A molecular analysis of communicative and problem behaviours

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ABSTRACT

Few studies have examined the relationship between communicative and problem behaviors that are already present in a behavioral repertoire. In this study, a detailed microanalysis of the antecedents and consequences of aggressive and communicative behavior of a 7-year-old boy was conducted. By using both descriptive and experimental methodologies, the data suggested that problem and communicative behavior were maintained on thin concurrent schedules of social negative reinforcement. A molar analysis of the descriptive data showed that the relative amount of time allocated to each behavior was a function of the relative amount of reinforcement that each behavior accrued. The implications of these findings are discussed in terms of conducting descriptive analyses and for enhancing the efficacy of interventions for problem behavior.
INTRODUCTION

Problem behaviors in children with developmental disabilities present substantial difficulties to the individuals, their careers, and service providers. The last decade of research in this area has been characterized by the rise of a more behavior-analytic approach best exemplified by the increasing attention paid to functional analysis (Carr, 1977; Iwata, Dorsey, Slifer, Bauman, & Richman, 1982/1994). In an experimental analysis, aspects of the individual’s environment are controlled tightly by an experimenter and the effect on subsequent responding is observed. Here, ecological validity is sacrificed for a high degree of control. Conversely, in a descriptive analysis, sequences of events are observed as they occur in the individual’s natural environment. These data comprise “natural experiments” in which the effect of a nominal independent variable on a nominal dependent variable can be examined (Sackett, 1987). It is apparent that in this method, control is sacrificed for ecological validity. Because of these difficulties, some researchers have advocated conducting both types of assessment and comparing their results (Mace, Lalli, & Lalli, 1991). Alongside this development, there has been a growing literature on the effects of problem behavior on others (Carr, Taylor, & Robinson, 1991; Taylor & Carr, 1992; Taylor & Romancyck, 1994) and the functional equivalence of problem and communicative behaviors (see Reichle & Wacker, 1993). The latter has predominantly been explored through interventions involving functional communication training (Carr & Durand, 1985; Durand & Carr, 1991). Less attention, however, has been paid to the relationship between problem and communicative behaviors, which are already in behavioral repertoires. Research in this area may add to the literature on the functional equivalence of problem and communicative behaviors, previously generated by intervention studies. The majority of evidence that problem and communicative behaviors may be functionally equivalent comes from studies that demonstrate that the two classes of behavior covary inversely when communicative behaviors are strengthened (Northup, et al. 1991; Sprague & Horner, 1992). This finding has led to the conclusion that the efficacy of functional communication training rests on the communicative response that is taught joining the same response class of the problem behavior and then acquiring greater response efficiency (Day, Horner, & O’Neill, 1994; Horner & Day, 1991). The latter may be attained via strengthening the communicative response in conjunction with
procedures that weaken the problem behavior, such as extinction or punishment (Wacker et al., 1990). There is good evidence, therefore, that communicative behaviors may attain functional equivalence to problem behaviors via intervention procedures. Increasing research attention has also been paid to molar accounts of behavior. The matching law states that there should be a linear relationship between the relative proportion of responses allocated to a given response and the relative proportion of reinforcements obtained for that response (Hernstein, 1961). This equation can be expressed mathematically:

\[
\frac{R_1}{R_1 + R_2} = \frac{r_1}{r_1 + r_2}
\]

where \( R_1 \) = the rate of response form 1, \( R_2 \) = the rate of response form 2, \( r_1 \) = the rate of reinforcements obtained from response form 1, and \( r_2 \) = the rate of reinforcements obtained from response form 2. Alternatively, the equation can be expressed in terms of time allocation, i.e., \( R_1 \) and \( R_2 \) can be replaced with \( T_1 \) and \( T_2 \), respectively. A demonstration of matching in natural human environments has important implications for promoting more efficient interventions for problem behaviors. For example, the matching law provides an accurate prediction of response allocation and demonstrates the utility of altering relative rather than absolute rates of reinforcement (McDowell, 1982). Hernstein’s hyperbola suggests that to decrease a target response, reinforcement for an available response alternative should be increased or alternatively, the rate of noncontingent reinforcement should be increased. The matching law also allows the precise determination of which schedule (and schedule value) of reinforcement should be supplied to an alternative response in an individual’s repertoire. The matching law also quantifies the interaction between schedules and thus aids the understanding of the “side effects” of particular interventions.

