
SOME EFFECTS OF AUDIO AND VISUAL STIMULATION ON MULTIPLE FORMS OF STEREOTYPY

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Three experiments were conducted to evaluate the effects of audio and visual stimulation, alone or in combination, on the behavior of three children who displayed multiple forms of stereotypy (e.g., hand mouthing, body rocking). The results of experiment 1 showed that all three participants displayed different forms of stereotypy when audio and visual stimulation were provided versus when no stimulation was provided. The results of experiments 2 and 3 showed that the form of one participant's stereotypy, but not the other two, changed when visual stimulation and audio stimulation were presented separately. Overall, the results suggest that ambient stimulation may influence both the form of and time allocation to stereotypy. Copyright © 2005 John Wiley & Sons, Ltd.

INTRODUCTION

'Stereotypy' typically refers to behavior that persists across time, involves repetitious movement of one or more body parts, and is relatively invariant in topography or form (e.g., Berkson, 1983). Although a recent review by Rapp and Vollmer (in press) concluded that most forms of stereotypy are automatically reinforced, little is known about specific antecedent events that may influence automatically reinforced behavior. In fact, the antecedent event that most often associated with stereotypy is 'low environmental stimulation' with and without reference to social and tangible reinforcers (e.g., Berkson & Davenport, 1962; Berkson & Mason, 1963, 1964; Emerson, Hatton, Robertson, Henderson, & Cooper, 1999; Hall, Thorns, & Oliver, 2003; Horner, 1980; Iwata, Dorsey, Slifer, Bauman, & Richman, 1982/1994).

A handful of studies have shown that the presence of a particular, often preferred, stimulus sets the occasion for some individuals to engage in automatically reinforced problem behavior (Carter, Devlin, Doggett, Harber, & Barr, 2004; Friman, 2000;

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Rapp, 2004; Van Camp et al., 2000). Friman demonstrated that a young child engaged in thumb sucking only when he held a small cloth. Rapp first found that providing access to automatically reinforced object twirling early in a given day resulted in decreased levels of object twirling later in that day. Subsequently, Rapp found that access to music (a highly preferred stimulus) increased object twirling even when prior access to object twirling had been provided. Similarly, Carter et al. found that levels of a boy's screaming and hand mouthing were higher during a no-interaction condition (no social consequences) with continuous and noncontingent tangibles than during a no-interaction condition without tangibles. In an elegant series of experiments, Van Camp et al. isolated antecedents associated with automatically reinforced problem behavior that was displayed by two boys. For one participant, the results showed that hand biting was exhibited only when vibratory stimulation was available from a toy. For the other participant, the results indicated that hand flapping occurred only when social interaction was provided noncontingently. Although these studies showed that antecedent stimulation of various modalities (e.g., audio, vibratory) may function as establishing conditions for engagement in automatically reinforced behavior, the results are somewhat limited in that each study evaluated individuals with only one or two forms of problem behavior and only the Van Camp et al. (2000) study evaluated multiple forms of stimulation.

In a recent study of individuals who displayed multiple forms of automatically reinforced behavior, Rapp, Vollmer, St. Peter, Dozier, and Cotnoir (2004) found that blocking or limiting access to the most probable behavior (the one that occurred for the highest percentage of time) produced orderly and dynamic changes in subsequent time allocation to other behavior. For two participants, one untargeted behavior decreased and another untargeted behavior increased when the most probable behavior was blocked. Based on this outcome, it may be useful to determine whether different modalities of stimulation (e.g., visual, audio) exert differential effects on individuals who display multiple forms of stereotypy. It is possible that stimulation produced by noncontingent access to preferred activities may alter the value of sensory consequences that are generated by stereotypy (or other automatically reinforced behavior).

EXPERIMENT 1: EFFECTS OF AUDIO AND VISUAL STIMULATION

The purpose of experiment 1 was to evaluate the effects of visual and audio stimulation on stereotypy exhibited by individuals diagnosed with developmental disabilities. Access to television was selected as the potentially 'establishing condition' because stimulus dimensions such as volume and visual content could be

held constant and presented individually or together. The focus of this experiment was to evaluate stereotypy in a condition with continuous access to a television that provided audio and visual stimulation and a condition without audio or visual stimulation. When compared to a condition with low ambient stimulation (i.e., no audio or visual stimulation from the TV), it is possible that access to audio stimulation and visual stimulation would have no effect on any form of stereotypy, decrease some forms of stereotypy, increase some forms of stereotypy, or increase some forms and decrease other forms of stereotypy.

Method

Participants, Setting, and Data Collection

Three individuals who displayed various forms of stereotypy (see below) participated in the present experiment. Carl was a 9-year-old male diagnosed with attention deficit hyperactivity disorder and moderate mental retardation. Carl engaged in body rocking, hand mouthing, hand flapping, and vocalizing. Ryan was a 9-year-old male diagnosed with autistic disorder and unspecified mental retardation. Ryan exhibited hand flapping and lip touching. Andy was an 11-year-old male diagnosed with pervasive developmental disorder, Down's syndrome, and moderate mental retardation. Andy displayed body rocking, vocalizing, hand flapping, and bruxing. These three individuals were selected for participation in the experiment based on their exhibition of two or more forms of stereotypy and relative preference for watching television (no other individuals participated). In terms of communication abilities, Ryan requested numerous items using a Picture Exchange Communication System (PECS), whereas Carl and Ryan requested only a few items using PECS (e.g., access to television, drinks). Response definitions for each participant are listed in Table 1.

All sessions took place in the same 5 m × 6 m room located within a short-term residential facility (a treatment center for individuals with severe behavior disorders). The room was equipped with a chair and a television. The location of the chair and television was kept constant across participants and sessions. This room also contained several windows. Although a trainer was present for each session, no social consequences were provided for any behavior. For each participant, six to nine, 5-min sessions were conducted per day for 3–5 days per week. On a given day, at least two different conditions (described below) were applied. To control for external variables, each participant's sessions were conducted at the same time each day.

