simon	6	Fidget toy, light spin toy, keyboard pop tubes, slinky, blocks	4	240
Oliver	6	Moon sand, pop tubes, fidget toy, light spin toy, squish ball, scratch art	3	126

Note: CSA = competing stimulus assessment.

Table 2

Functional Analysis Data Summary and Subtyping

Participant	FA Topographies	Target Response No-interaction	Play	Attn	Escape	Subtype	LOD
Ava	Saliva Play	4.1	2.9	3.5	2.9	2	30.51%
Julian	Skin Picking	3.5	0	2.0	1.8	1	100%
Otis	Eye Pressing	1.27	.13	1.40	1	1	89.76%
Amelia	Fabric Picking	100%	63.3%	96.6%	42%	2	36.67%
Simon	Mouthing	51%	33%	57.7%	52.7%	2	34.16%
Oliver	Stereotypy	3.2	2.33	2.9	2.2	2	27.19%

Note: The values in the FA conditions represent responses per min unless indicated as a percentage of session with "%" FA= functional analysis, Attn = Attention, LOD = level of differentiation between no-interaction and play condition.

Table 3

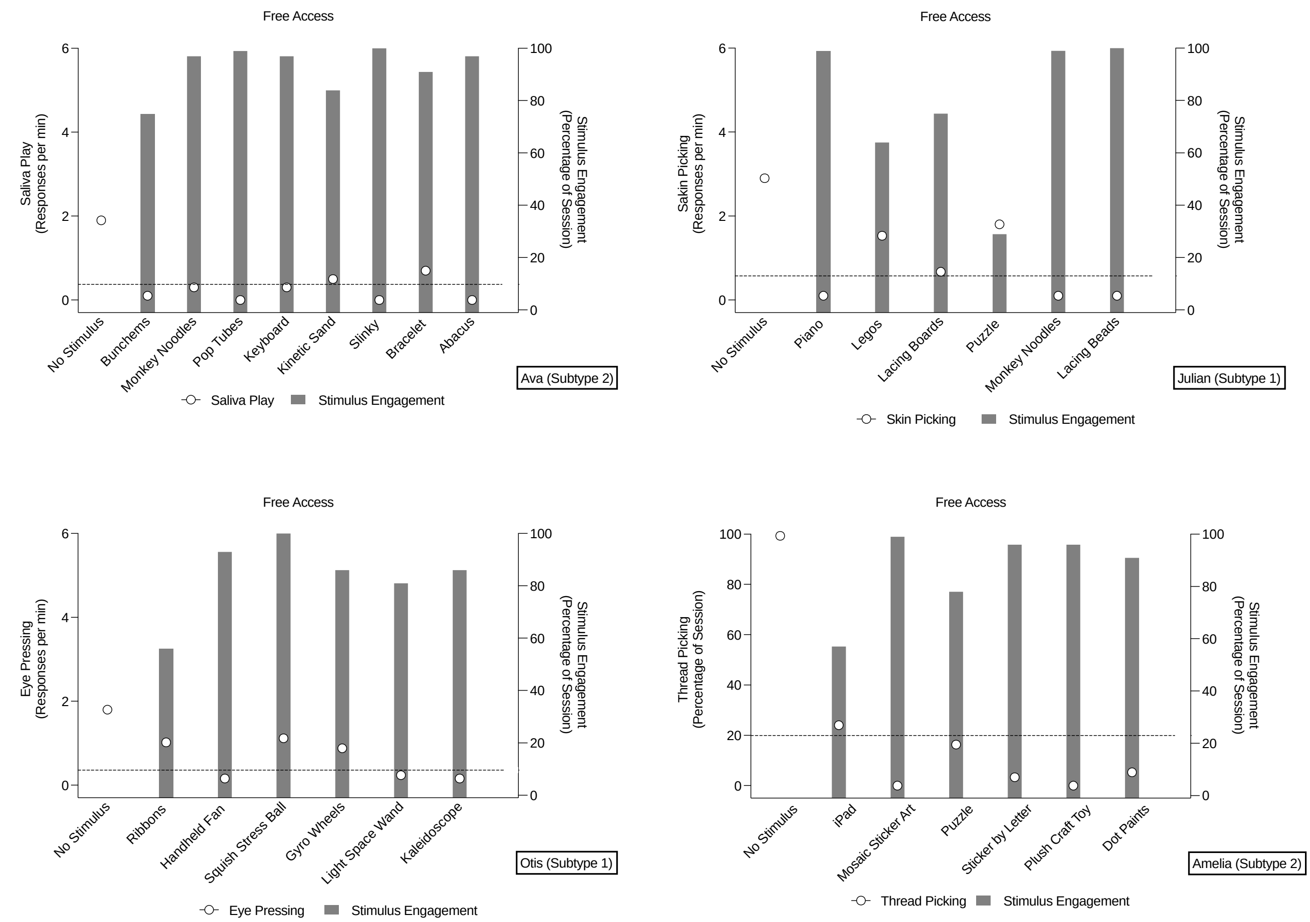
Number of Stimuli Associated with an 80% Reduction in Problem Behavior

