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AN APPLICATION OF THE MATCHING LAW TO SOCIAL DYNAMICS

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Using a procedure similar to the one described by Conger and Killeen (1974), we evaluated levels of attending for 25 college students who participated in either a 20-min ($n = 12$) or 30-min ($n = 13$) discussion on juvenile delinquency. Confederates delivered statements of agreement (e.g., "I agree with that point") according to independent variable-interval schedules. Pooled results were evaluated using three generalized formulations of the matching law, and showed that matching was more likely during the first 5 min of the discussion than during the last 5 min. Individual data for 7 of 9 participants were better described by the generalized response-rate matching equation than by the generalized time-allocation matching equation when response allocation was characterized in terms of frequency rather than duration.

DESCRIPTORS: choice, matching law, social dynamics, conversation, agreement, verbal behavior

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Response allocation under concurrent schedules of reinforcement has been the subject of appreciable basic and applied behavior-analytic research (Fisher & Mazur, 1997). This may be due in part to the ubiquitous nature of concurrent schedules in the natural environment. As suggested by McDowell (1988, 1989) and others, at any moment, organisms have the opportunity to engage in one of several concurrently available responses (e.g., read a newspaper, mow the lawn, or go for a run). Similarly, a pigeon may peck one of two concurrently available keys, or engage in grooming, and so on. Which one of two or more available alternatives is selected describes choice (Catania, 1998), and by observing choice and subsequent preference, we look next to the variables that control response allocation.

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Behavior-analytic research on choice has shown that there are a number of factors that may contribute to response allocation (e.g., reinforcer quality, reinforcer magnitude), perhaps the most widely studied of which is reinforcer rate. Given two concurrently available response alternatives (all other variables being equal), response allocation has been shown to be a function of relative reinforcer rates associated with each alternative. This frequently observed linear relation between relative response rate and relative reinforcer rate is known as the matching law, and was first described by Herrnstein (1961). Herrnstein assessed the responding of pigeons when key pecking was exposed to a series of concurrent variable-interval (VI) schedules. For example, one pair of schedules arranged reinforcers on the left key according to a VI 75-s schedule while reinforcers on the right key were arranged according to a VI 270-s schedule. Across all pairs of concurrent-schedule arrangements, relative response allocation occurred in linear relation to relative reinforcer rates, when the appropriate changeover delay was included as part of the procedure. These results were assessed in terms of the following equation:

$$\frac{R_1}{R_1 + R_2} = \frac{r_1}{r_1 + r_2}, \qquad (1)$$

where R_1 and R_2 represent the rate of responding to the left and right keys, respectively, and r_1 and r_2 represent the rate of reinforcement for responses to the left and right keys, respectively. Equation 1 is often referred to as the proportional matching equation or the strict matching equation.

Based on certain deviations from strict matching as described by Herrnstein (1961), Baum (1974) proposed what is now known as the generalized matching equation, or more formally,

$$\log\left(\frac{R_1}{R_2}\right) = s \log\left(\frac{r_1}{r_2}\right) + \log b, \qquad (2)$$

where R_1, R_2, r_1, and r_2 represent the same features of the environment described in Equation 1. The s parameter describes sensitivity (the slope), and the b parameter describes response bias (the intercept). The generalized matching equation takes into account performance sensitivity (s) given a one-unit change in the relative reinforcer ratio. For example, if an initial reinforcer ratio of 2:1 (e.g., VI 30 s VI 60 s; twice as much reinforcer availability on Response Alternative 1) were altered to a ratio of 3:1 (e.g., VI 30 s VI 90 s; three times as much reinforcer availability on Response Alternative 1), one would expect a concomitant one-unit change in relative response allocation. Although an s parameter equal to unity (or $\log 1 = 0$) occurs infrequently in the published literature, s values of less than 1 are the most frequently reported in the literature and are termed *undermatching* (a less than one-unit increase in relative response ratios given a one-unit increase in relative reinforcer ratios; e.g., Madden, Peden, & Yamaguchi, 2002). Measures of s that exceed 1 (e.g., Aparicio, 2001) are less frequently reported and are termed *overmatching* (a greater than one-unit change in relative response ratios given a one-unit change in relative reinforcer ratios). For example, in the study by Aparicio, overmatching was associated with increased response effort (e.g., climbing obstructions). The b parameter describes alterations in response allocation that are not accounted for by differences in relative reinforcer rates. In both nonhuman and human laboratories, bias may result from qualitatively different stimuli (e.g., food vs. water), differences in effort associated with the two response alternatives (e.g., difficult math problems vs. mastery level math problems), and seemingly immutable preferences for one alternative relative to the others (e.g., a strong preference for the color green; Baum; Neef, Shade, & Miller, 1994).