Observers were seated behind a one-way window and collected data using hand-held computers. The duration of each form of stereotypy was scored in real time and then converted into a percentage of time measure. A second observer scored at least

Table 1. Target responses and interobserver agreement scores.

Participant	Response form	Response definition	Mean IOA (%)	IOA range (%)
Carl	Hand mouthing	Insertion of either hand past plane of mouth	95	89–100
	Body rocking	Two or more forward and backward torso movements	95	91–100
	Hand flapping	Two or more up or down or side to side hand movement	86	80–100
	Vocalizing	Any audible product with open mouth	88	85–100
Ryan	Lip touching	Contact of a finger with any part of the lip	98	95–100
	Hand flapping	Two or more up or down or side to side hand movement	95	93–100
Andy	Hand flapping	Two or more up or down or side to side hand movement	91	87–100
	Body rocking	Two or more forward and backward torso movements	96	92–100
	Vocalizing	Any audible product with open mouth	96	88–100
	Bruxing	Grinding audible product with mouth closed	85	72–100

24% of the sessions (range, 24–28%). Interobserver agreement (IOA) was calculated using the average agreement within 10-s intervals method. Using this method, data collected by the primary and secondary observers were compared in 10-s bins (e.g., there are thirty 10-s bins in a 5-min session). For each bin, the smaller number was divided by the larger number and then multiplied by 100 to arrive at the percentage of agreement for that bin. Percentages from each of the bins were then totaled and divided by the total number of bins to arrive at the overall percentage of agreement score. The mean IOA scores for each participant’s response forms (across all three experiments) are also listed in Table 1.

Design and Procedures

The effects of antecedent conditions (described below) on each participant’s stereotypy were evaluated using either a multiple-probe design (Carl and Ryan) or a combination of multiple-probe and reversal design (Andy). Videos that were used during the assessment conditions were recommended by the participants’ parents and were subsequently identified as highly preferred during a free-operant stimulus preference assessment (e.g., Roane, Vollmer, Ringdahl, & Marcus, 1998). Both audio and visual stimulation from the television were available during the preference assessment. Prior to conducting the stimulus preference assessment, the participants were trained to sit on a specific chair in order to access television. The participants’ stereotypy was first evaluated during the TV condition and then compared to No TV probes (see below).

Based on the procedures described by Van Camp et al. (2000), the effects of time-out (from television) on body rocking and hand flapping were also evaluated for Andy. Because Andy initially displayed such high levels of body rocking during the

TV condition, time-out (TV loss) for body rocking was implemented to evaluate the possibility that rocking was elicited by stimulation from the TV. If Andy's body rocking was elicited then punishment in the form of brief TV loss would not be expected to decrease this behavior. Conversely, if Andy's behavior was operant, and access to the TV was a potent reinforcer, then contingent TV loss should decrease body rocking, increase other (possibly stereotypic) behavior, or both (see Rapp et al., 2004). Subsequently, time-out was implemented contingent on hand flapping to determine whether Andy would reallocate time to body rocking when hand flapping was punished.

No Television (No TV). In this condition, the participant was seated in front of the television, but the television was 'off' for the duration of the session (i.e., no audio or visual stimulation was provided). This condition evaluated levels of stereotypy (i.e., time allocation to various response forms) in the absence of audio and visual stimulation.

Continuous TV (TV). In this condition, the participant was seated in front of the television and his preferred video was played for the duration of the session. The volume of the TV was set at the same level (setting 27; approximately 70 dB) across sessions for all three participants. This condition evaluated the extent to which levels of stereotypy changed as a function of visual and audio stimulation from the television. To control for the effects of the video contents (e.g., music, rapid movement) across sessions, the video was rewound and played from the beginning at the start of the first session of each day.

Time-out from TV for Body Rocking (TO Body Rock) (Andy Only). This condition was the same as the TV condition except that the trainer turned the television 'off' (via remote control) for 30 s following the initiation of body rocking. At the end of the 30-s time-out period, the TV was turned back 'on.' No consequences were provided for other forms of stereotypy. This condition evaluated the extent to which body rocking decreased when it was followed by the removal of stimulation from the television.

Time-out from TV for Hand Flapping (TO Hand Flap) (Andy Only). This condition was the same as the TV condition except that the trainer shut the television 'off' (via remote control) for 30 s following the initiation of hand flapping. No consequences were provided for other forms of stereotypy. This condition was implemented because hand flapping emerged as the most probable stereotypy during

TO Body rock and persisted during the ensuing TV phase. Thus, this condition evaluated the extent to which hand flapping decreased (and other behavior increased) when it was followed by the removal of stimulation from the television.