Although applications of the matching law to human behavior in natural environments may be considered important to applied behavior analysis (Mace, 1994; McDowell, 1988; Myerson & Hale, 1984; Pierce & Epling, 1995), relatively few studies have appeared in the literature. Conger and Killeen (1974) showed that the proportion of time that a participant
spent talking to one of two experimenters was equivalent to the proportion of social praise received from each experimenter. However, variable interval schedules of social praise were “programmed” in this study and, therefore, could not be considered naturalistic. McDowell (1982) employed the single-alternative form of the matching law to describe the self-injurious behavior of a 10-year-old boy. Direct observations of the child’s self-injurious behavior and the contingent reprimands in four 20-min observations showed that the behavior conformed to Hernstein’s equation. Similarly, Martens and Houk (1989) observed the disruptive and on-task behavior of an 18-year-old girl with developmental disabilities and the contingent social reinforcement for engaging in each activity. By using a real-time data-collection method, results showed that both responses were allocated time in accordance with the matching law. Finally, Fernandez and McDowell (1995) showed that, in chronic pain sufferers, the rate of “pain” and “healthy” behaviors were proportional to the amount of social reinforcement each behavior accrued when the data were pooled across 12 participants.

There are, therefore, some demonstrations of the matching law involving human participants that have examined the application of the matching law. However, there are no studies that have attempted to apply the matching law to the communicative and problematic behaviors of people with developmental disabilities in the natural environment. In this study, therefore, a complex microanalysis of the antecedents and consequences of communicative and problem behavior was conducted. After this study, a molar account of the relationship between the two behaviors was developed and the implications this had for designing appropriate interventions was discussed.

**METHOD**

*Participant and settings*

Mike was a 7-year-old male with Down’s syndrome diagnosed with having severe developmental disabilities. He lived at home and attended a local school for children with severe developmental disabilities. Mike had been referred to an assessment and outreach service for treatment of his aggressive behaviors, which were interfering with his educational progress. For the descriptive assessment, the locations varied both inside and outside the school although usually they were in the classroom, on the playground, and in the hall. For
the experimental assessment, individual sessions were conducted during one school day in a room containing a table and several chairs.

**Recording Technique, Response Definitions, and Interobserver Reliability**

Observers collected data on response frequency and duration by using an Olivetti Quaderno PC. The software (Repp, Harman, Felce, Van Acker, & Karsh, 1989) allows up to 43 separate behaviors to be simultaneously recorded in continuous time and thus avoids any form of time sampling. Although not commonly used in these type of assessments (see Mace, Lalli & Lalli, 1991), previous studies examining the matching law have adopted this method of data capture in order to enable exact percentage durations to be calculated (Martens & Houk, 1989). Response definitions were developed on the basis of staff interviews and informal observations of the participant before the study. For both the descriptive and experimental assessments, two participant and two adult responses were recorded. Participant responses were: *Aggression*—forceful slapping or kicking others, spitting, banging, and throwing objects by using the palm or side of hand to knock the object away and *signing/vocalizing*—hand gestures or signals usually accompanied by the words “go away,” “no,” and “bye bye.”

Adult responses were: *instruction delivery*—directions to complete a task including physical prompts, verbal requests, and commands, and *attention delivery*—interactions with the participant including touching, offering drinks or favorite items, talking, or blocking participant behavior. For the descriptive analysis, three categories were defined post hoc: *instruction removal*—defined as the discontinuation of instruction delivery for 10, 1-s intervals (or whatever time was available between successive occurrences of instruction delivery, if instruction delivery recurred within 10, 1-s intervals); *attention removal*—defined as the discontinuation of attention delivery for 10, 1-s intervals (or whatever time was available between successive occurrences of attention delivery, if attention delivery recurred within 10, 1-s intervals); and *no interaction*—defined as the absence of instruction delivery, attention delivery, instruction removal, and attention removal. In this way, five environmental event categories were therefore considered in the descriptive analysis, i.e., instruction delivery, attention delivery, instruction removal, attention removal, and no interaction* (cf. Lerman & Iwata, 1993). This ensured that both the analysis and the subsequent interpretation of the data would be consistent with previous research (e.g., Lerman & Iwata,
An independent observer also collected data during 20% of the observations for the descriptive assessment and 25% of the observations for the experimental assessment. For both assessments, agreement was calculated on a 10-s interval by interval basis by using the formula for Cohen’s K (Cohen, 1960). For the descriptive assessment, agreement was calculated for the presence of each category, the onset of each category and its offset. For the experimental assessment, agreement for the presence of each category was calculated. Table 1 shows the percentage of intervals scored by each observer and the corresponding K indices for each category for each type of assessment.

