

Functional Analysis of Stereotypical Hand-Mouthing in a Student with Autism

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The current study included three experiments that functionally analyzed stereotypical behavior. An analogue functional analysis was used in Experiment 1 to detect the function of one student's stereotypy which might serve to escape from task demands, obtain attention from others, or produce sensory self-stimulation. An analysis of sensory modalities was conducted in Experiment 2 to further analyze the possible sensory consequences causing the student's stereotypy. Alternative sensory reinforcer was used in Experiment 3 to compete with specific sensory consequences maintaining the student's stereotypy. Results of the present study demonstrated sensory reinforcement was a determinant of stereotypical behavior in this student. The specific function of stereotypy in this student was maintained by tactile stimulation.

Keyword: stereotypy, functional analysis, sensory reinforcer

Stereotypic behavior is often defined as repetitive and nonfunctional behavior, and it usually occurs in the form of body rocking, mouthing, or complex hand and finger movement (LaGrow & Repp, 1984). Stereotypical behavior might affect learning activities if it exhibited at high rates (Koegel & Covert, 1972). Besides, it might inversely relate to social integration in more inclusive settings (Durand & Carr, 1987). Therefore, detecting the causes of stereotypy and reducing this aberrant behavior becomes an important issue. The origin and functions of stereotypical behaviors remains unclear. Some researchers posit that stereotypy may be maintained by negative reinforcers involving escape or

avoidance of task demand (Durand & Carr, 1987; Mace & Belfiore, 1990). Other assert that these behaviors may be maintained by positive reinforcers involving attention or tangible items from others (Dadds, Schwartz, Adams, & Rose, 1988; Thompson & Berkson, 1985; Frea & Hughes, 1997).

However, it was initially assumed that stereotypical behavior was maintained by sensory consequences (Lovaas, Newsom, & Hickman, 1987). If stereotypy occurs with and without task demands, across most settings (Rincover, Peoples, & Packard, 1979), and has no observable antecedents or consequences (Devany & Rincover, 1982), this suggests sensory reinforcement. This hypothesis

postulates that repetitive behaviors function to modulate sensory input to an individual when the environment lacks or provides too much stimulation. Support for this position can be found in Rincover's (1978) study. He demonstrated that subjects' stereotypical behaviors could be maintained by different sensory consequences. In his studies, one subject's plate spinning stereotypy was eliminated when the table was carpeted to reduce auditory consequences. The proprioceptive feedback was masked by taping a vibrator to the back of the second subject's hand, and finger flapping was reduced. When the proprioceptive feedback was masked through vibration, the third subject's object twirling was significantly decreased. These results have been supported by subsequent studies (Rincover et al., 1979; Devany & Rincover, 1982). In accordance with these findings, Mason and Newsom (1990) investigated 3 children with severe mental retardation and also found that sensory changes effectively reduced children's repetitive hand movements. These studies suggest that sensory consequences function as positive and/or negative reinforcers maintaining stereotypy.

Recent studies used analogue functional analyses (Iwata et al., 1994) to simulate a lack of environmental stimulation. If environments occasion people engaging in stereotypy, individuals might exhibit high incidences of stereotypy in alone conditions either because of negative reinforcement (i.e., lowered levels of stimulation) or to self-stimulate themselves (positive reinforcement) owing to

understimulation in the environment. More evidence comes from studies using analogue functional analyses to detect the relationship between alone settings and stereotypical behaviors (Applegate, Matson, & Cherry, 1999; Mason & Iwata, 1990; Sturmey, Carlsen, Crisp, & Newton, 1988; Wehmeyer, Bourland, & Ingram, 1993). These researchers found that some subjects' stereotypical behaviors were self-stimulation and unrelated to any of the events that were manipulated in the alone condition. Their findings suggest that stereotypical behaviors might be maintained by self-stimulation which provides sensory reinforcement.

Although sensory consequences may contribute to the maintenance of stereotypic responses, it still lacks robust evidence to conclude that these stimuli can be responsible for the development of the stereotypy due to difficulties in measuring these events (Kennedy, 1994). It is difficult to declare that stereotypy is maintained by sensory consequences unless the consequence can be systematically manipulated to demonstrate its relation to this behavior. In most cases, it is often hard to detect sensory consequences. Some cases even have no antecedent consequence events associated with stereotypy. Therefore, unless all potential antecedent and consequence variables that might contribute to stereotypy are thoroughly examined, there remains a lack of evidence to show that sensory consequences cause stereotypy.