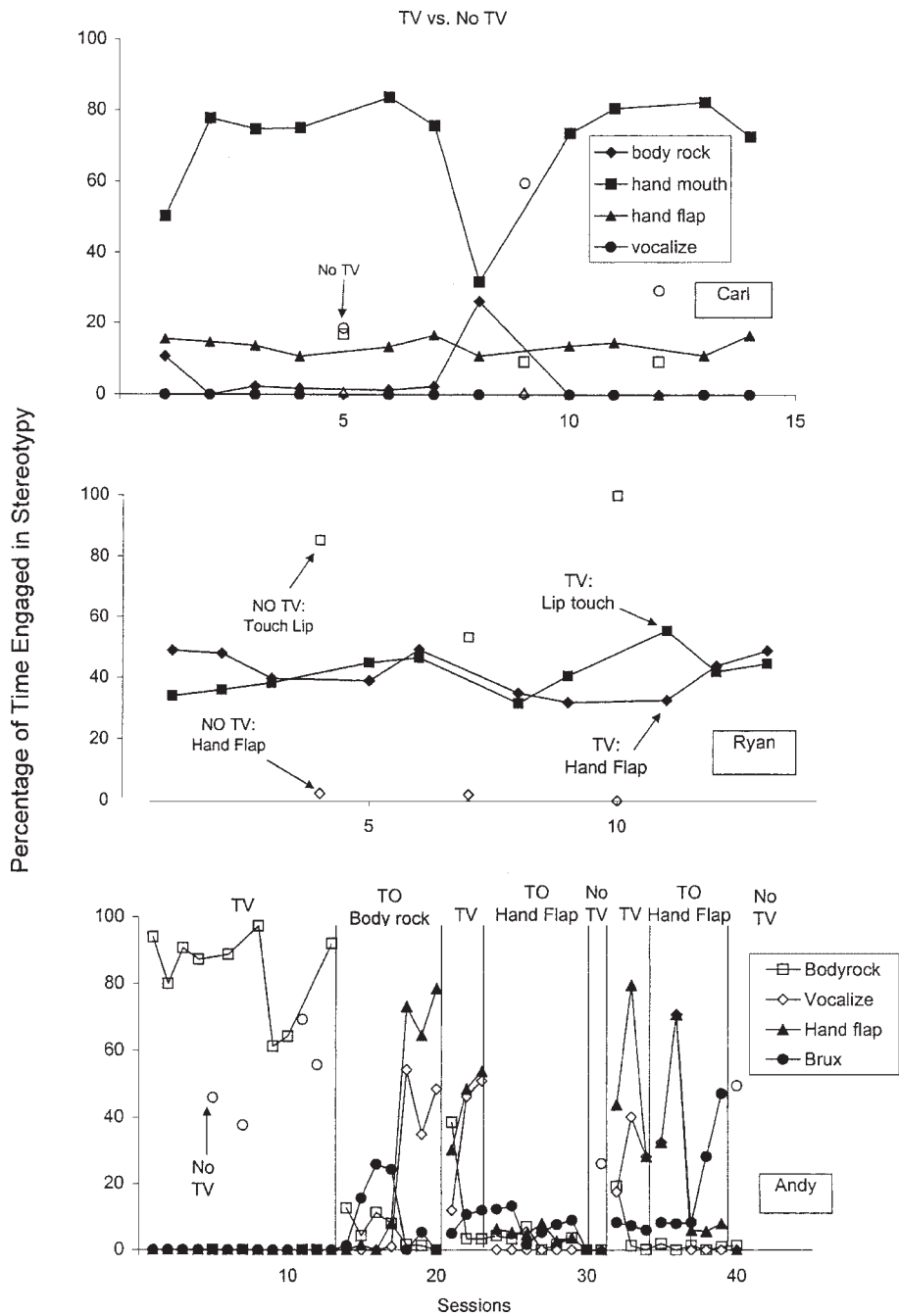
Results and Discussion

Figure 1 shows the results of the TV and No TV comparison. The top panel of Figure 1 shows the percentage of time Carl engaged in hand mouthing, hand flapping, vocalizing, and body rocking across TV and No TV conditions. During the TV condition, Carl exhibited relatively high levels of hand mouthing ($M = 71\%$), low, consistent levels of hand flapping ($M = 14\%$), and zero to near-zero levels of body rocking ($M = 4\%$) and vocalizing ($M = 0.1\%$). During No TV probes, Carl displayed relatively high levels of vocalizing ($M = 36\%$), low levels of hand mouthing ($M = 12\%$), and no body rocking or hand flapping. In summary, when the TV was 'off,' Carl displayed moderate to high levels of vocalizing and low levels of hand mouthing. When the TV was 'on,' Carl displayed high levels of hand mouthing and stable, moderate levels of hand flapping. Thus, in comparison to the No TV probes, it appeared that audio and visual stimulation in combination increased hand mouthing and hand flapping, but decreased vocalizing.

The middle panel of Figure 1 shows the percentage of time Ryan engaged in hand flapping and lip touching across TV and No TV conditions. Similar to the results for Carl, the presence of audio and visual stimulation produced dynamic changes in Ryan's time allocation to stereotypy. During the TV condition, Ryan displayed moderate levels of hand flapping ($M = 42\%$) and lip touching ($M = 41\%$). During No TV probes, Ryan exhibited high levels of lip touching ($M = 80\%$) and near-zero levels of hand flapping ($M = 1\%$).

The bottom panel of Figure 1 shows the percentage of time Andy engaged in hand flapping, vocalizing, body rocking, and bruxing across the TV, No TV comparison, and time-out phases. During the TV condition (left side), Andy displayed high levels of body rocking ($M = 84\%$), near-zero levels of bruxing, and no hand flapping or vocalizing. Conversely, in the No TV condition, Andy engaged in moderate to high levels of bruxing ($M = 52\%$) and near-zero levels of other forms of stereotypy.

Figure 1. Percentage of time Carl engaged in stereotypy (top panel) across TV and No TV (probes) conditions. Open symbols denote No TV probes. Percentage of time Ryan engaged in stereotypy (middle panel) across TV and No TV (probes) conditions. Percentage of time Andy engaged in stereotypy (bottom panel) during TV, No TV (probes), and Time-out conditions. Open symbols on the left side of the figure for Andy denote No TV probe sessions.



Introduction of TO Body rock (for Andy) decreased body rocking ($M=6\%$) and gradually increased hand flapping ($M=32\%$), vocalizing ($M=20\%$), and temporarily increased bruxing ($M=10\%$). The subsequent TV phase produced increasing trends for hand flapping ($M=44\%$), vocalizing ($M=36\%$), and bruxing ($M=9\%$), and low levels of body rocking ($M=15\%$). Due to low levels of body rocking and high levels of hand flapping during the second TV phase, time-out was implemented for hand flapping in the subsequent phase. The decrease in body rocking and concomitant increase in hand flapping suggested that Andy's stereotypy was operant, as opposed to respondent, behavior.