In some instances, behavior may be more appropriately captured in terms of its duration. For example, Baum and Rachlin (1969) assessed the behavior of pigeons in terms of time spent on one side or another of a modified operant chamber as a function of relative reinforcer rates. Baum and Rachlin assessed matching using the following equation:

$$\log\left(\frac{T_1}{T_2}\right) = s \log\left(\frac{r_1}{r_2}\right) + \log b, \qquad (3)$$

where T_1 and T_2 represent time allocated to Response Alternatives 1 and 2, respectively, and r_1 and r_2 are as described in Equations 1 and 2. In general, relative time allocation matched relative reinforcer rates; however, considerable bias was observed.

Oliver, Hall, and Nixon (1999) assessed the aggressive and communicative behavior exhibited by a young boy in terms of its duration as a function of the relative duration of reinforcer access associated with the two response alternatives (aggression and communication) using the following equation:

$$\log\left(\frac{T_1}{T_2}\right) = s \log\left(\frac{t_1}{t_2}\right) + \log b, \qquad (4)$$

where T_1 and T_2 are as described in Equation 3, and t_1 and t_2 represent duration of reinforcement associated with Response Alternatives 1 and 2, respectively. This seems to have been a particularly appropriate model because aggression was shown to be sensitive to negative reinforcement in the form of escape from instructional demands. It is likely that the duration of escape would be a more relevant reinforcement parameter than its rate. Also noteworthy is that the data used to assess the matching relation were gathered in the participant's natural classroom environment during interactions with his teacher. The results reported by Oliver et al. were consistent with matching and illustrated how the phenomenon could be modeled using parameters of reinforcement other than rate, as well as quantifications of behavior in terms other than rate.

Equation 1 and its proportional variations have been applied infrequently in more recent experimental research (relative to Equations 2, 3, and 4), in part because of the increased explanatory utility of the latter equations. Specifically, the generalized matching equations describe whether, and to what extent, behavior deviates from perfect matching. Further, the generalized equations describe potential sources of these deviations (e.g., bias to one alternative or insensitivity to reinforcer rates).

Although the response alternatives described by Herrnstein (1961) and Baum (1974) involved key pecks exhibited by pigeons, the work of Oliver et al. (1999) and Borrero and Vollmer (2002) have demonstrated that relative measures of communication and problem behavior exhibited by individuals with developmental disabilities can also be expressed in terms of the matching relation. Other applications of the matching law (see Davison & McCarthy, 1988, for an extensive review) have involved assessments of academic responding of individuals with and without developmental disabilities (Mace, McCurdy, & Quigley, 1990) and collegiate (Vollmer & Bourret, 2000) and professional (Reed, Critchfield, & Martens, 2006) sports performance. Thus, the matching law is not limited by conceptualizations of response alternatives (e.g., key pecks or communicative responses). Rather, the limits of the matching law remain a subject of ongoing behavior-analytic research.

Although there have been numerous demonstrations of the matching relation with nonhumans (responding for primary reinforcers), there have been considerably fewer studies involving humans and attention as reinforcement (e.g., Pierce & Epling, 1983). Like the key pecks of pigeons or the academic engagement of students, communicative exchanges during conversation (i.e., verbal behavior, Skinner, 1957) should also be amenable to evaluations of matching. In one such study Snyder and Patterson (1995) evaluated interactions between socially aggressive boys and their mothers as well as boys who were not socially aggressive and their mothers. The researchers accumulated 10 hr of interactions for each mother–child dyad and then conceptualized maternal termination of the conflicts as the reinforcer for selection of various tactics (e.g., positive verbal, negative verbal) adopted by their children. These data were then evaluated in terms of the matching relation; results suggested that the likelihood of a particular tactic was in part determined by the likelihood of reinforcement associated with each of those tactics, a conclusion consistent with the matching law.

In a similar study, Dishion, Spracklen, Andrews, and Patterson (1996) evaluated the interactions of adolescent boys while focusing on the content of these discussions (e.g., discussion of illegal behavior, discussions of family and school that did not involve inappropriate activities, termed rule breaking and normative, respectively) and the responses of the listener (e.g., laughing or pausing). Data for 181 dyads were assessed using Equation 1, and the researchers found that relative rates of rule breaking were well accounted for by relative rates of laughing. Stated differently, Dishion et al. suggested that the content of naturally occurring conversations between adolescents was a function of the extent to which listeners reinforced (laughed at) the conversation content.

The studies by Synder and Patterson (1995) and Dishion et al. (1996) are particularly important because they speak to the durability of the matching phenomenon (in terms of social dynamics) when reinforcer rates are not experimentally manipulated. However, these analyses involved between-groups comparisons; thus, conclusions regarding matching at the level of the individual cannot be discerned from these results. However, the extent to which adults differentially attend to, or engage with, others in social exchanges has also been evaluated when reinforcer rates were experimentally programmed (Beardsley & McDowell, 1992).