Purpose of the Study

The first purpose of this study was to examine possible functions of one student's stereotypy maintained mainly by positive and/or negative social reinforcement, and/or sensory reinforcement. Analogue functional analyses were used in Experiment 1 to detect stereotypy which served as escape from task demand, obtaining attention from the investigator, and producing self-stimulation.

Second, if the functions for the student's stereotypy were maintained by sensory consequences, this study would seek to expand the field's current ability to identify specific sensory reinforcers that maintain stereotypy. To conduct experimental analyses of possible visual, auditory, or tactile sensory consequences that might maintain stereotypy, functional analyses in Experiment 2 were used to mask the possible sensory consequences causing stereotypy.

Third, if specific sensory consequence maintained stereotypy could be marked to demonstrate its effect on stereotypy, this study would seek to detect possible alternative sensory reinforcers that might compete with specific sensory consequences maintaining stereotypy. Functional analyses in Experiment 3 were used to demonstrate the effect of alternative sensory reinforcers.

having autism. She could walk independently but cried frequently. Her performance on the Preschool Language Scale-3 indicated that her auditory comprehensive ability was 6 months and her expressive communication ability was 9 months. Her spontaneous vocalizations consisted of combining vowel and consonant sounds (e.g., "ma-ma"). Her stereotypy consisted of mouthing. She usually put her fingers or hand in her mouth. Assessment and intervention for her was conducted in one 5 m by 6 m separate room near her classroom that allowed for uninterrupted observations and minimal distractions. There were one table and several chairs in the room.

Measures

The dependent variables were stereotypical responses. For Janey, her stereotypical response was hand mouthing. It was further defined operationally as (1) putting her finger(s) into her mouth and/or closing her mouth, or (2) biting her hand or her palm. The investigator videotaped each condition using a videocassette recorder and a stopwatch. Two observers recorded the frequency of stereotypical responses by employing a 15 s partial interval sampling method. All data were converted to percentage of 15 s intervals during which stereotypical behavior occurred.

GENERAL METHOD

Students and Settings

Janey was a 6-year-old girl diagnosed as

Interobserver Agreement

Before conducting the functional analysis, two graduate students in special education were trained for 4 hr to use the

observational system and reached a 90% agreement criterion, and then served as observers for all sessions. These two observers recorded data independently and compared with data sheet simultaneously. Across experiments an average of 22% session (range, 20% to 33%) were scored for interobserver agreement. An agreement was computed using an interval-by-interval agreement method to assess percentage agreement for the frequency of stereotypical behaviors (Kazdin, 1982). Interobserver agreement was computed by dividing the number of agreements by the number of agreements plus the number of disagreements and multiplying by 100%. The interobserver agreement for Janey's stereotypical behavior is 98% (95% to 100%) in Experiment 1, 94% (85% to 100%) in Experiment 2, 98% (90% to 100%) in Experiment 3.

Data analysis

Visual inspection was used to examine the effects of different conditions on student's stereotypical behavior across three experiments.

EXPERIMENT 1: ANALOGUE FUNCTIONAL ANALYSIS

Hypotheses of the Experiment

The functions of this student's stereotypy may be maintained either by sensory reinforcement, positive social reinforcement, or negative social reinforcement.

Method

Procedure

Before functional analyses were conducted, Janey was observed in her classroom to analyze possible antecedent and consequence events. She was observed about 4 hr across activities for 1 day.

A multielement design (Sidman, 1960) was employed to assess the occurrence of Janey's stereotypy across four conditions: (a) attention, (b) demand, (c) alone, and (d) play, and to detect whether stereotypy was maintained by positive social reinforcement, negative social reinforcement, or sensory reinforcement. Each condition was presented once per day for 5 min with a random sequence occurring each day. Sessions were conducted at the same time each day. All sessions were videotaped by a graduate student and recorded by two graduate students using data sheets. The graduate student positioned video camera facing the student from approximately 2 m, repositioning it if the participant moved. These conditions were used to identify possible operant functions that the stereotypy might serve. During the Attention condition, the investigator and Janey were seated next to each other. When seated the investigator read a magazine, while Janey was provided with toys. If stereotypy occurred, the investigator provided 5 s of social comments to her, telling her not to engage in stereotypical responses, and provided physical contact. After the 5 s of social comments elapse, the next occurrence of stereotypical responses occasion a similar consequence. All other responses exhibited by

her were ignored. During the Demand condition, the investigator and Janey were seated next to each other. The investigator delivered a verbal demand every 10 s (e.g., "Put the blocks in the cup"). Correct responses were immediately praised and incorrect or no responses resulted in a partial physical prompt after 10 s elapsed. Any occurrence of stereotypical responses resulted in 30 s cessation of task demands. During the Alone condition, Janey was seated on a chair. No social interaction or activities occurred during this condition. During the Play condition, the investigator and Janey were seated next to each other. She was provided with various toys identified by her teachers as being preferred and was praised every 30 s in the absence of stereotypy (occurrences of stereotypical responses were ignored).