The first TO Hand flap phase (for Andy) decreased hand flapping ($M=4\%$) and vocalizing ($M=0.1\%$), but produced little or no change in bruxing ($M=7\%$) or body rocking ($M=3\%$). A No TV probe yielded a moderate level of bruxing ($M=26\%$) and zero-levels of other stereotypy. The ensuing TV phase again produced high levels of hand flapping ($M=51\%$) and vocalizing ($M=38\%$), and low levels of bruxing ($M=8\%$) and body rocking ($M=5\%$). The second TO Hand flap phase produced low levels of hand flapping ($M=7\%$) and zero or near-zero levels of vocalizing and body rocking; however, bruxing ($M=28\%$) increased substantially. Interestingly, when the TV was turned 'off,' Andy immediately stopped hand flapping and typically began bruxing. Thus, with the on-going loss of TV for hand flapping, the TV condition became similar to the No TV condition (insofar as both contained low audio stimulation and low visual stimulation). In the final No TV probe session, Andy again displayed a high level of bruxing ($M=50\%$).

As with Carl and Ryan, the presence of audio and visual stimulation yielded different forms of stereotypy for Andy. In addition, increases in untargeted forms of stereotypy were noted for Andy during two of the three punishment phases.

EXPERIMENT 2: EFFECTS OF VISUAL STIMULATION

The stereotypy of all three participants changed as a function of audio and visual stimulation. As both modes of stimulation were presented in experiment 1, experiment 2 was designed to analyse the specific effects of the visual stimulation on stereotypy. For example, Carl displayed high levels of hand mouthing when audio and visual stimulation from the TV were presented. It is possible that visual stimulation alone will produce comparable levels of hand mouthing, decrease hand mouthing, or increase other forms of stereotypy.

Participants, Setting, and Data Collection

The participants, setting, and data collection were the same as in experiment 1.

Design and Procedures

The effects of conditions involving no visual or audio stimulation, visual and audio stimulation, and visual stimulation only on each participant's stereotypy were evaluated using either a multiple-probe design (Ryan) or a reversal design with probes (Carl and Andy).

Continuous TV (TV)

This condition was the same as the TV condition that was conducted in experiment 1.

Continuous TV Visual Stimulation Only (TV Visual)

This condition was the same as the TV condition except that the volume was turned to zero to eliminate audio stimulation from the television. This condition evaluated the extent to which time allocation to various forms of stereotypy changed as a function of visual stimulation.

No Television (No TV)

This condition was the same as the No TV condition that was conducted in experiment 1.

Results and Discussion

Figure 2 shows the results of the TV versus TV Visual comparison. The top panel shows the results for Carl's stereotypy. During the first TV condition, Carl displayed high levels of hand mouthing ($M = 78\%$) and low levels of hand flapping ($M = 14\%$). Introduction of TV Visual decreased hand mouthing ($M = 38\%$) and increased vocalizing ($M = 23\%$). The first return to TV again yielded high levels of hand mouthing ($M = 78\%$), low levels of hand flapping ($M = 17\%$), and near-zero levels of other stereotypy. The re-introduction of TV Visual decreased hand mouthing ($M = 56\%$) and hand flapping ($M = 0.7\%$), and increased vocalizing ($M = 18\%$). The third TV phase produced greater variability in stereotypy with a decreasing trend in body rocking ($M = 29\%$), an increasing trend in hand mouthing ($M = 48\%$), and low levels of vocalizing ($M = 9\%$). In the third TV Visual phase, Carl displayed near-zero levels of all forms of stereotypy. In the fourth TV phase, hand mouthing ($M = 83\%$) returned to previous levels, whereas hand flapping ($M = 8\%$) and body rocking ($M = 5\%$) increased only slightly. The fourth TV Visual phase produced increased vocalizing ($M = 47\%$), variable levels of hand mouthing ($M = 27\%$), low levels of

hand flapping ($M = 3\%$), and an increasing trend in body rocking ($M = 9\%$). In the No TV probe, Carl displayed a moderate level of vocalizing ($M = 31\%$) and a low level of body rocking ($M = 4.6\%$). In general, when only visual stimulation was present, Carl's hand mouthing decreased from high to moderate levels and his vocalizing increased from zero to moderate levels.

The middle panel of Figure 2 shows the percentage of time Ryan engaged in hand flapping and lip touching across No TV (probe), TV, and TV Visual conditions. During the No TV probe, Ryan again exhibited high levels of lip touching ($M = 100\%$) and zero levels of hand flapping. During the TV condition, Ryan displayed moderate levels of hand flapping ($M = 42\%$) and lip touching ($M = 43\%$). In the TV Visual condition, Ryan displayed high levels of lip touching ($M = 92\%$) and low levels of hand flapping ($M = 4\%$). Thus, visual stimulation alone produced little, if any, change in Ryan's stereotypy.

The bottom panel of Figure 2 shows the percentage of time Andy engaged in stereotypy across TV, TV Visual, and No TV (probe) conditions. With the possible exception of temporary decreases in vocalizations at the beginning of the TV Visual phases, visual stimulation alone produced little change in Andy's stereotypy.