Conger and Killeen (1974) evaluated levels of attending for 5 college students who were invited to participate in a 30-min discussion. According to independently programmed concurrent VI schedules, confederates delivered statements of agreement (e.g., ''I agree with that point'') following a participant's comments. Data for the first and last 5 min of each session were then evaluated using a variation of Equation 1 (a classic iteration of the matching equation) and pooled for all participants. Results showed that during the relatively brief discussions, participants' relative response allocation (between each of the confederates) was well described by relative rates of agreement during the last 5 min of the session. During the first 5 min of the discussion, however, no linear relation was observed. These data seemed to support the notion that matching is a steady-state phenomenon (e.g., Baum, 1974) that requires some exposure to experimental contingencies before it occurs.

Pierce, Epling, and Greer (1981) extended the work described by Conger and Killeen (1974) by using Equations 2 and 3 (more contemporary models of the matching relation) and by conducting more extended experimental sessions. Using procedures similar to those of Conger and Killeen, the response allocation of 6 participants was assessed during seven 1-hr sessions. For 2 of 6 participants, matching was observed during the last 30 min of experimental sessions (coefficients of determination ranged from .45 to .69). Also noteworthy was the observation that 3 of 6 participants allocated relatively more verbal behavior and time to the confederate who provided relatively less agreement.

Taken together, the results reported by Conger and Killeen (1974) and Pierce et al. (1981) leave the matter of matching during communicative exchanges unresolved when data are evaluated at the level of the individual. The present study was designed to replicate the procedures reported by Conger and Killeen, and later by Pierce et al., by evaluating levels of attending, given concurrent schedules of agreement, for a larger sample of college students, using contemporary (Equations 2, 3, and 4) variations of the matching equation (McDowell, 2005).

METHOD

Participants and Setting

Participants were 25 undergraduate college students who were enrolled in a small private university and had completed no more than two college-level psychology courses. The mean age of participants was 20.2 years, and each had completed a mean of 3 years of college-level course work. Forty-eight percent of participants were female. Prior to the experimental session, participants were asked to sign an informed consent form (approved by the university institutional review board) in a room near the experimental session room. Participants were told that contingent on their consent, they would participate in a discussion to assess college students' understanding of the factors contributing to juvenile delinquency. Two confederates also completed the informed consent process. Next, participants were reminded that the discussion would be videotaped (also included in the informed consent form).

After the consent form was signed, an experimenter directed the participant and the two confederates into the session room. Sessions were conducted in a laboratory that measured approximately 5 m by 5 m. Materials included a desk, four chairs (one for the participant, one for each confederate, and one for a moderator responsible for evoking discussion), and posters on the walls (included to evoke discussion). Only 1 participant at a time was involved in a discussion session. The participant was strategically seated with his or her back to a one-way mirror, with each confederate seated approximately 1.5 m to either side of the participant. The moderator was seated directly across from the participant (approximately 1 m) and facilitated conversation (described in more detail below).

Response Measurement and Interobserver Agreement

Data were collected on comments made by the participants (any vocal responses in reference to the topic); attending, defined as eye contact between the participant and either confederate or the moderator; and orientation of the body toward either confederate or the moderator. Data were collected separately for attending to Confederate 1, Confederate 2, and the moderator. Data were also collected on statements of approval delivered by each confederate (e.g., "I think you are right"). Both frequency and duration data were collected on handheld computers for each of the aforementioned measures by both primary and secondary observers for 88% of all sessions. Duration of participant responses was scored given an instance of attending and ended the moment attending to either confederate or the moderator ceased. Agreement coefficients were calculated by dividing the smaller frequency (or duration in seconds) by the larger frequency (or duration in seconds) in each 10-s interval and multiplying by 100%. Mean agreement coefficients for all measures exceeded 80% (range, 81% to 94%).

Procedure and Data Analysis

While seated in the experimental setting, the moderator read the following instructions to the participants at the beginning of the discussion:

> Before this session begins, we ask that you do not disclose any personal information about yourself regarding any of the topics to be discussed. To further control for this, we also ask that all experiences shared be in third person such as "I know this person who …" This is to further insure your confidentiality. Thank you.

Participants were asked not to disclose any personal information regarding any of the topics to be discussed. After the instructions, the moderator began the experimental session with the question, "What do you think are some factors that influence juvenile delinquency?" or a similarly phrased question.