Results

Janey displayed high rates of stereotypical behavior across four conditions (see Figure 1). The results suggest that her functions of stereotypy were undifferentiated yet highly variable. For all of the sessions a mean of 80% (range, 15% to 100%) of intervals contained stereotypy in the Alone condition, a mean of 72% (range, 0% to 100%) of intervals contained stereotypy in the Play condition, a mean of 76% (range, 30% to 95%) of intervals contained stereotypy in the Demand condition, and a mean of 50% (range, 20% to 100%) of intervals contained stereotypy in the Attention condition.

EXPERIMENT 2: ANALYSIS OF SENSORY MODALITIES

Because Janey's rates of stereotypical behavior were high across all conditions in Experiment 1 suggesting that her stereotypy might serve to sensory consequences, Experiment 2 was conducted to further analyze the specific functions of her stereotypy.

Hypotheses of the Experiment

If the student's stereotypy was maintained by sensory reinforcement, it could be reduced by masking either visual, auditory, or tactile consequences.

Method

The second study further analyzed high levels of stereotypical behaviors occurring in the Alone condition identified in Experiment 1 to assess possible sensory functions that caused these behaviors. The same definitions of stereotypical responses, measures, settings, student, and interobserver agreement in Experiment 1 were conducted through this study.

Procedure

Experiment 2 used functional analyses to assess the possible sensory consequences of stereotypy for Janey. A multielement design was used to assess the occurrence of stereotypy across four conditions: (a) Alone, (b) Auditory masking, (c) Tactile masking, and (d) Visual masking conditions. During the Visual masking condition, an investigator and Janey who was seated in a chair, were seated next to each other. One metal plate was put in front of Janey's eyes to cover visual effects possibly

produced by stereotypy. The mental plate is 33 cm in length, 30 cm in width, and 1 cm in thickness and was held between her eyes and fingers that allowed her to exhibit stereotypy, but did not allow her to see her stereotypic responses. During the Auditory masking condition, Janey was seated alone. A pair of plastic safety earplugs was put in her ears to mask possible auditory consequences produced by stereotypy. The earplugs are circular cones with a diameter of 0.6 cm and 1.5 cm in length. During the Tactile masking condition, Janey sat alone. A pair of mittens was used to cover tactile effects for her. During the Alone condition, Janey was seated in a chair and received no social interaction or activities. Each condition was presented once per day for 5 min with a random sequence occurring each day. Sessions were conducted at the same time each day.

Results

The results for Janey's analysis of sensory modalities presented a high frequency of stereotypy across the Alone, Auditory, and Visual masking conditions, but a low yet highly variable frequency of stereotypy in the Tactile masking condition (see Figure 2). The results suggest that tactile stimulation may be functioning as reinforcer for Janey. For all of the sessions a mean of 84% (range, 45% to 100%) of intervals contained stereotypy in the Alone condition, a mean of 74% (range, 25% to 100%) of intervals contained stereotypy in the Auditory masking condition, a mean of 64% (range, 20% to 100%) of intervals contained stereotypy in the Visual masking

condition, and a mean of 52% (range, 30% to 70%) of intervals contained stereotypy in the Tactile masking condition.

EXPERIMENT 3: ANALYSIS OF COMPETING SENSORY STIMULATION

Hypotheses of the Experiment

Alternative sensory reinforcers may be successfully used to compete with the student's stereotypy.

Method

This experiment examined competing sensory stimulation as a means to decrease Janey's stereotypy and to further test the sensory consequences identified in Experiment 2. The same definitions of stereotypical responses, measures, settings, student, and interobserver agreement in Experiment 1 were conducted through this study.

Procedure

A multielement design was used to assess the occurrence of stereotypy across five conditions: (a) String, (b) Alone, (c) Tactile masking, (d) Auditory masking and (e) Visual masking conditions. During the String condition, Janey sat alone. One rubber string was used to compete with possible tactile consequence caused by stereotypical behavior. The Alone, Visual, Auditory, and Tactile masking conditions were the same as those conducted in Experiment 2. Each condition was presented once per day for 5 min with a random sequence occurring each day. Sessions were conducted at the same time each day.