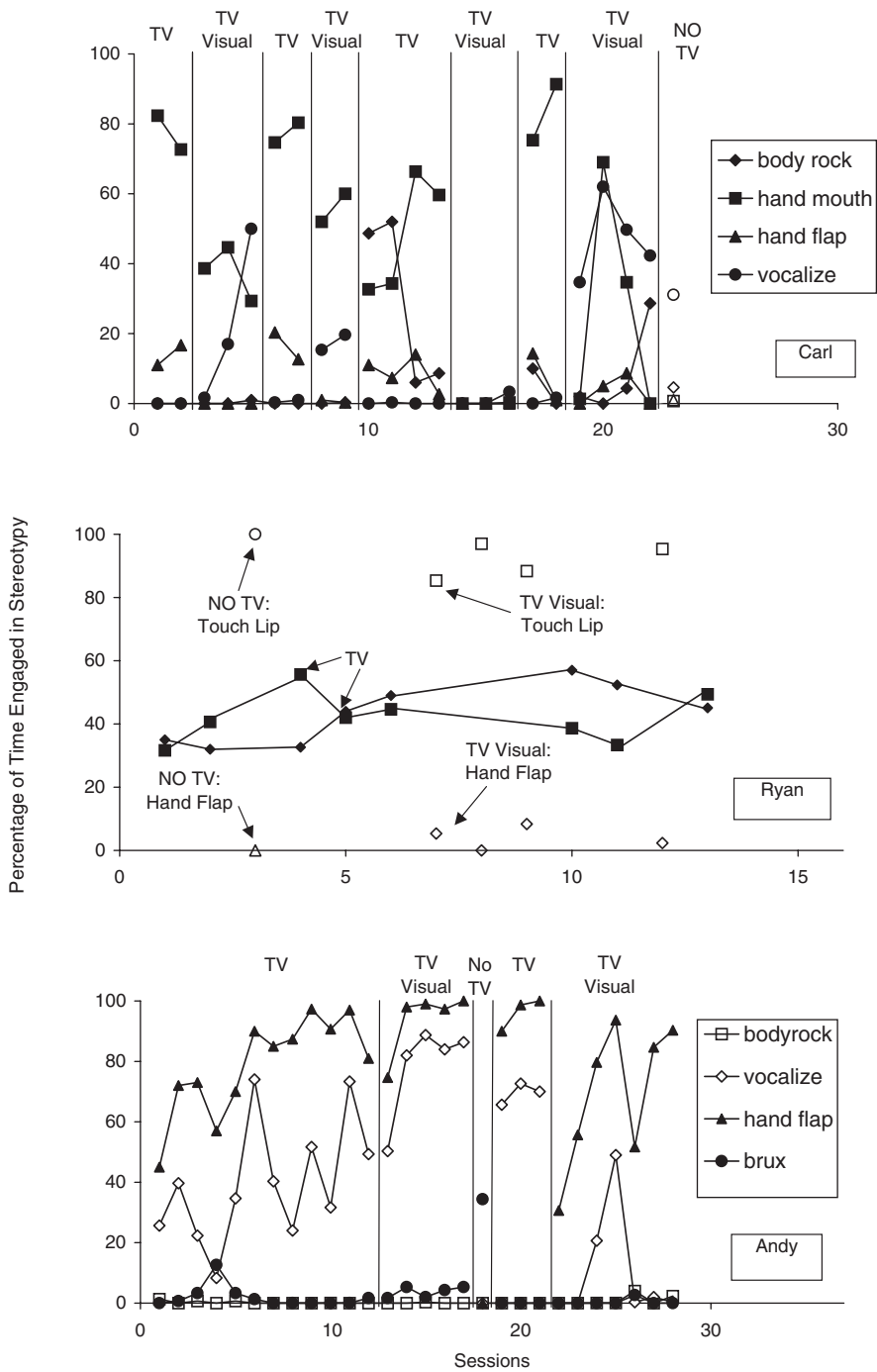
EXPERIMENT 3: AUDIO STIMULATION

The results of experiment 2 showed that only one (Carl) of the three participants displayed different forms of stereotypy when visual stimulation was presented alone. As all three participants displayed changes in stereotypy when audio and visual stimulation were presented in combination (see experiment 1), the purpose of experiment 3 was to determine whether the changes observed in experiment 1 were a function of audio stimulation alone or audio and visual stimulation in combination.

Design and Procedures

The effects of conditions involving audio and visual stimulation, audio stimulation alone, and visual stimulation alone (Carl only) on each participant's stereotypy were again evaluated using either a multiple-probe design (Ryan) or a reversal design (Carl and Andy).

Figure 2. Percentage of time Carl engaged in stereotypy (top panel) across TV, TV Visual, and No TV (probes) conditions. Percentage of time Ryan engaged in stereotypy (middle panel) across No TV (probes), TV, and TV Visual conditions. Percentage of time Andy engaged in stereotypy (bottom panel) during TV and TV Visual conditions.



Continuous TV (TV)

This condition was identical to the TV condition that was conducted in experiments 1 and 2.

Continuous TV Audio Stimulation Only (TV Audio)

This condition was the same as the TV condition except that cardboard was taped over the television screen to block visual stimulation from the television. The volume was adjusted to the previous level (setting 27; approximately 70 dB). This condition evaluated the extent to which stereotypy changed as a function of audio stimulation.

Results and Discussion

Figure 3 shows the results of the TV versus TV Audio comparison. Consistent with the results of experiments 1 and 2, the top panel of Figure 3 shows that Carl displayed high levels of hand mouthing ($M=63\%$), moderate levels of hand flapping ($M=25\%$), and low levels of vocalizing ($M=9\%$) and body rocking ($M=3\%$) during the TV condition. The introduction of TV Audio increased body rocking ($M=56\%$), and decreased hand mouthing ($M=15\%$) and hand flapping ($M=2\%$). The next TV phase was marked by high levels of hand mouthing ($M=68\%$), and low levels of hand flapping ($M=14\%$) and body rocking ($M=12\%$). Re-introduction of TV Audio again increased body rocking ($M=85\%$) and decreased other forms of stereotypy to zero or near-zero levels. As in experiment 2, TV Visual increased vocalizing ($M=53\%$) and decreased body rocking ($M=17\%$), hand mouthing ($M=16\%$), and hand flapping ($M=0\%$). The third TV Audio phase again yielded high levels of body rocking ($M=94\%$) and near-zero levels of other forms of stereotypy. A return to TV Visual increased vocalizing ($M=50\%$) and hand mouthing ($M=26\%$), and yielded low levels of other forms of stereotypy. Thus, for Carl audio stimulation alone produced high levels of body rocking and low levels of other forms of stereotypy. As in experiment 2, visual stimulation alone produced moderate to high levels of vocalizations and low to moderate levels of hand mouthing. Table 2 provides a summary of the changes in the form of Carl's stereotypy across experimental conditions.