During the discussion, confederates emitted infrequent verbal responses that were not in response to a statement made by the participant. Given an extended lull in the conversation (e.g., 30 s), the moderator attempted to evoke discussion using the following list of discussion topics:

Factor 1: Drug and alcohol use
Factor 2: Peers and cliques
Factor 3: Quality of school system or school environment
Factor 4: Unfavorable home environment
Factor 5: Subculture participation

Confederates participated in the conversation (directed to the participant) (a) following a verbal response from a participant that (b) occurred after the VI interval associated with each confederate elapsed. Confederates were signaled by colored flashlights operated by experimenters on the opposite side of the one-way mirror. For example, Confederate 1 was signaled by a blue light, and Confederate 2 was signaled by a yellow light. The signal indicated that a VI schedule for one confederate had elapsed, and that a statement of agreement could be delivered after a participant's current or next response. The lights were not visible to the participant. It was possible to have a signal delivered at a time when the opportunity to deliver an agreeable statement was not available. For example, a VI interval might have elapsed during a period in which the participant was not talking. Thus, the confederate delayed delivery of an agreeable statement until a participant's next response. For this reason, programmed and obtained reinforcer rates were not identical. Confederates were instructed not to attend (look at, orient toward, or speak) to the participant under any other circumstances. Between reinforcer deliveries, the confederates either looked down, at each other, or at the moderator.

Statements of agreement were delivered according to independent VI schedules (i.e., VI 120 s VI 300 s for 20-min discussions, and VI 30 s VI 120 s for 30-min discussions). Distributions of the VI schedules were determined using the method described by Fleshler and Hoffman (1962). The fidelity with which confederates delivered statements of agreement was not assessed and cannot be discerned. Data were reported in either 5-min components or for the entire session. For the 20-min discussions, the confederate who initially delivered statements of agreement according to the VI 120-s schedule switched to the VI 300-s schedule after 10 min, and the confederate who initially delivered statements of agreement according to the VI 300-s schedule provided statements of agreement according to the VI 120-s schedule. During the 30-min sessions, confederates switched schedules after 10 min. At the conclusion of the session, the participant was debriefed and was awarded extra credit in a required seminar for his or her participation.

Data for all participants were then evaluated using Equations 2, 3, and 4. Data were expressed in several ways. First, data were pooled for all participants and plotted during the first 5 min of the discussion, during the last 5 min of the discussion, and during the entire 20- or 30-min discussion. Second, for participants who completed the 30-min discussion, we also evaluated response allocation in terms of Equations 2 and 3 in an attempt to determine whether duration of response allocation or rate of response allocation would be better described by relative rates of statements of agreement.

RESULTS

Figure 1 depicts the results of the matching analyses using Equations 2, 3, and 4. The left column depicts results of the analyses during the first 5 min of the discussion for all participants. The middle column depicts data according to each equation during the last 5 min of the discussion for all participants. The right column depicts data according to each equation during the entire 20- or 30-min discussion for all participants.

When evaluated as pooled data (across all participants) using Equation 2, results illustrate undermatching (i.e., $s < 1$), with no noteworthy b values. Results using Equations 3 and 4 also were generally similar, in that coefficients of determination were modest, but were larger in all cases during the first 5 min of the discussion than in the last 5 min. One analysis (Equation 3, from the first 5 min of the discussion) produced a slope greater than 1 and considerable bias ($b = -0.372$).

Figure 2 depicts data for 4 participants who completed the 30-min discussion, in 5-min intervals. Data for individuals who completed the 30-min discussion were selected for further analysis if there were at least five data points to evaluate (i.e., the numerator or denominator was nonzero for at least five 5-min intervals because the logarithm of zero is undefined). Data depicted in each row reflect analyses for individual participants. The left column depicts results according to Equation 2, and the right column depicts results according to Equation 3. Equations 2 and 3 were selected to compare the time-allocation and response-rate variations of the generalized matching equation during social interaction. For Participants 15, 18, 20, and 17, Equation 2 produced relatively larger s param-