		Number of Stimuli Associated with 80% Reduction				
Participant	Number of Stimuli	FA	RP	RP+ RD	RFA	LTA
Ava	8	6	–	–	–	8
Julian	6	3	–	–	–	5
Otis	6	3	–	–	–	1
Amelia	6	5	–	–	–	5
Simon	6	0	0	6	2	0
Oliver	6	2	–	4	4	3

Note: A dash (–) indicates that the condition was no conducted.
FA = free access, RP = response promotion, RP+RD = response promotion and response blocking, RFA = repeated free access, LTA = long–term analysis.

Figure 1

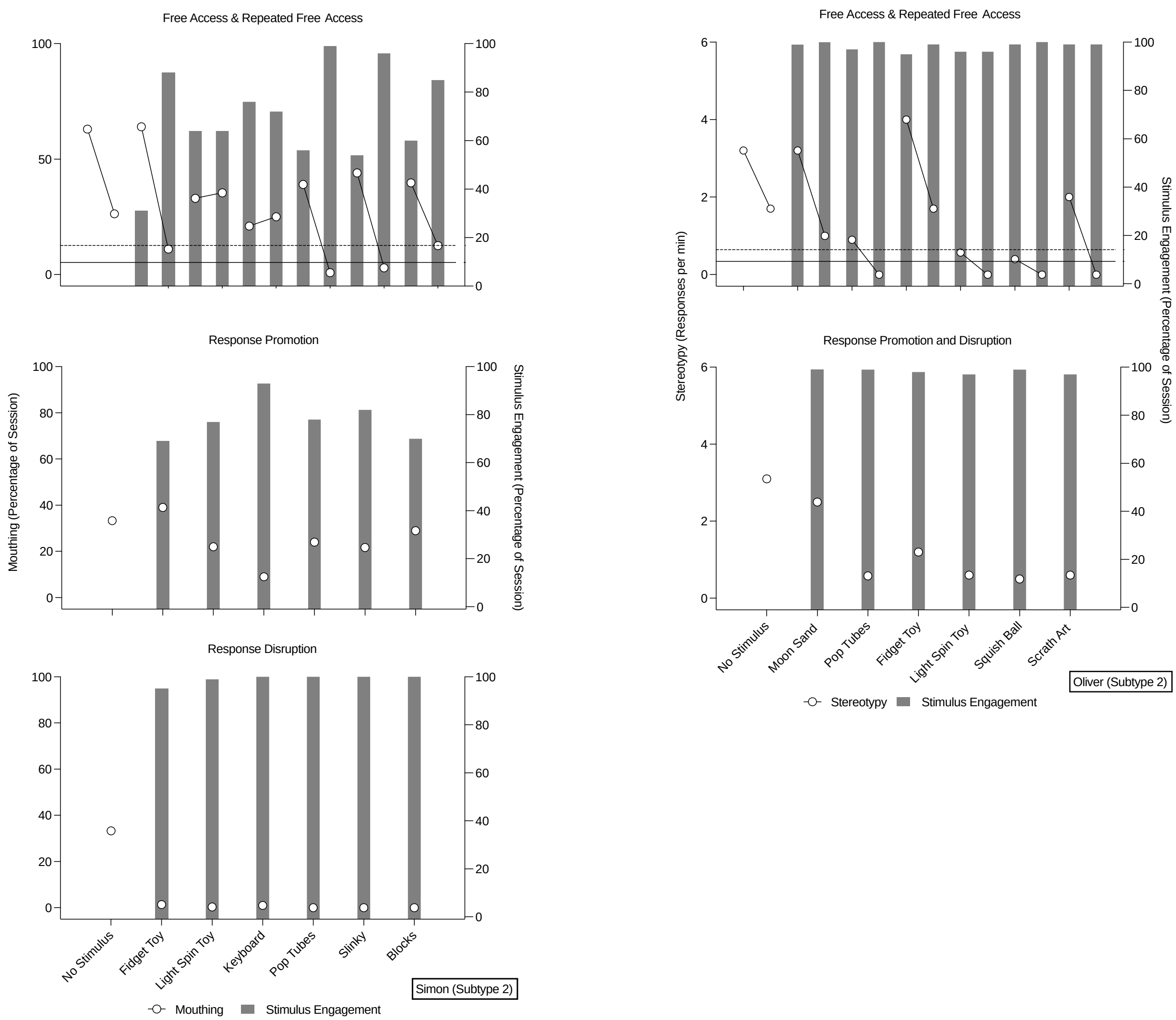
Individual Outcomes of the CSA for Ava, Julian, Otis, and Amelia