Figure 3. Percentage of time Carl engaged in stereotypy (top panel) across TV, TV Audio only, and TV Visual conditions. Percentage of time Ryan engaged in stereotypy (middle panel) across TV and TV Audio conditions. Percentage of time Andy engaged in stereotypy (bottom panel) during TV and TV Audio conditions.

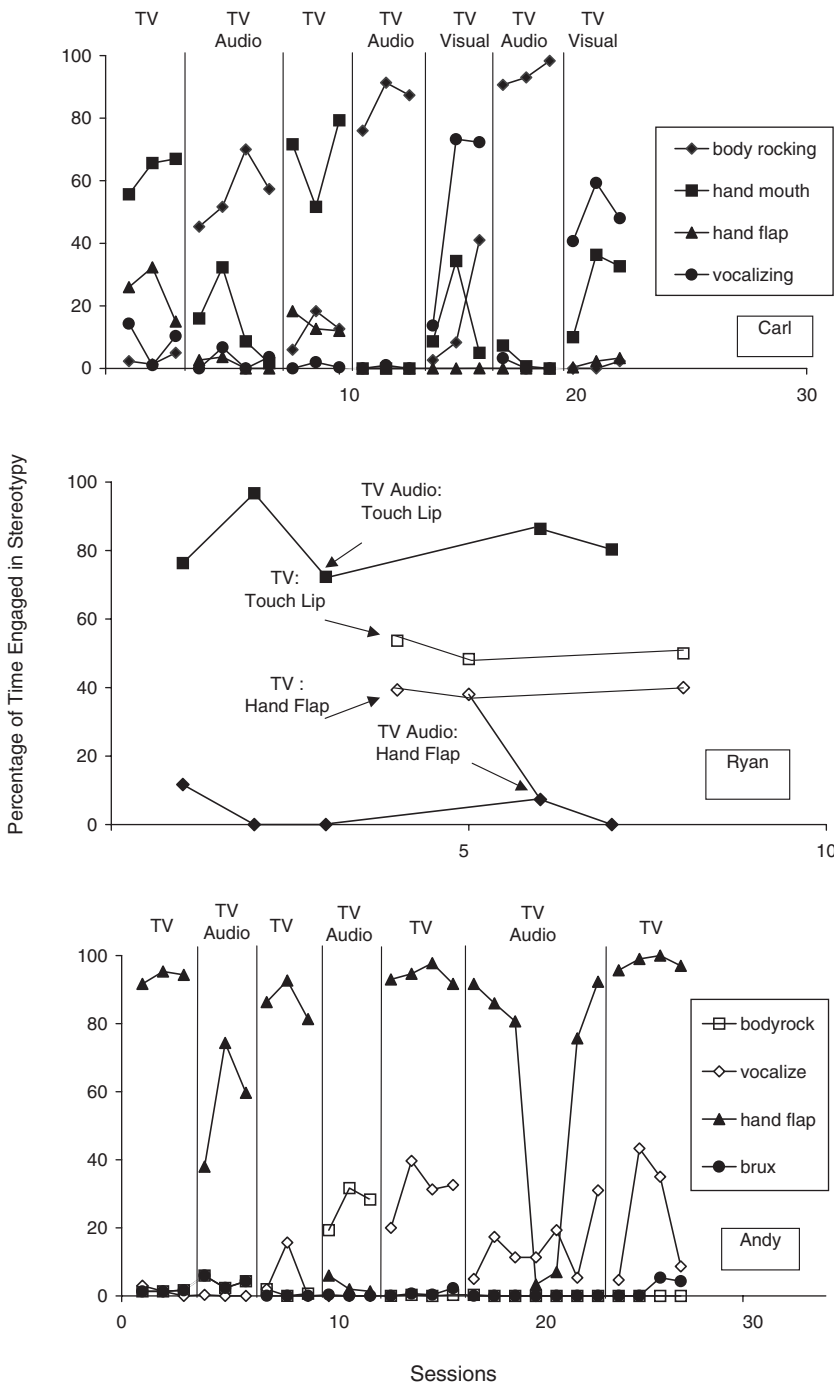


Table 2. Highest probability stereotypy by experimental condition.

	No TV (compare)	TV	TV visual	TV audio	TO body rock	TO hand flap
Carl	Vocalize	Hand mouth Hand flap	Vocalize Hand mouth	Body rock		
Ryan	Lip touch	Lip touch ^a Hand mouth	Lip touch	Lip touch		
Andy	Brux	Body rock ^b Hand flap ^c	Hand flap	Hand flap	Hand flap	Brux

^aTime allocation to lip touch and hand mouth was similar.
^bThe highest probability stereotypy prior to the TO body rock phase.
^cThe highest probability stereotypy subsequent to the TO body rock phase.

The middle panel of Figure 3 shows the results for Ryan’s stereotypy across the TV and TV Audio conditions. In the TV Audio condition, Ryan displayed high levels of lip touching ($M = 82\%$) and low levels of hand flapping ($M = 4\%$). In the TV condition, Ryan exhibited lower levels of lip touching ($M = 51\%$) and higher levels of hand flapping ($M = 40\%$). These results indicate that audio stimulation alone did not alter Ryan’s time allocation to lip touching or hand flapping. A summary of changes in Ryan’s stereotypy across conditions is provided in Table 2.

The bottom panel of Figure 3 shows the results for Andy’s stereotypy during the TV and TV Audio conditions. As before, with the possible exception of slightly lower and more variable levels of hand flapping across conditions, TV audio exerted little, if any, effect on Andy’s stereotypy. A summary of the changes in Andy’s stereotypy across conditions can also be seen in Table 2.