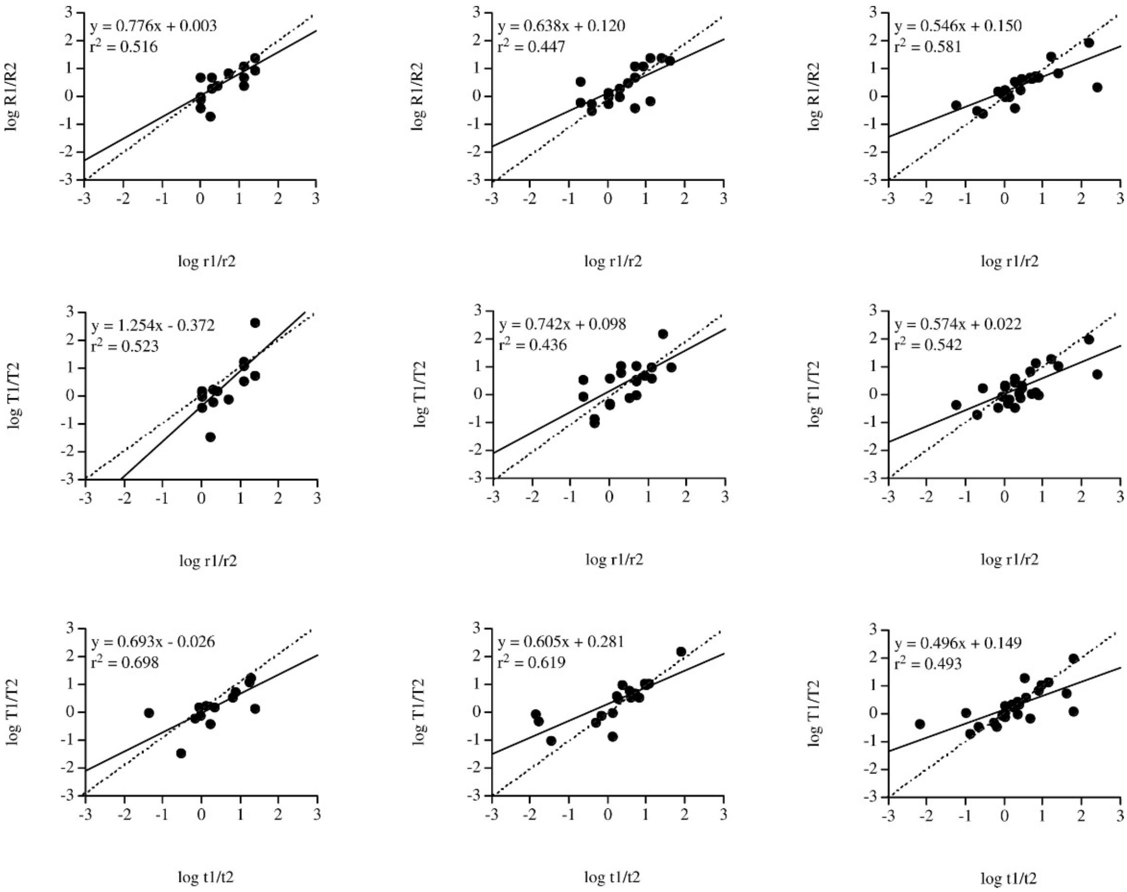

Figure 1. The left column depicts pooled data for all participants during the first 5 min of the discussion according to Equations 2, 3, and 4 (from top to bottom). The middle column depicts pooled data for all participants during the last 5 min of the discussion according to Equations 2, 3, and 4 (from top to bottom). The right column depicts pooled data for all participants during the entire 20- or 30-min discussion according to Equations 2, 3, and 4 (from top to bottom). Dashed diagonal lines represent perfect matching, and solid lines represent best fit lines.

eters (indicating that they were more sensitive to changes in relative reinforcer ratios when statements made by the participants were expressed in terms of relative rate of occurrence), smaller *b* parameters (indicating that factors not captured by relative reinforcer ratios had a negligible impact on relative response allocation), and larger coefficients of determination. Participants 20 and 17 produced perfect matching when expressed using Equation 2. Note that three data points for Participant 20 are plotted in coordinates (0, 0), and thus, only three data points are visible.

Figure 3 depicts results for the remaining 5 participants who completed the 30-min discussion, in 5-min intervals. Results are similar to those depicted in Figure 2, with two notable exceptions. First, Participants 26 and 27 exhibited considerable bias to one of the two confederates ($b = -0.648$, -0.560, and $b = 0.286$, 0.193, respectively, for Equations 2 and 3 and Participants 26 and 27). Based on the available data, we cannot determine why these 2 participants might have demonstrated such bias. Second, Participants 27 and 14 were the 2 participants for whom Equation 3 produced