+++++ Table 1 here ++++

Procedure
Descriptive assessment. For the descriptive assessment, 8 hr of direct observations were conducted at Mike’s school over 3 days. Before the initiation of data collection, a copy of Mike’s daily timetable was obtained to ensure that the observations included a representative sample of activities: meals, free time, group activities, and one-on-one sessions. Throughout the observations, the observer followed the participant as unobtrusively as possible to all areas of the school; the staff had previously been told to ignore the observer and interact with the Mike as normally as possible.

The 8 hr of descriptive data were divided into 8, 1-hr blocks and conditional probabilities calculated for each 1-hr block. This procedure was used so that the analysis would be comparable with that found in previous studies (e.g., Lerman & Iwata, 1993; Mace & Lalli, 1991). Conditional probabilities were calculated in the following manner. First, periods of time antecedent and consequent to each response were defined†. A period antecedent to a response was defined as the 10, 1-s interval period before the onset of the response. A period of time consequent to a response was defined as the 10, 1-s interval period after the offset of the response (cf., Lerman

* The environmental event categories were exhaustive but not necessarily mutually exclusive, e.g., instruction delivery could co-occur with attention removal, and attention delivery could co-occur with instruction removal.
& Iwata, 1993). By using these definitions, however, if the time between successive occurrences of a response was less than 20, 1-s intervals, periods of time consequent to the first occurrence of a response would overlap with the period of time antecedent to the second occurrence and so on, hence, producing anomalies in the data. To avoid this problem, where time periods overlapped, the period of time between successive occurrences of a response was split, the first half being assigned to the consequent period of the first occurrence, the second half being assigned to the antecedent period of the second occurrence and so on (see Hall & Oliver, 1997).

Conditional probabilities for each environmental event, $E$, occurring antecedent to, concurrent with, and consequent to each response, $R$, were then calculated by using the following formula:

$$p(E_{\text{1}}/R) = \frac{\text{no. of 1-s intervals of event during antecedent time periods}}{\text{no. of 1-s intervals of antecedent time periods}}$$

$$p(E_{\text{0}}/R) = \frac{\text{no. of 1-s intervals of event during response}}{\text{no. of 1-s intervals of response}}$$

$$p(E_{\text{1}+}/R) = \frac{\text{no. of 1-s intervals of event during consequent time periods}}{\text{no. of 1-s intervals of consequent time periods}}$$

In this way, given that five environmental events and two child responses were considered in the analysis, 30 conditional probabilities were calculated for each observation hour. In addition, conditional probabilities for signing/vocalizing occurring antecedent to, concurrent with and consequent to aggression were also calculated.

As Lerman and Iwata (1993) have pointed out, however, if some events occur at higher frequencies than others in the data, high conditional probabilities may occur simply “by chance.” For instance, if an observation hour included low frequency aggression and high-frequency instruction delivery, then the conditional probability of instruction delivery preceding aggression would be high, even though instructions may rarely have occasioned aggression. One solution to this problem would be to calculate the conditional probability of

†In this way, maintaining variables were determined from a “child effects” perspective, i.e., conditional probabilities for events given a child response were calculated. If conditional probabilities for child response-given events had been calculated, the results would be the same, given that associations between events and responses were statistically evaluated.
aggression after instruction delivery. Thus, if the high conditional probability was an artifact of high-frequency instructions (and instructions did not evoke aggression), then this conditional probability would be low (cf. Lerman & Iwata, 1993). An alternative solution (and one that also aids data interpretation) is to use a statistical measure of association (e.g., Yule’s Q‡), which evaluates the extent to which an event is associated with a response over and above what would be expected by chance (Bakeman & Quera, 1995; Hall & Oliver, 1997). This method of conditional probability appraisal was therefore adopted in the present analysis.