GENERAL DISCUSSION

The results from three experiments show that the form of all three participants’ stereotypy changed as a function of visual and audio stimulation in combination and one participant’s stereotypy changed as a function of audio stimulation alone and visual stimulation alone (see Table 2). As a whole, preferred stimulation (TV access) was associated with decreases in some forms of stereotypy and increases in other forms. Interestingly, each participant displayed high levels of what was arguably a more salient form of stereotypy during TV (with visual and audio) than during No TV (low ambient stimulation). This finding is consistent with previous studies (Carter et al., 2004; Rapp, 2004; Van Camp et al., 2000) and is potentially important because it suggests that merely enriching the environment with preferred stimulation may produce undesirable effects on automatically reinforced behavior. Specifically, the

results show that some antecedent events may set the occasion for some individuals to display automatically reinforced behavior.

Previous studies by Friman (2000) and Van Camp et al. (2000) showed that automatically reinforced behavior occurred only in the presence of specific antecedent stimuli. The results of the present study for Carl extend the literature by showing that time allocation to distinct forms of stereotypy (hand mouthing, vocalizing, and body rocking) varied as a function of audio and visual stimulation alone and in combination. Studies by Carter et al. (2004) and Rapp (2004) showed that the presence of a preferred stimulus increased the exhibition of automatically reinforced behavior. The results from experiment 2 replicate this effect by showing that Carl displayed increased levels of hand mouthing, which was displayed at low levels during No TV, when both audio and visual stimulation were present.

Van Camp et al. (2000) showed that contingent removal of an evocative stimulus (e.g., a vibrating toy) decreased automatically reinforced behavior. The present results (see experiment 1) extend those of the Van Camp et al. study by showing that Andy reallocated time to another automatically reinforced behavior when the evocative stimulus was contingently removed; this behavior pattern has been observed in other studies (e.g., Rapp et al., 2004; Rollings & Baumeister, 1981). The change in Andy's behavior allocation during and following the TO body rocking condition (from body rocking to hand flapping) suggests that his stereotypy was operant behavior.

The behavior changes observed in the present study may be attributed to various behavioral processes. It is possible that specific forms of Carl's stereotypy were evoked by audio stimulation, visual stimulation, or a combination of both. Specifically, it is possible that the stimulation generated by stereotypy may have been 'complementary' to the ambient (evoking) stimulus. Green and Freed (1993) suggested that reinforcers may be described as complementary when consumption of one is associated with consumption of another (e.g., when cookies are consumed, milk is also consumed). In this sense, the ambient stimulus (a potential reinforcer) serves as an establishing operation that increases the value of the stimulation generated by stereotypy (a known reinforcer). For Carl, audio stimulation may have been a more potent reinforcer when stimulation produced by his body rocking was simultaneously consumed; however, this was not experimentally demonstrated. It is also possible that ambient stimulation functioned as a discriminative stimulus, but this seems unlikely because the probability of reinforcement for stereotypy did not change when the ambient stimulation was present.

Several studies have shown that automatically reinforced problem behavior decreases when noncontingent access to preferred stimulation that matches the overt product of the problem behavior is provided (e.g., Piazza, Adelinis, Hanley, Goh, & Delia, 2000; Rapp et al., 2004). It is possible that the audio or visual stimulation

presented in the respective condition was similar to stimulation that was produced by one or more forms of stereotypy (e.g., Carl did not vocalize during conditions containing audio stimulation [TV and TV Audio]). Thus, when audio stimulation was available on a response-independent basis, Carl reallocated time to another form of stereotypy with a different response product (e.g., body rocking during TV Audio). Although this effect was not directly evaluated, the dynamic changes that were produced for Carl's behavior suggest that ambient stimulation influenced, either directly or indirectly, multiple behavioral mechanisms.

Finally, it is possible that audio stimulation or visual stimulation established an aversive stimulus condition and stereotypy attenuated this condition (i.e., stereotypy was maintained by automatic negative reinforcement). This explanation seems unlikely because each participant learned to sit on the chair contingent on access to the TV and none displayed behavior that may be indicative of discomfort, such as leaving their chair or covering their face or ears, during any of the conditions.

Some specific changes in allocation to stereotypy are also worthy of discussion. First, Carl displayed an increasing trend in body rocking and a concomitant decrease in other forms of stereotypy across the first, second, and third TV Audio phases (see top panel of Figure 3). A similar pattern was reported by Rapp et al. (2004) when access to high probability stereotypy was restricted and then subsequently permitted. It is possible that high levels of hand mouthing during the TV phase and vocalizing during the TV Visual phase, both of which were correlated with low levels of body rocking, imposed deprivation for stimulation generated by body rocking. Alternatively, this pattern may simply be an artifact of the assessment process.

Second, although each participant's time allocation to specific forms of stereotypy was generally consistent, some changes in response allocation were observed independent of experimental manipulations. For example, Andy switched from body rocking to hand mouthing in the TV phase that followed the TO Body rock phase. It is possible that body rocking developed discriminative properties for punishment (i.e., the loss of TV); however, this seems unlikely because hand flapping recovered during the ensuing TV phases despite a history of punishment. Similarly, Carl displayed high levels of body rocking for two sessions during one TV phase and zero to near-zero levels of all forms of stereotypy during one TV visual phase (see top panel of Figure 2). Thus, even though attempts were made to control external variables (e.g., access to television outside of sessions), it is possible that uncontrolled variables also influenced the participant's stereotypy. However, because sessions were conducted at the same time each day and the daily schedule was generally the same, the effects of confounding variables should have been minimized.

In conjunction with the results of previous studies (Carter et al., 2004; Rapp, 2004; Van Camp et al., 2000), the outcome of the present study illustrates at least two important considerations for the assessment and treatment of stereotypy. First,

providing an access to preferred stimulation that is intended to decrease stereotypy may increase other stereotypic behavior. Specifically, access to some forms of stimulation may serve as an establishing condition for targeted or untargeted forms of automatically reinforced behavior. Second, some individuals may display different forms of stereotypy under different environmental conditions, but the overall level of stereotypy may be relatively unchanged. Thus, in order to assess and treat stereotypy, it is necessary to collect data on separate, possibly novel, response forms.