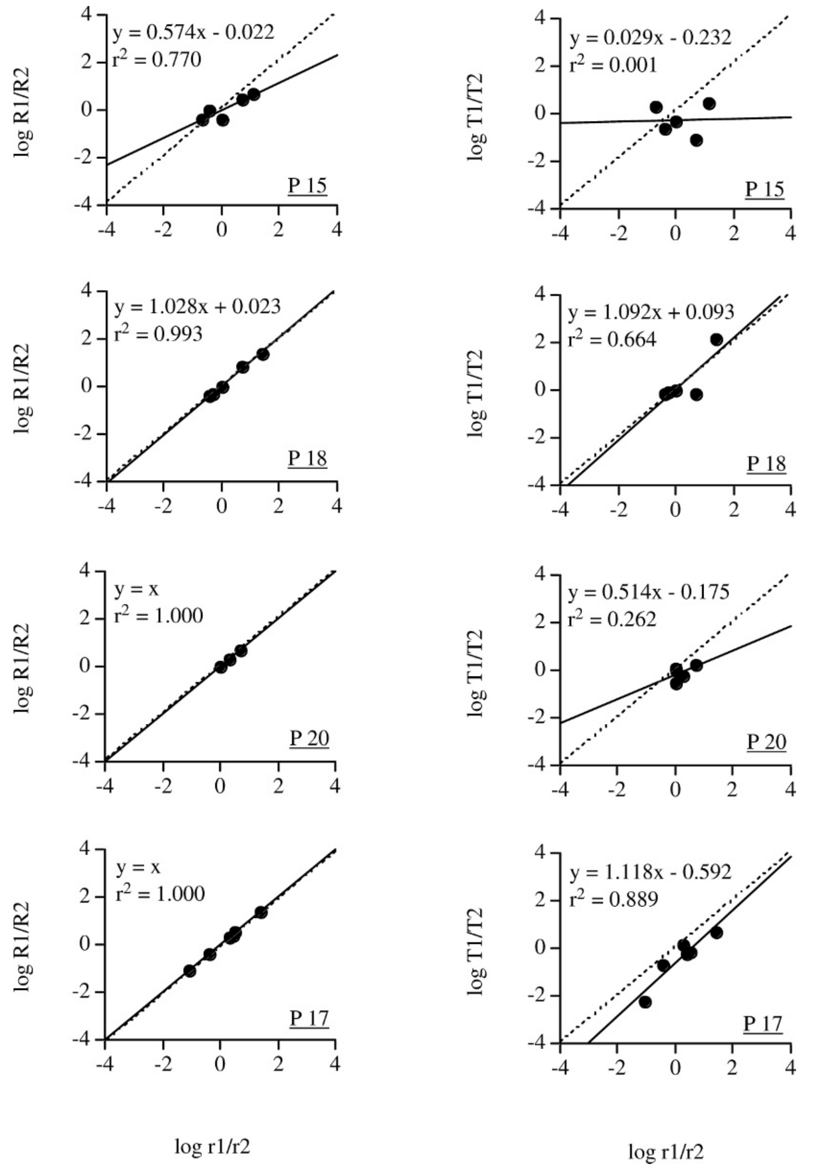

Figure 2. Data depicted according to Equations 2 and 3 for 4 participants whose data were selected for further analysis. All data are for participants who completed the 30-min discussion. Dashed diagonal lines represent perfect matching, and solid lines represent best fit lines.

larger coefficients of determination (relative to Equation 2); however, the difference observed for Participant 14 was rather small. For Participant 27, these differences may be better explained in terms of the spread in relative reinforcer ratios. That is, relative reinforcer ratios were highly concentrated such that evaluations of matching might be limited based on the limited range of relative reinforcer rates and not based on the model assessed.

For 7 of 9 participants who completed the 30-min discussion, Equation 2 provided a better account of response allocation than did Equation 3, suggesting that characterizations of response allocation in terms of relative rate or duration may influence summaries based on

