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Evaluating the Operative Mechanisms Underlying the High-Probability Request Sequence

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EVALUATING THE OPERATIVE MECHANISMS UNDERLYING THE HIGH-PROBABILITY REQUEST SEQUENCE

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Failure to comply with requests in educational settings interferes with the learning process. The high-probability request sequence has been demonstrated to be an effective treatment for noncompliance. However, the operative mechanisms underlying this treatment remain unknown. This study sought to further elucidate high-p behavior change mechanisms through the manipulation of reinforcement and response rate variables. The purpose was to determine whether increases in compliance to low-probability requests could be obtained with either the high-p sequence or with the delivery of preferred stimuli on a response-independent basis. Math problems served as high-p and low-p requests, and data were collected on compliance to requests for three children attending an after-school day care. Results of an alternating treatment design showed that increases in low-p compliance occurred following implementation of two of the three treatment conditions. These findings extend previous research on the high-p sequence by demonstrating that it was as effective to provide preferred stimuli on a response-independent basis prior to issuing a low-p request as it was to assess, verify, and deliver a series of high-p requests in order to achieve compliance gains.

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Introduction

Failure to comply with requests in educational settings interferes with the learning process. As a result, the development and validation of interventions to increase compliance to instructional requests has been the focus of much behavior analytic research. Some researchers (e.g., Davis, Brady, Williams, & Hamilton, 1992) have pointed out that the foundation of instructional interaction depends on responding to instructions or requests. Indeed, learning opportunities may be compromised when an individual engages in noncompliant behavior. Failure to respond not only makes learning difficult for the learner (Davis et al., 1992), but may also decrease the future frequency of instruction-based teacher-student interactions (Carr, Taylor, & Robinson, 1991). Instructional demands in learning environments have been identified as a common antecedent variable that evokes a range of disruptive behaviors such as aggression, self-injury, and tantrums (Karsh, Repp, Dahlquist, & Munk, 1995). Subsequently, the teacher's attempt to interact with a student in an instructional way is discouraged by student noncompliance and may be punished by the inappropriate behavior that may covary with noncompliant behavior (Carr & Durand, 1985; Carr, Newsom, & Binkoff, 1976).

The prevalence of noncompliance as a behavior problem has been amply documented (e.g., Forehand & McMahon, 1981; Schoen, 1983). "Although there are no large-scale data on the failure of students to follow instructions, it is a very common problem among both children with and without disabilities" (Karsh et al., 1995, p. 189). Some researchers have noted that the most frequent parental complaint among clinic-referred children is noncompliance (Barkley, 1981; Bernal, Klinnert, & Schultz, 1980). Further, one study found that 87% of individuals with disabilities referred to a residential setting for treatment displayed noncompliance as a target behavior (Fidura, Lindsey, & Walker, 1987). Additionally, what is sometimes referred to as oppositional defiant disorder (American Psychiatric Association, 1999) includes noncompliance as one of its defining features. High levels of oppositional behavior and low levels of compliance may preclude some children from learning more adaptive prosocial behaviors (Sanders & Dadds, 1993).

In short, there is adequate research to suggest that noncompliance is a common problem among both diagnosed and non-diagnosed children. Depending on the frequency of noncompliance and the intensity of correlated problem behaviors, noncompliance may have serious ramifications for the person engaging in noncompliant behavior and those in his or her environment that are directly or indirectly affected by this problem behavior (Brady, McDougall, & Dennis, 1989). As a result, the development of efficacious treatment procedures for noncompliance is a worthy area of investigation.

A large amount of research has evaluated interventions for increasing compliance and, in some cases, for reducing compliance latency and/or task completion duration. Most intervention packages rely on a combination of reinforcement for compliant behavior and the delivery of some form of punishment for noncompliant or disruptive behavior. Two of the more commonly used consequences for noncompliance are time out and guided compliance.

Time out involves the temporary removal of a person from a more reinforcing to a less reinforcing environment contingent upon noncompliant behavior (e.g., Forehand & McMahon, 1981). Guided compliance requires that the person be physically guided through the requested behavior sequence as a consequence for noncompliance. In many cases, the instructional request is issued again with the physical guidance procedure repeated one or more times until such time that the person independently engages in the designated behavior (e.g., Whitman, Zarkaras, & Chardos, 1971). However, both physical guidance and time-out are limited in their usefulness as they may involve physical manipulation of a person in order to achieve treatment integrity, which may be contraindicated for aggressive or otherwise resistant clients (Roberts, 1982, 1984).

In recent years, an alternative to interventions based on punitive consequences for noncompliance (e.g., time-out and guided compliance) has been developed and reported in the literature. Specifically, a procedure commonly referred to as the high-probability (high-p) request sequence has emerged as a promising treatment for noncompliance. Developed by Mace et al. (1988), the high-p intervention involves the delivery of a sequence of 3 to 5 requests to which a person complies with a high relative frequency (referred to as a high-probability or high-p sequence) followed immediately by a low-probability (low-p) request (typically the target behavior based on a history of low-probability compliance). Working with adults with developmental delays, Mace et al. (1988) demonstrated that compliance with low-p requests that were preceded by a high-p sequence produced significantly higher levels of compliance than low p requests that were not preceded by a high p sequence.