Note. The dashed horizontal line depicts an 80% reduction in problem behavior from the no-stimulus control trials and as such is skewed to the left to touch the primary *y-axis*.

Figure 2

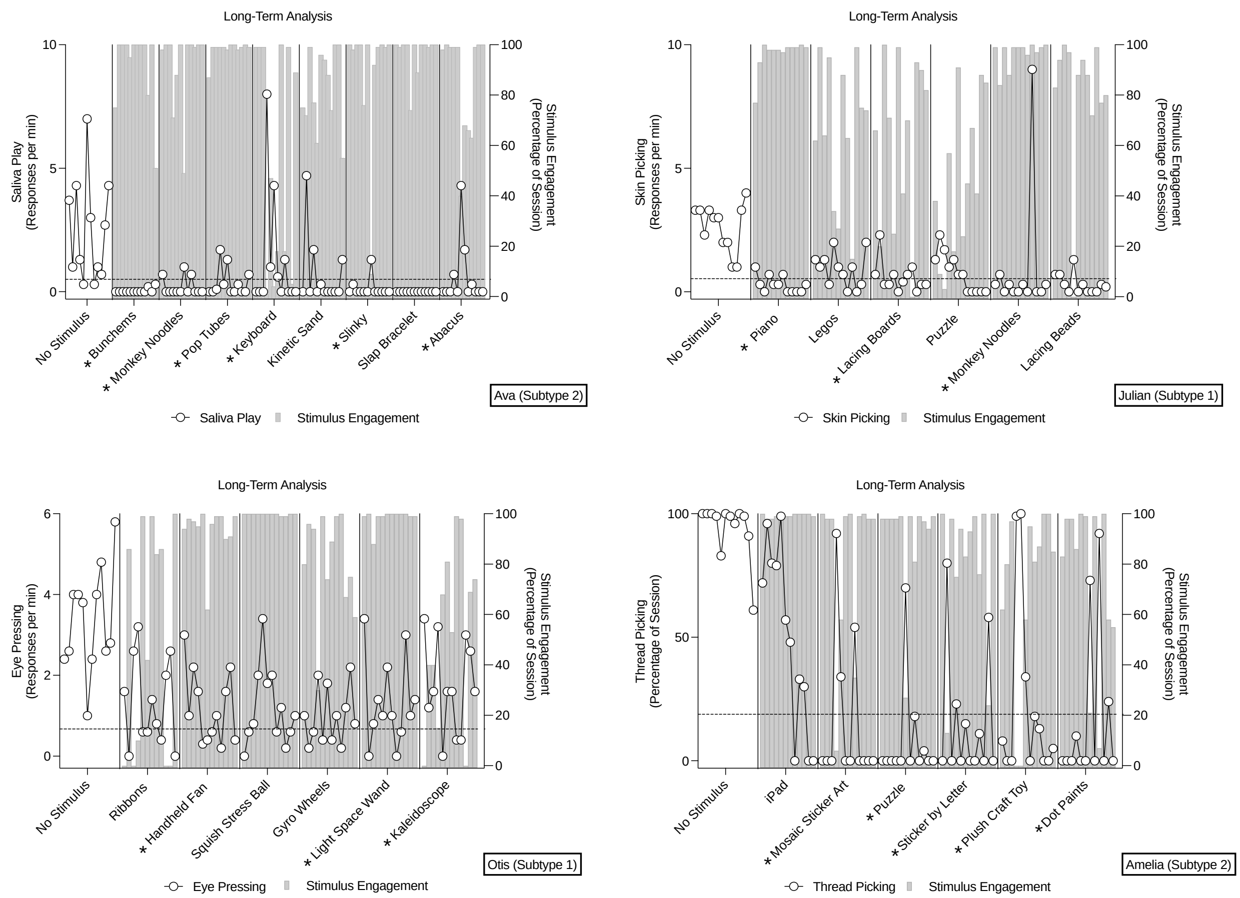
Individual Outcomes of the Modified CSA for Simon and Oliver