Results

Janey exhibited a high and variable frequency of stereotypy within the Alone,

Auditory, and Visual masking conditions but a slightly and consistently low frequency of stereotypy in the String condition (see Figure 3). The results suggest that tactile stimulation (string) can be successfully substitutable for her stereotypical responses. For all of the sessions a mean of 78% (range, 60% to 100%) of intervals contained stereotypy in the Alone condition, a mean of 66% (range, 15% to 100%) of intervals contained stereotypy in the Auditory masking condition, a mean of 91% (range, 80% to 100%) of intervals contained stereotypy in the Visual masking condition, a mean of 48% (range, 0% to 85%) of intervals contained stereotypy in the Tactile masking condition, and a mean of 28% (range, 0% to 95%) of intervals contained stereotypy in the String condition.

DISCUSSION

Undifferentiated Patterns: Multiple or Sensory Consequence

Results of the present study demonstrated that sensory reinforcement was a determinant of Janey's stereotypical behavior. The functions of her stereotypies were maintained by tactile stimulation. This study supported the hypothesis that stereotypical behavior was maintained by sensory consequences (Applegate et al., 1999; Lovaas et al., 1987; Mason & Iwata, 1990; Sturmey et al., 1988; Wehmeyer et al., 1993). With respect to the analogue functional analysis conducted in Experiment 1, the present data were undifferentiated for Janey, because high levels of stereotypy occurred during all assessment

conditions. One possible explanation is that her stereotypy served multiple functions and stimulation provided in the Play (control) condition failed to compete with stereotypy. This is consistent with few recent studies conducted by Singh, Landrum, Ellis, and Donatelli (1993) and Sprague, Holland, and Thomas (1997) who demonstrated stereotypical behaviors occurred at high rates across all assessment conditions. However, these patterns of Janey's stereotypical responses might also suggest that none of the alternative activities available during all assessment conditions could compete with the sensory reinforcers maintaining stereotypical behaviors, and the functions of stereotypy might be merely under control of sensory reinforcement. That is, specific types of antecedents and consequences selected for the assessments may not be relevant to the actual maintaining factors in the subjects' environments. This explanation was supported by Iwata et al. (1994) who showed three subjects exhibited extremely high levels of self-injurious behaviors during all assessment conditions and suggested that these behaviors were maintained by sensory reinforcement. However, without further analysis to test the functions of stereotypy, it is unclear whether Janey's stereotypy was maintained by multiple functions or just by sensory consequences. On the other hand, it is possible that carryover effects across assessment conditions could cause undifferentiated results in Experiment 1. Because the investigator never changed the

assessment settings for all four conditions and the duration of intersession interval lasted only a short period of time (5 min), the carryover effects may have an impact on students' undifferentiated stereotypic responses.

High Variable Data: Some Explanations

Janey's data in Experiment 1 indicated that her stereotypy might serve multiple functions. However, after further analyses of the functions of her stereotypical behavior identified that her behavior only occurred in the alone condition. Subsequent experiments demonstrated that sensory reinforcers served to maintain her stereotypy. After the analysis of sensory modalities in Experiment 2, the reduction in stereotypical behavior during the tactile masking condition suggests that compared with other masking effects, tactile stimulation might serve to the maintenance of Janey's stereotypical behavior (sensory reinforcement). But her highly variable data showed in Experiment 2 may also suggest that extraneous variables might influence her stereotypy as well. Further evidence comes from the analysis in Experiment 3 which showed that alternative tactile stimulation (a rubber string) caused decreases in stereotypy. Again, the data were highly variable across all conditions. This might support that some extraneous factors did exert an impact on her stereotypical behavior. The results of Experiment 3 were similar to a study by Favell, McGimsey, and Schell (1982) who showed that one subject's hand mouthing decreased when given rubber toys. This finding is also consistent with Mason and Newsom's (1990)

study that demonstrated sensory changes could decrease students' repetitive hand movements. The results of Experiments 2 and 3 suggest that tactile stimulation functions to maintain Janey's stereotypy. However, without a further analysis of the functions in the Attention and Demand conditions, it is unclear that her stereotypical behavior was maintained by positive and negative social reinforcers as well.