Yule’s Q statistics for each event occurring antecedent to, concurrent with, and consequent to each response were then calculated by using the following formula:

\[
\text{Yule’s Q (} \frac{E_1}{R} \text{)} = \frac{[p(E_1/R) \times (1 - p(E_1/R))] - [(1 - p(E_1/R)) \times p(E_1/R)]}{[p(E_1/R) \times (1 - p(E_1/R))] + [(1 - p(E_1/R)) \times p(E_1/R)]}
\]

\[
\text{Yule’s Q (} \frac{E_{+0}}{R} \text{)} = \frac{[p(E_{+0}/R) \times (1 - p(E_{+0}/R))] - [(1 - p(E_{+0}/R)) \times p(E_{+0}/R)]}{[p(E_{+0}/R) \times (1 - p(E_{+0}/R))] + [(1 - p(E_{+0}/R)) \times p(E_{+0}/R)]}
\]

\[
\text{Yule’s Q (} \frac{E_+}{R} \text{)} = \frac{[p(E_+/R) \times (1 - p(E_+/R))] - [(1 - p(E_+/R)) \times p(E_+/R)]}{[p(E_+/R) \times (1 - p(E_+/R))] + [(1 - p(E_+/R)) \times p(E_+/R)]}
\]

where \(p(E_1/R)\) is the corresponding conditional probability of the event occurring during the absence of the periods antecedent to a response, \(p(E_{+0}/R)\) is the corresponding conditional probability of the event occurring during the absence of the response, and

‡ The interpretation of Yule’s Q is analogous to the correlation coefficient. Thus, a positive value for Q indicates that the conditional probability of the event is higher than would be expected by chance, whereas a negative value for Q indicates that the conditional probability of the event is lower than would be expected by chance (Yule’s Q values range from -1 to +1).
\( p(E_{\perp R}) \) is the corresponding conditional probability of the event occurring during the absence of the periods consequent to a response. In addition, Yule’s Q statistics for signing/vocalizing occurring antecedent to, concurrent with and consequent to aggression were also calculated.

**Experimental assessment.** For the experimental assessment, three conditions were devised in which the presence or absence of establishing operations were manipulated: \( EO \) (i.e., the absence of an establishing operation of deprivation and aversive stimulation), \( EO_{dep} \) (i.e., the presence of an establishing operation of deprivation), and \( EO_{av} \) (i.e., the presence of an establishing operation of aversive stimulation). In the \( EO \) condition, Mike sat at the table next to the experimenter, was allowed to engage in a preferred activity (playing with plasticine), and received attention in the form of praise and comments. In the \( EO_{dep} \) condition, Mike sat at the table with the experimenter nearby, was allowed to engage in the preferred activity, but received very little attention. In the \( EO_{av} \) condition, Mike sat at the table with the experimenter and was prompted to engage in a nonpreferred activity (building towers with Lego bricks) by using a three-step procedure consisting of sequential verbal, gestural (or modelled), and physical prompts. In all conditions, there were no programmed social contingencies, i.e., in the \( EO_{av} \) condition, instructions were not terminated if Mike displayed problem behavior and/or signing, and in the \( EO_{dep} \) condition, attention did not follow problem behavior and/or signing.

The \( EO_{dep} \) and \( EO_{av} \) conditions were alternated between the \( EO \) conditions (which acted as the control condition) in a series of reversal designs. Given that the \( EO_{dep} \) and \( EO_{av} \) were repeated 5 times, there were 20 sessions in total. Each session was 5 min long and sessions were separated by a 2-min break in which Mike and the experimenter left the room. The mean percentage of time that instructions were delivered was 0.03% (range, 0.00–0.30%) in the \( EO \) condition, 0.00% (no range) in the \( EO_{dep} \) condition, and 43.39% (range, 37.00–47.66%) in the \( EO_{av} \) condition. The mean percentage of time that attention was delivered was 70.26% (range, 27.33–95.33%) in the \( EO \) condition, 16.53% (range, 10.53–19.33%) in the \( EO_{dep} \) condition, and 5.3% (range, 2.33–20%) in the \( EO_{av} \) condition.
RESULTS

Figure 1 shows the base rates for each participant response (upper panel) and for each environmental event (lower panel) occurring in each 1-hr block of the descriptive data.