Note. Participants who experienced modified CSA condition(s). The dashed (free-access) and solid (repeated free-access) horizontal lines depict 80% reduction in problem behavior from the no-stimulus control trials of each respective condition and as such are skewed to the left to touch the primary *y-axis*.

Figure 3

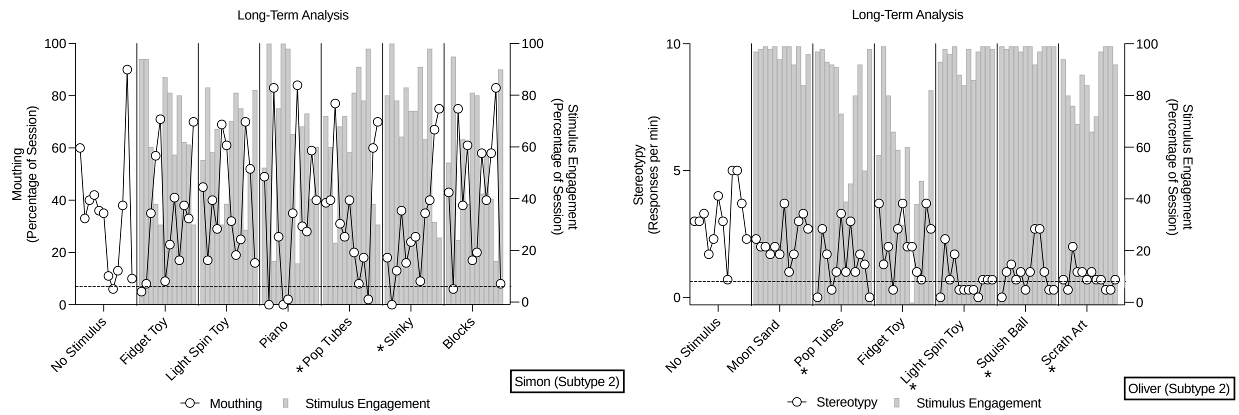
Individual Outcomes of the Long-Term Analysis for Ava, Julian, Otis, and Amelia



Note. The dashed horizontal line depicts an 80% reduction in problem behavior from the no-stimulus control trials and as such is skewed to the left to touch the primary *y-axis*. Each data point on the x-axis for each leisure item represents rate or percentage of session of problem behavior during that week's free access condition. Each bar along the x-axis for each leisure item represents level of engagement during that week's free access condition. In this manner, results from week 1 of the CSA are the first data points for each leisure item. An "*" indicates items that were high-competing stimuli during the initial CSA.