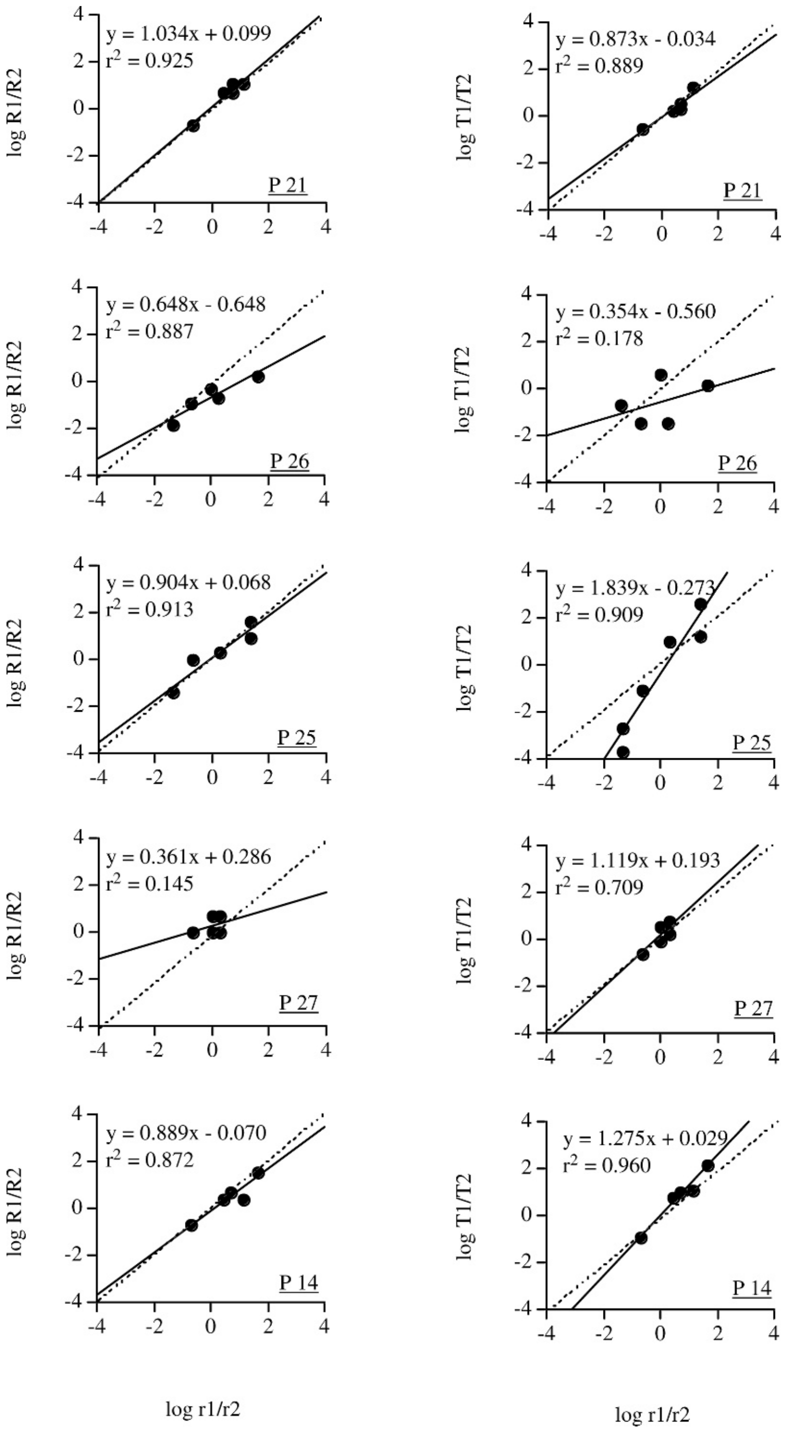

Figure 3. Data depicted according to Equations 2 and 3 for 5 participants whose data were selected for further analysis. All data are for participants who completed the 30-min discussion. Dashed diagonal lines represent perfect matching, and solid lines represent best fit lines.

relative reinforcer rates. In other words, not only is selection of an appropriate model important, but the way in which responding is characterized may also contribute to findings in support of the matching relation.

DISCUSSION

The matching relation was assessed during experimentally arranged conversations among college students. To extend the classic work of Conger and Killeen (1974) and Pierce et al. (1981), three iterations of the matching equation were assessed at the between-subjects level. Each equation was applied to capture relevant features of social dynamics (i.e., relative durations of response allocation, relative rates of response allocation, relative durations of agreement, and relative rates of agreement). At the between-subjects level, positive correlations between relative response allocation and relative reinforcer rates were obtained, despite the way in which behavior and statements of agreement were expressed. This general finding is consistent with those reported by Conger and Killeen. In addition to the between-subjects analyses, the matching relation was also assessed at the level of the individual, using Equations 2 and 3. These two models were selected to determine whether rate or duration of response allocation was better accounted for by relative rates of agreement. Results of these analyses were indicative of matching using one or both of the models for all participants. These results are also consistent with those reported by Pierce et al., although matching was observed for relatively more participants in the current investigation than in the study by Pierce et al.

The present findings also differ from those reported in prior work. For example, when data were pooled, Conger and Killeen (1974) found that closer approximations to matching were observed during the last 5 min of the 30-min discussion than in the first 5 min. Results of the present investigation found just the opposite (i.e., closer approximations to matching during the first 5 min than in the last 5 min of the discussion), suggesting that participants in the current investigation were immediately sensitive to reinforcer rates. As noted previously, Conger and Killeen applied a variation of Equation 1 (a proportional equation), which has been shown to be of less explanatory utility. Thus, if data reported by Conger and Killeen were reexpressed using generalized matching equations, the findings may not be commensurate. A second discrepancy lies in the rather low coefficients of determination obtained in the current study (at the between-subjects level) relative to those reported by Conger and Killeen. However, this discrepancy may not be unique to these two studies. Consider an experiment in which 13 pigeons respond on a pair of five VI schedules, during which each pair of VI schedules is presented for 5 min. If one were to assume stable responding and then select (at random) pairs of schedules and plot the data across subjects, low coefficients of determination would be expected. However, when those data are reexpressed at the level of the individual subject, considerably higher coefficients of determination would likely be obtained. Differences of this sort may even be expected given differences in terms of sensitivity and bias (as reflected in Figures 2 and 3). Therefore, although low coefficients of determination were obtained at the between-subjects level in the current investigation (which might be expected), improvements were observed at the level of the individual (which also might be expected).

It is also possible that the 20-min discussions in the current investigation did not allow sufficient time for participants' behavior to come under the control of the programmed schedules, and thus, influenced the utility of the equations in describing the pooled data. Matching is a steady-state phenomenon. In fact, analyses conducted for the 20-min participants and the 30-min participants separately showed that more of the variance was accounted for among 30-min participants (r^2 = .79) than 20-min participants (r^2 = .06) using Equation 2 (data not depicted). However, considerably fewer data points were available for comparison in the 20-min discussion; thus, this conclusion should be interpreted cautiously.