The figure shows that Mike’s aggressive and communicative behaviors seemed to decrease across 1-hr blocks of time. A similar trend was observed for teacher instruction delivery and instruction removal. These results could be interpreted from a “child effects” perspective (see Discussion).

The top panel of Figure 2 shows the Yule’s Q values for the conditional probability of signing/vocalizing occurring antecedent to Mike’s aggression (left), Yule’s Q values for the conditional probability of Mike’s aggression occurring concurrently with aggression (middle), and Yule’s Q values for the conditional probability of Mike’s aggression occurring consequent to aggression (right) calculated for each observation hour.

The figure shows that signing/vocalizing was more likely to occur both preceding and following aggression and was less likely to occur during aggression. This suggested that both behaviors may have formed part of a response chain.

The middle panel of Figure 2 shows the Yule’s Q values for the conditional probability of each teacher response occurring antecedent to Mike’s aggression (left), Yule’s Q values for the conditional probability of each teacher response occurring concurrently with Mike’s aggression (middle), and the Yule’s Q values for the conditional probability of each teacher response after Mike’s aggression (right). If Mike’s aggression was maintained by social negative reinforcement, the Yule’s Q values for the conditional probability of instruction delivery (or attention delivery) antecedent to aggression and the Yule’s Q value for the conditional probability of instruction removal (or attention removal) consequent to aggression should both be high relative to the other Yule’s Q values. Conversely, if Mike’s aggression was maintained by social positive reinforcement, the Yule’s Q values for the conditional probability of no interaction (or instruction removal or attention removal) antecedent to aggression and the Yule’s Q values for the conditional probability of attention delivery (or instruction delivery) consequent to
aggression should both be high relative to the other Yule’s Q values. Finally, if Mike’s aggression was maintained by automatic reinforcement, the Yule’s Q values for the conditional probability of no interaction antecedent to aggression and the Yule’s Q values for the conditional probability of no interaction consequent to aggression should both be high relative to the other Yule’s Q values.

+++++ Figure 1 here ++++

The middle panel of Figure 2 shows that the Yule’s Q values for the conditional probability of instruction delivery preceding aggression (left) and the Yule’s Q values for the conditional probability of instruction removal after aggression (right) were both high relative to the other Yule’s Q values in 7 of the 8 observation hours. Though this may have suggested a social negative reinforcement account for Mike’s aggression, for most of the observation hours, Yule’s Q values for the conditional probability of instruction removal preceding aggression and the Yule’s Q values for the conditional probability of instruction delivery after aggression were also high. Taken together, therefore, these data appeared to support both a social negative reinforcement account and a social positive reinforcement account for Mike’s aggression (i.e., some types of instruction may have been a preferred form of attention for Mike and, therefore, also served as a reinforcer). An alternative explanation is that Mike’s aggression was maintained by a thin intermittent schedule of escape, and that the conditional probability analysis failed to isolate this variable because instructions may sometimes have still been present immediately after his aggression (cf. Lerman & Iwata, 1993).