Figure 4

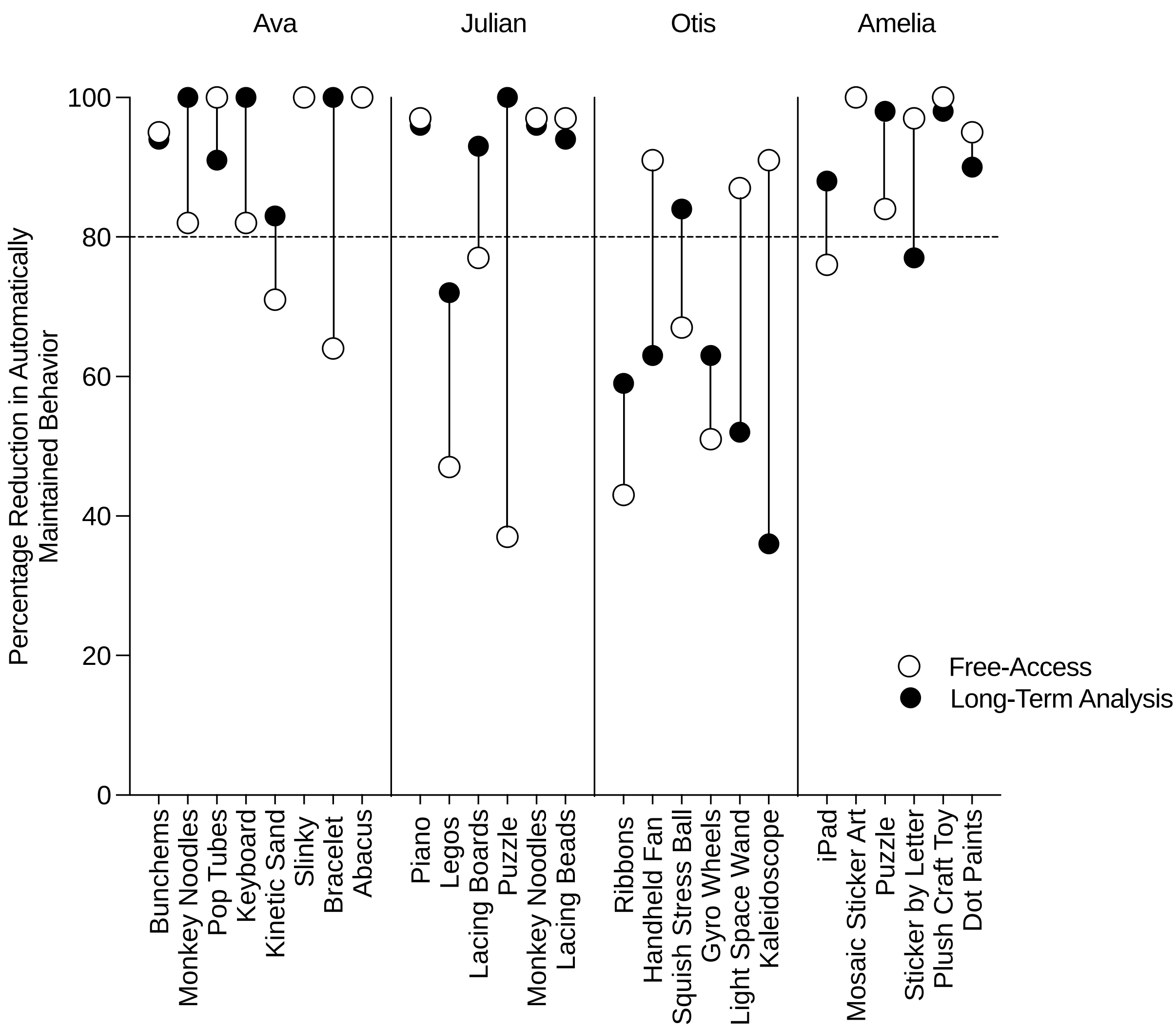
Individual Outcomes of the Long-Term Analysis for Simon and Oliver