Oral Stimulation or Hand Stimulation

Another interesting issue raised by the current findings is the source of self-stimulation. For Janey's mouthing, this study showed her stereotypies were maintained by tactile consequences. The results show that masking Janey's hands with a pair of mittens or providing a rubber string reduced her stereotypical behavior. The source of self-stimulation for Janey may be her hand and fingers owing to reduce her stereotypy after masking as showed in Experiment 2. The results are consistent with the study conducted by Goh et al. (1995) who found that subjects' hand mouthing was maintained by sensory reinforcement and was primarily maintained by hand stimulation. However, it should be noted that the effects of tactile masking seemed insignificant. Thus, drawing definite conclusions seems impossible. In contrast, when providing a string to compete with her stereotypical responses, the string was substitutable for her hand and fingers into her mouth. It could be that her mouthing was maintained by oral stimulation despite no further evidence provided. It is not clear whether her mouth was the source of self-

stimulation due to the difficulty of masking her mouth or both sources (mouth and fingers). If the latter hypothesis is the case, blocking either source may reduce her stereotypical behavior. More research is needed to examine sources of self-stimulation.

Response Topography and Function

A related issue is the relation between response function and response topography. The function of stereotypical behavior may relate to its topography in analysis of sensory modalities. In this analysis of sensory consequences response topography may imply operant function. That is, the type of stimulation a response produces was associated with the behavior that occurred. It could well be that stereotypical behavior with a specific topography can be predictive of a particular sensory function. For example, Janey repetitively put her fingers into her mouth. Such a topography suggests that tactile stimulation may function as a sensory reinforcer maintaining her stereotypical behavior, as was demonstrated by Experiments 2 and 3. These findings are consistent with the study of Kennedy and Souza (1995) who showed that self-injurious eye-poking was associated with the visual stimulation it produced. In such cases the topography of the response provides clues as to why the response is occurring. However, as for Janey, putting fingers into her mouth might also function to gain attention or to escape from demand as showed in Experiment 1. Therefore, it seems impossible to use the topography of stereotypy

to predict its social functions. This suggests that the form of a response may predict the sensory function it serves but that may not necessarily predict the social functions it serves. Therefore, it seems to support the stance proposed by Kennedy, Meyer, Knowles, and Shukla (2000) that the greater the degree of social-mediation present in producing reinforcement, the less predictive the topography of responding.

A Need to Detect Specific Function

Finally, the results of this study suggest that more studies extending functional analyses to detect specific sensory consequences maintained stereotypy are needed. Previous studies (e.g., Runco, Charlop, & Schreibman, 1986; Sturmey et al., 1988) indicated that stereotypy occurred in the Alone condition might be relevant to sensory reinforcement. However, little is known about the actual mechanisms underlying the behavior. The hypotheses regarding what kind of sensory stimulation contributes to stereotypy never be tested thoroughly, so it lacks the evidence that sensory consequence is the cause of stereotypy. At best, these analyses only show some relation between stereotypy and poor environmental stimulation. So far, few studies (e.g., Rincover, 1978; Patel, Carr, Kim, Robles, Eastridge, 2000) have conducted further analyses to examine what specific sensory consequences might cause stereotypical behaviors. Therefore, there is a need to further extend alone condition analyses which assume a lack of stimulation in the

environment to examine specific sensory stimulation that may control stereotypy before

more effective environmental stimulation could be adopted.

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自閉症學童咬手行為的功能分析之研究

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摘要

固著行為（stereotypical behavior）的起因與功能仍不清楚。學家們大都從操作制約觀點來研究此異常行為。本研究共有三個子研究，採功能分析的方法，試圖找出影響自閉症學童固著行為之原因。研究一、以類似的功能分析（analogue functional analysis）從操弄四種情境（引起注意、工作要求、單獨、及遊玩情境）來分析該學童固著行為的功能。結果顯示：四種情境都無法對固著行為產生區分性的結果。研究二、以功能分析來操弄四種情境（單獨、聽覺遮蔽、觸覺遮蔽、及視覺遮蔽情境）來分析造成固著行為的感官功能。結果顯示：只有在觸覺遮蔽的情境下，固著行為顯著減少。研究三、繼續以功能分析來操弄五種情境（繩子、單獨、聽覺遮蔽、觸覺遮蔽、及視覺遮蔽情境）來檢視替代性的觸覺刺激能否與固著行為產生對抗的效果。研究顯示：以繩子能成功地替代固著行為。最後，本研究對固著行為的感官功能與感官刺激的來源，進一步地討論，並對未來的研究提出建議。

關鍵詞：固著行為，功能分析，感官增強