+++++ Figure 2 here ++++

Data for Mike’s signing/vocalizing appear in the lower panel of Figure 2. Here, the Yule’s Q values for the conditional probability of instruction delivery preceding Mike’s signing/vocalizing (left) and the Yule’s Q values for the conditional probability of instruction removal following signing/vocalizing (right) were both high in comparison to the Yule’s Q values for the other events for 6 of the 7 observation hr for which signing/vocalizing occurred. (Signing/ vocalizing did not occur in the eighth observation hour). Taken together, these data supported a social negative reinforcement account for Mike’s signing/ vocalizing.
Figure 3 shows the results of the experimental assessment. The top panel of Figure 3 shows the percentage duration of Mike’s aggression in each brief experimental condition. The mean percentage duration of Mike’s aggression in each condition was 0% (no range) in the EO-condition, 0% (no range) in the EOdep condition, and 5.20% (range, 0.33 to 9.00%) in the EOav condition. Because Mike’s aggression increased only in the EOav condition, these data suggested that an establishing operation of aversive stimulation served to reliably evoke aggression and that in the past, the behavior may have led to the establishing operation being subsequently removed. This hypothesis was further supported by noting that aggression appeared to decrease across EOav conditions (i.e., the absence of the hypothesised maintaining contingency resulted in extinction). The bottom panel of Figure 3 shows the percentage duration of Mike’s signing/vocalizing in each brief experimental condition. The mean percentage duration of signing/vocalizing was 0.2% (range, 0–0.7%) in the EOcondition, 0.1% (range, 0–0.3%) in the EOdep condition, and 4.5% (range, 3.3–7.3%) in the EOav condition. Because Mike’s signing/vocalizing was elevated only in the EOav condition, these data suggested that an establishing operation of aversive stimulation also served to reliably evoke signing/vocalizing and that in the past, the behavior may have led to the establishing operation being removed.

+++++ Figure 3 here ++++

A molar analysis of the descriptive data were also conducted. In each hour of the descriptive data, the number of 1-s intervals, during which either aggression and signing/vocalizing were observed and the number of reinforcements (i.e., number of 1-s intervals of instruction removal) that occurred contingent (i.e., within 10, 1-s intervals) on either aggression or signing/vocalizing was derived. This then allowed the matching law to be examined by plotting $T_1/(T_1 + T_2)$ as a function of $t_1/(t_1 + t_2)$, where $T_1$ = the number of 1-s intervals of aggression, $T_2$ = the number of 1-s intervals of signing/vocalizing, $t_1$ = the number of 1-s intervals of reinforcements obtained from aggression and $t_2$ = the number of 1-s intervals of reinforcements obtained from signing/vocalizing. Figure 4 shows the resultant plot.

+++++ Figure 4 here ++++
Figure 4 shows a linear relationship between the relative proportion of responses allocated to problem behavior and signing/vocalizing and the relative proportion of contingent reinforcements obtained for aggression and signing/vocalizing. This relationship is in accordance with the matching law. To examine the data for significant bias and undermatching, the base 10 logarithms of the aggression/signing behavior ratios were regressed linearly on logarithms of aggression/signing reinforcer ratios (see Martens & Houk, 1989). Figure 5 shows the resultant plot.

+++++ Figure 5 here ++++

The slope of the regression line was 0.45 (SE = 0.22). This differed significantly from unity—$t(5) = 2.05, p > .05$—indicating that there was some degree of undermatching present in the data (see McDowell, 1988). The intercept of the regression line was $-0.13$ (SE = 0.14). This did not differ significantly from zero—$t(5) = -0.89, p > .05$—indicating that there was no bias in the data.

DISCUSSION

The descriptive analyses showed that communicative and problem behaviors were both evoked when instructions were presented and both resulted in the termination of instructions. This finding adds to existing literature on the functional equivalence of communicative and problem behaviors by showing that the two topographies of behavior may coexist in behavioral repertoires before introducing communicative behaviors.

The results of the brief experimental analysis showed that Mike’s signing/vocalizing and problem behavior were both primarily evoked under the same condition of high instructions to engage in a low preference task. Whereas the methodology used in this analog analysis is procedurally dissimilar to that previously reported (e.g., Carr & Durand, 1985; Iwata et al., 1982/1994), there is no reason to doubt the validity of the results. The critical components of the antecedent conditions were present, i.e., discriminative stimuli and establishing operations, with the independent variables in the experimental analysis conforming to the procedure thus demonstrating integrity.
Although previous studies have shown that the results of experimental and descriptive methods of analysis are not always in agreement (see Lerman & Iwata, 1993; Mace & Lalli, 1991), the results of this study indicated that both methods of analysis revealed the same maintaining variable. One possibility for the improved agreement between the methods may have been that both assessment methods were conducted in the same environment (i.e., the school setting). For example, in the Lerman and Iwata (1993) study, experimental assessments were conducted in the subjects’ day settings, whereas the descriptive assessments were conducted in the subjects’ residential homes. Although Lerman and Iwata (1993) found both methods to successfully distinguish between social versus nonsocial contingencies, the methods agreed on the specific maintaining variables for only one subject out of six. As Lerman and Iwata (1993) acknowledged, it is likely that the scheduling of events in the descriptive assessments may have approximated better to the experimental assessments if the descriptive assessments had been conducted in the subjects’ day setting. The finding from this study, therefore, supports the notion that descriptive assessments may be a useful adjunct to experimental methods under certain conditions.