The present findings also differed from those reported by Pierce et al. (1981) in that positive correlations were observed for all 9 participants (using one or both models) whose data were assessed at the level of the individual, whereas Pierce et al. observed matching in only 2 of 6 cases. This apparent discrepancy may be the result of procedural differences and differences at the level of data analysis. Specifically, participants in the study by Pierce et al. were exposed to 7 hr of discussion, and data from the first and last 30 min of each discussion were aggregated. Discussions in the current investigation were considerably shorter (20 or 30 min), and the unit of analysis was considerably smaller in the present investigation (5 min vs. 30 min). With such a lengthy experiment (seven 1-hr discussions), participants may have become suspicious of the experimental procedure (reported for 1 participant in Pierce et al.), and as a result engaged in behavior that was antithetical to the matching relation (Sidman, 2000). Although possible, this represents nothing more than conjecture that can be addressed only by experimentation. If procedural differences were responsible for these findings, these discrepancies may be elucidated by employing similar procedures and may warrant future research.

The current investigation should be interpreted in light of at least three potential limitations. First, a single pair of VI schedules was evaluated. Current evaluations of the matching relation in the nonhuman experimental laboratory typically involve several pairs of schedules. Had a greater number of schedule parameters been evaluated, or schedule parameters that were either more or less disparate been evaluated, the results of the current investigation might have differed. Second, the integrity with which confederates delivered statements of agreement cannot be extracted from the data. It is possible that poor integrity might have influenced these results, however, confederates received extensive training in mock sessions before initiating the experiment. Finally, programmed rates of reinforcement were not equivalent to obtained rates. As noted by Baum (1974) and others (e.g., Herrnstein, 1970), the matching law applies only to obtained reinforcement. However, this was in part a result of the procedure. Rather than interrupting a participant's comment, confederates waited until the participant completed a comment. This sometimes delayed the availability of the next reinforcer on the same schedule. Similarly, reinforcer availability occurred independent of the participant's comments. Therefore, the absence of responding also drove down the rate of obtained statements of agreement.

Naturally occurring interactions may be under multiple sources of control. Although responding was well described by relative reinforcer rates in the current study (at the level of the individual), future research may assess relative measures of response allocation using concatenated versions of the matching law. For example, it may be the case that individuals allocate their responding in better accordance with the matching law when magnitude (duration) of agreement and rate are assessed. Similarly, qualitative aspects of agreeable statements may also exert control over response allocation. In the present experiment, confederates were specifically instructed to provide approximately equivalent forms of agreement; however, this is clearly not how reinforcers are distributed during social interactions in everyday conversation. Concatenated equations of this sort have been applied to the behavior of nonhumans (e.g., Miller, 1976) and humans (e.g., Vollmer & Bourret, 2000), and may affect evaluations of matching during complex social interactions.

Statements of agreement are also not the only type of response encountered during typical conversational exchanges. In some instances, the content of verbal behavior may be punished, producing either a decrease in the specific source of content, a decrease in the overall level of communicative exchanges, or both. Future research may assess relative response allocation when concurrently available alternatives are associated with asymmetrical outcomes. For example, using procedures similar to those in the current study, one confederate might emit what are procedurally punitive responses while another delivers what are procedurally reinforcing responses (like those delivered in the present study), followed by a switch in associated outcomes. One might expect to see differences based on the specific models evaluated in such an arrangement. For example, punitive statements may result in greater durations of engagement directed toward the source of the statement but a decrease in the relative rate of those interactions.

Some implications for a variety of applied social contexts may also be extracted from the present experiment. First, unacceptably low (or high) levels of classroom participation may be easily altered based on programmed schedules of agreement or teacher approval. For example, relatively dense rates of teacher approval may be arranged for students exhibiting relatively low levels of vocal participation (and vice versa). Similarly, the relentless and repetitious verbal behavior (e.g., speaking without permission) of young school-aged children might be assessed under nonexperimental conditions (e.g., Borrero & Vollmer, 2002) and then subsequently evaluated experimentally (using schedule values derived from descriptive observations). Although a matching analysis may not be necessary to draw this conclusion, it does provide a parsimonious account of the variables that control behavior, and may provide a more quantitative description of sensitivity to concurrent-schedules arrangements than those offered in other disciplines (e.g., developmental and stage theorists). Second, and related to the prior point, results of the current study and those reported by Conger and Killeen (1974) illustrate that changes in attending can be observed in a relatively short period of time at the level of the individual. Thus, if the initially low participatory behavior of 1 student quickly becomes unacceptably high, changes in levels of participation can be controlled just as easily. As suggested previously, this (e.g., comparisons of behavioral sensitivity both within and across students of various ages) might allow behavioral research on what are commonly areas of child developmental research.

These results add to the generality of the matching law and were based on the social interactions of adults. These findings reiterate the contention that verbal behavior is subject to the contingencies of reinforcement that are also responsible for nonverbal behavior. However, as noted by Skinner (1957), verbal behavior is frequently a function of more than one variable. The present experiment was designed to assess the frequency and duration of verbal behavior based on known parameters of reinforcement, using a durable model of behavior (the matching law). There remain, however, multiple factors that may contribute to relative response allocation in social dynamics, all of which can benefit from additional research.

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