Some limitations to the current results also warrant discussion. First, the results are potentially limited because a functional analysis of each participant's stereotypy was not conducted (e.g., Iwata et al., 1982/1994). In terms of time, it would have been prohibitive to assess the sensitivity of every form of the participants' stereotypy to social-positive and social-negative consequences; however, the 'automatic' function of the participants' behavior would have been more optimally evaluated in the absence of a trainer (a potential discriminative stimulus for social consequences). Nevertheless, none of the participants had a known history (particularly with the two trainers) of gaining access to preferred events for engaging in any form of stereotypy. In fact, each participant was taught to request preferred items using PECS. Furthermore, each participant's behavior was shown to persist in the absence of social consequences and changes in stereotypy occurred almost exclusively when ambient stimulation changed (see Experiment 1). Thus, it is unlikely that the behavior observed during these experiments was affected by socially mediated consequences (e.g., attention) or the potentially correlated antecedents (e.g., stimuli discriminative for attention).

Results from the present investigation set the stage for further investigation of stereotypy and other automatically reinforced behavior. Future research could evaluate preference for external stimulation (audio stimulation or visual stimulation) that is not correlated with stereotypy. For example, as an extension of the present study, a concurrent-operants procedure could be used to allow Carl to choose between a chair that was correlated with the blocking of stereotypy (i.e., an inhibitory stimulus for stereotypy) and another chair with no history of blocking. Likewise, the relative value of different stimulus conditions could also be evaluated using a contingent time-out procedure similar to that used for Andy. Rather than shutting off the television, either audio or visual stimulation could be removed (e.g., mute the volume) contingent on the target behavior. The results could provide further information about a possible complementary relation between external stimulation and stimulation generated by stereotypy. Finally, to further evaluate the position that ambient stimulation sets the occasion for stereotypy to function as reinforcement, future research could utilize sensory extinction procedures to determine whether attenuating sensory products affects time allocation to certain forms of stereotypy (e.g., Tang, Patterson, & Kennedy, 2003).

REFERENCES

- Berkson, G. (1983). Repetitive stereotyped behaviors. *American Journal of Mental Deficiency*, 88, 239–246.
- Berkson, G., & Davenport, R. K. (1962). Stereotyped movements in mental defectives. *American Journal of Mental Deficiency*, 66, 849–852.
- Berkson, G., & Mason, W. A. (1963). Stereotyped movements in mental defectives: III. Situation effects. *American Journal of Mental Deficiency*, 68, 409–412.
- Berkson, G., & Mason, W. A. (1964). Stereotyped movements of mental defectives: IV. The effects of toys and the character of the act. *American Journal of Mental Deficiency*, 68, 511–524.
- Carter, S. L., Devlin, S. R., Doggett, A., Harber, M. M., & Barr, C. (2004). Determining the influence of tangible items on screaming and handmouthing following an inconclusive functional analysis. *Behavioral Interventions*, 19, 51–58.
- Emerson, E., Hatton, C., Robertson, J., Henderson, D., & Cooper, J. (1999). A descriptive analysis of the relationship between social context, engagement, and stereotypy in residential services for people with severe and complex disabilities. *Journal of Applied Research in Intellectual Disabilities*, 12, 11–29.
- Friman, P. C. (2000). 'Transitional objects' as establishing operations for thumb sucking: A case study. *Journal of Applied Behavior Analysis*, 33, 507–509.
- Green, L., & Freed, D. E. (1993). The substitutability of reinforcers. *Journal of the Experimental Analysis of Behavior*, 60, 141–158.
- Hall, S., Thorns, T., & Oliver, C. (2003). Structural and environmental characteristics of stereotyped behaviors. *American Journal on Mental Retardation*, 108, 391–402.
- Horner, R. D. (1980). The effects of an environmental 'enrichment' program on the behavior of institutionalized profoundly retarded children. *Journal of Applied Behavior Analysis*, 13, 473–491.
- Iwata, B. A., Dorsey, M. F., Slifer, K. J., Bauman, K. E., & Richman, G. S. (1994). Toward a functional analysis of self-injury. *Journal of Applied Behavior Analysis*, 27, 197–209. (Reprinted from: *Analysis and Intervention in Developmental Disabilities*, 2, 3–20, 1982).
- Piazza, C. C., Adelinis, J. D., Hanley, G. P., Goh, H. L., & Delia, M. D. (2000). An evaluation of the effects of matched stimuli on behaviors maintained by automatic reinforcement. *Journal of Applied Behavior Analysis*, 33, 13–27.
- Rapp, J. T. (2004). Effects of prior access and environmental enrichment on stereotypy. *Behavioral Interventions*, 19, 287–295.
- Rapp, J. T., & Vollmer, T. V. (in press). Stereotypy I: A review of behavioral assessment and treatment. *Research in Developmental Disabilities*.
- Rapp, J. T., Vollmer, T. V., St. Peter, C., Dozier, C. L., & Cotnoir, N. (2004). Analysis of response allocation in individuals with multiple forms of stereotyped behavior. *Journal of Applied Behavior Analysis*, 37, 481–501.
- Roane, H. S., Vollmer, T. R., Ringdahl, J. E., & Marcus, B. A. (1998). Evaluation of a brief stimulus preference assessment. *Journal of Applied Behavior Analysis*, 31, 605–620.
- Rollings, J. P., & Baumeister, A. A. (1981). Stimulus control of stereotypic responding: Effects on target and collateral behavior. *American Journal of Mental Deficiency*, 86, 67–77.
- Tang, J. C., Patterson, T. G., & Kennedy, C. H. (2003). Identifying specific sensory modalities maintaining the stereotypy of students with profound disabilities. *Research in Developmental Disabilities*, 26, 433–451.
- Van Camp, C. M., Lerman, D. C., Kelley, M. E., Roane, H. S., Contrucci, S. A., & Vorndan, C. M. (2000). Further analysis of idiosyncratic antecedent influences during the assessment and treatment of problem behavior. *Journal of Applied Behavior Analysis*, 33, 207–221.