In the conditional probability analysis, conditional probabilities were appraised by using a statistical measure of association. Thus the likelihood that a relevant variable may have been obscured by an irrelevant one was substantially reduced (see Iwata, Vollmer, & Zarcone 1990). However, a further problem not addressed by the conditional probability method was the identification of intermittent schedules of reinforcement. It was likely, for example, that the traditional conditional probability method used here may not have been sufficiently sensitive to detect the thin scheduling of events. For example, in the descriptive data, delivery of instructions also seemed to follow aggression during most of the 8 observation hr, suggesting that aggression was maintained on a thin intermittent schedule.

The plot presented in Figure 4 shows that the proportion of time Mike allocated to the different topographies of behavior that were maintained on concurrent schedules was related in a linear fashion to the proportion of reinforcement made contingent on each topography. This is in accordance with the matching law. It appeared, however, that there was some degree of under-matching in the data. Although the reasons for this deviation from the matching law cannot be deduced from this study, it is likely, however, that the problem behaviors were more aversive to
others than communicative behaviors and thus were more likely to comprise an establishing operation that evoked escape behavior. This interpretation is in accordance with the results of the studies by Carr et al., (1991), Taylor and Carr (1992), and Taylor and Romanczyk, (1994), which showed that teachers were less likely to present demands to children whose behavior was escape motivated. Figure 1 shows this relationship.

Finally, the results of this study have implications for the natural development of problem behavior in children with developmental disabilities and for interventions. It has been suggested elsewhere, that the mutual social reinforcement processes that maintain problem behavior, are in part driven by the aversive properties of problem behaviors, which are establishing operations for reinforcing responses by others (Oliver, 1995). It is these aversive properties that may ensure that problem behaviors are more efficient responses in a child’s behavioral repertoire than “normal” communicative behaviors by determining the relative ratios of reinforcement (see Horner & Day, 1991). If this is the case, it is important that further research delineates the relationship between naturally occurring reinforcing contingencies for problem and communicative behaviors. In addition, Figure 4 suggests that it is not necessary to extinguish problem behavior while providing reinforcement for communicative behavior. Increasing the rate of reinforcement for communicative behavior will have a positive effect even if problem behavior is reinforced at baseline levels.
REFERENCES


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Figure 1. Base rates of participant responses (upper panel) and teacher events (lower panel) in each observation hour.
Figure 2. Results of the "conditional-probability" analysis conducted on the descriptive data. Upper panel: Yule’s Q values for the conditional probability of aggression occurring antecedent to signing/vocalizing (left), occurring concurrently with signing/vocalizing (middle), and occurring consequent to signing/vocalizing (right). Middle panel: Yule’s Q values for the conditional probability of each teacher event occurring antecedent to aggression (left) occurring concurrently with aggression (middle), and occurring consequent to aggression (right). Lower panel: Yule’s Q values for the conditional probability of each teacher event occurring antecedent to signing/vocalizing (left), occurring concurrently with signing/vocalizing (middle), and occurring consequent to signing/vocalizing (right). Note: Signing/vocalizing did not occur in the last observation hour.
Figure 3. Results of the brief experimental assessment. (Upper panel) Percentage duration of aggression in each condition. (Lower panel) Percentage duration of signing/vocalizing in each experimental condition.
Figure 4. Relative proportion of responses allocated to problem behavior and signing/vocalizing plotted against the relative proportion of contingent reinforcements obtained for aggression and signing/vocalizing for each observation hour.
Figure 5. Base 10 logarithms of aggression/signing behavior ratios plotted against logarithms of aggression/signing reinforcer ratios for each observation hour. The line of best fit is also shown.