Note. The dashed horizontal line depicts an 80% reduction in problem behavior from the no-stimulus control trials and as such is skewed to the left to touch the primary *y-axis*. Each data point on the x-axis for each leisure item represents rate or percentage of session of problem behavior during that week's free access condition. Each bar along the x-axis for each leisure item represents level of engagement during that week's free access condition. In this manner, results from week 1 of the CSA are the first data points for each leisure item. An "*" indicates items that were high-competing stimuli during the initial CSA.

Figure 5

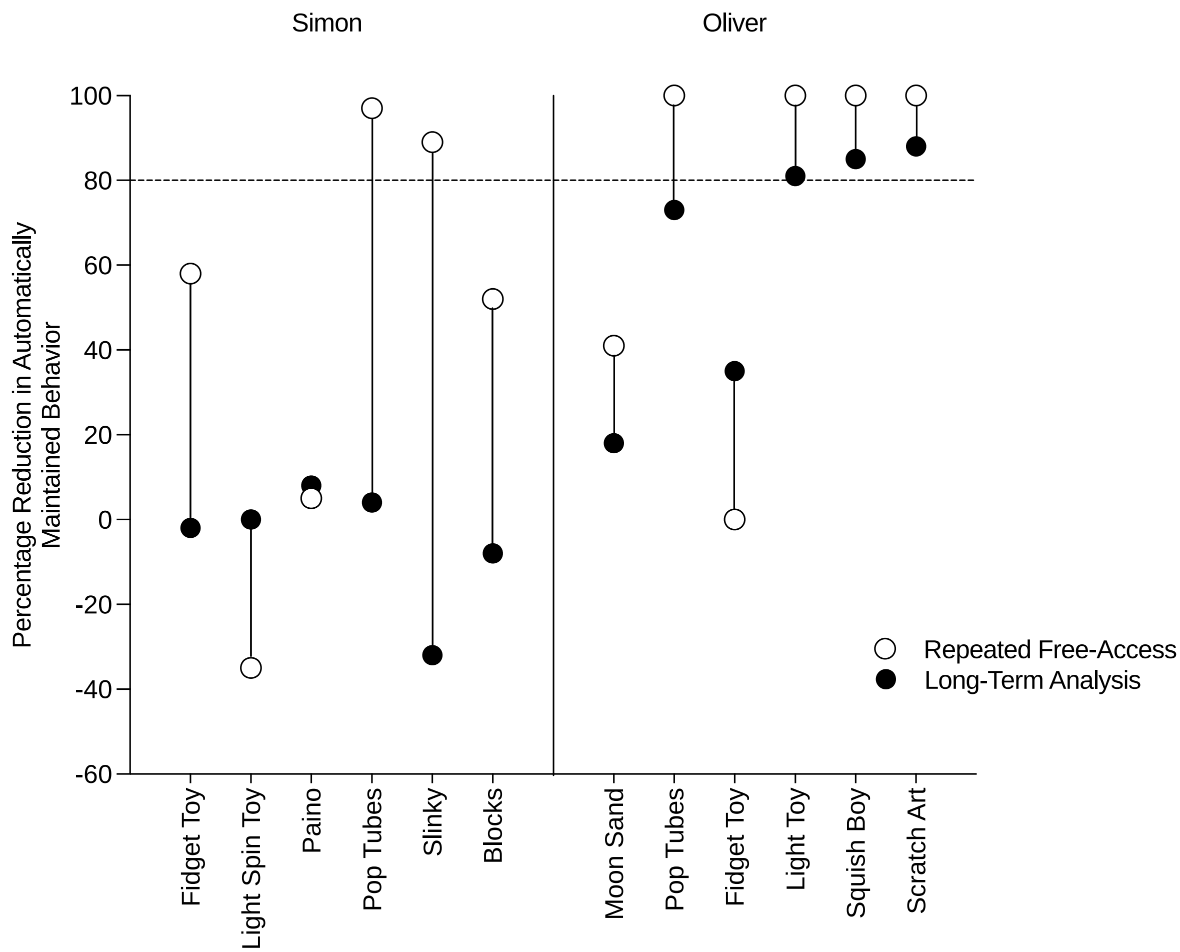
Percentage Reduction in Problem Behavior in the Free-Access and Long-Term Analysis Conditions



Note. Each test stimulus is presented consecutively and, in the order, listed in each participant's respective CSA graph. Data points above the dashed horizontal line indicate an 80% reduction in problem behavior.

Figure 6

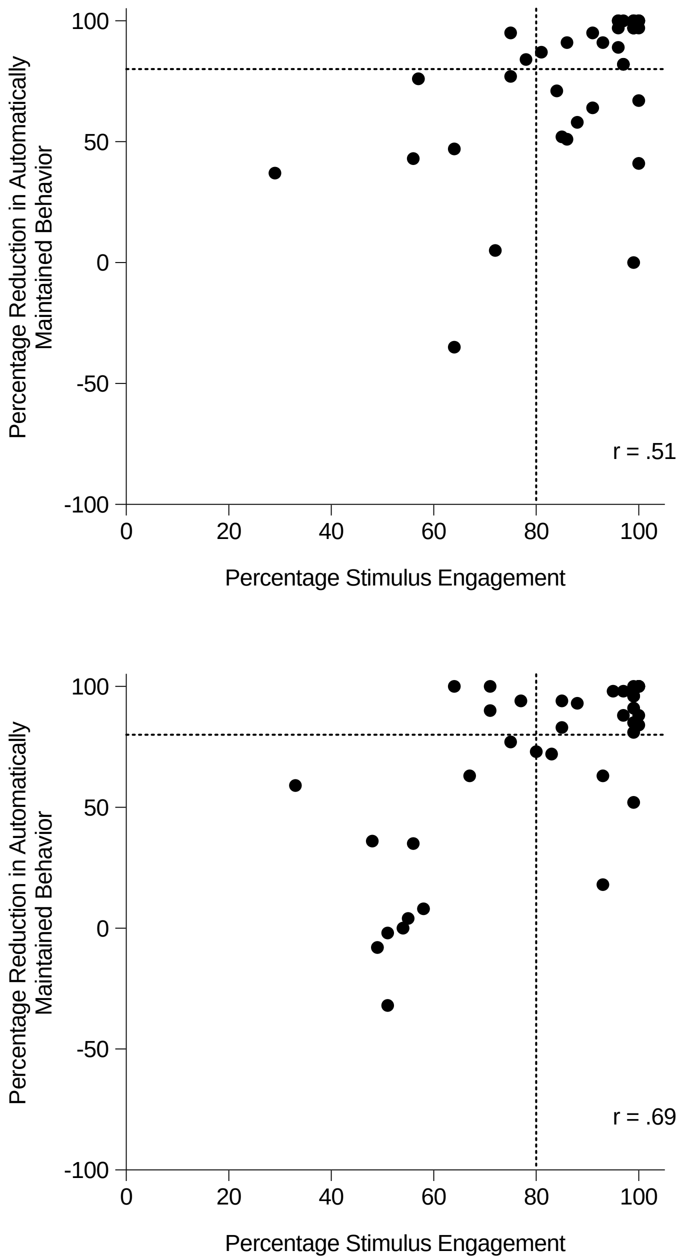
Percentage Reduction in Problem Behavior in the Free-Access and Long-Term Analysis Conditions



Note. Each test stimulus is presented consecutively and, in the order, listed in each participant's respective CSA graph. Data points above the dashed horizontal line indicate an 80% reduction in problem behavior.

Figure 7

Percentage of Engagement and Percentage Reduction in Problem Behavior



Note. Percentage reduction in problem behavior for participants in the initial CSA condition (top panel) and long-term analysis (bottom panel). The dotted horizontal line depicts an 80% reduction in problem behavior. The dotted vertical line depicts 80% stimulus engagement.