A sizeable number of subsequent studies have replicated and extended these initial findings. That is, the intervention has been applied successfully with different populations (e.g., typically developing children, children and adults with developmental disabilities) (Ardoin, Martens, & Wolfe, 1999; Davis, Brady, Hamilton, McEvoy, & Williams, 1994; Mace et al., 1988) and in a variety of settings (e.g., group home, school) (Davis et al., 1994; Davis et al., 1992; Davis, Reichle, & Southard, 1998; Ducharme & Worling, 1994). Further, the high-p treatment has been shown to: increase compliance in a self-medication routine (Harchik & Putzier, 1990); produce increases in compliance to action-based commands with concurrent reductions in disruptive stereotypy and aggressive behavior (Horner et al., 1991; Singer, Singer, & Horner, 1987); promote generalized compliance with multiple trainers (Davis et al., 1992); increase social interaction (Davis et al., 1994); increase social initiations of students with emotional/behavioral disorders (Davis & Reichle, 1996); increase sign use (Sanchez-Fort, Brady, & Davis, 1995); increase conversational skills in augmentative system users (Davis, Reichle, & Southard, 1998), and increase student compliance during transitions (Ardoin et al., 1999). Among the people who have implemented high-p request sequences are school employees (Ardoin, et al., 1999; Davis et al., 1992; Singer et al., 1987), peers (Davis & Reichle, 1996), group-home staff (Horner et al., 1991; Mace et al., 1988), parents, and grandparents (Davis et al., 1996; Ducharme & Worling, 1994).

In recent years, research on the high-p procedure has been extended to include academic tasks. For example, Belfiore, Lee, Vargas, and Skinner (1997) determined that single-digit multiplication problems were high-p tasks relative to multiple-digit multiplication problems (low-p tasks) for two students who had been expelled from regular school for academic and social noncompliance. They then demonstrated that adding a sequence of three high-p math problems prior to the presentation of a low-p math problem decreased latency to initiate the more challenging problems when compared to baseline levels of latency between problems for both students.

Belfiore and colleagues (1997) extended high-p research in that they (a) used a form of academic behavior as the topographical variable under study because the first step to academic engagement with academic stimuli is initiation; (b) used functional paper-pencil tasks as the high-p sequence as opposed to arbitrary action-based responses, which are more common in high-p applications (e.g., "Touch your nose"), and (3) relied on problem completion, not on contingent verbal praise as the consequence as many academic settings do not permit one-on-one attention.

In a follow up study, Hutchinson and Belfiore (1998) demonstrated that a sequence of preferred arithmetic tasks (high-p math problems) improved the rate and accuracy of digits completed on a less preferred academic task (low-p math problems). The demonstration of this effect with elementary students with a history of noncompliance and lack of persistence on academic tasks suggests the potential educational value of the high-p intervention. Similar effects of high-p academic tasks on completion and accuracy of subsequent low-p academic tasks have been reported by other researchers (e.g., Belfiore, Lee, Scheeler, & Klein, 2002; Wehby & Hollahan, 2000).

One limitation to the above studies, however, is that the use of problem completion by Belfiore and colleagues (1997) does not make clear the mechanism that is responsible for decrements in their dependent measures. That is, in the absence of social reinforcement for compliance, latency may have decreased as a function of either positive reinforcement in the form of problem completion, or negative reinforcement in the form of a covert verbal statement such as, “one less problem to go.”

Given the potential robustness of the high-p sequence several groups of researchers have examined some of the variables and underlying processes that may contribute to the procedure's effectiveness (Davis et al., 1992; Davis & Reichle, 1996; Ducharme & Worling, 1994; Mace et al., 1997). For example, variations of the high-p procedure have included the use of short (5 s) (high-p to low-p) interprompt intervals, which have been shown to be more effective than longer (20 s) intervals (Houlihan et al., 1994; Mace et al., 1988). The effectiveness of the treatment also appears to increase as the number of high-p instructions increases from 2 to 4 high-p instructions (Eckert, Boyajian, & Mace, 1995). In addition, Davis and Reichle (1996) compared the effects of variant (i.e., random order of presentation) versus invariant (i.e., constant order of presentation) high-p request sequences on requests to initiate social interactions by children with emotional-behavioral disorders. The delivery of variant high-p sequences was more effective in producing increases in compliance to requests. Ducharme and Worling (1994) further increased the procedure's clinical utility by demonstrating that the high-p request sequence could be gradually withdrawn (faded) without observing a decrement in compliance gains.

In spite of the successfulness of the above high-p applications, treatment failures have been reported (e.g., Zarcone, Iwata, Mazaleski, & Smith, 1994). Inspired by this, Mace et al. (1997) later demonstrated that the provision of higher quality reinforcers for the high-p request sequence seemed to produce higher levels of compliance than lower quality reinforcers for the high-p sequence.

Although the high-p treatment has been demonstrated to be an effective treatment for noncompliance, the mechanisms underlying its effectiveness remain unknown. In the high-p intervention a sequence of three to five high-probability behaviors are requested. If we assume that the high probability behaviors produce reinforcement either in the form of programmed social or contrived consequences or in the form of stimulus changes inherent in the response (e.g., sensory stimuli or problem completion), then performance of the high-p response sequence produces a relatively high rate of reinforcement prior to the presentation of the low-p response. The assumption that the high-p responses are producing some form of reinforcement seems plausible otherwise there would be no reason for the responses to be high-probability unless they were producing reinforcing consequences. The high-p response also produces a high rate of compliance immediately prior to the presentation of the opportunity to perform the low-p response. Some have argued that the sequence of several compliant responses (to the high-p requests) creates behavioral persistence, sometimes referred to as "behavioral momentum" analogous to physical momentum that carries over to and increases compliance to the low-p request (see Nevin, 1996 for a more complete description of the theory of behavioral momentum).

The above analysis suggests that behavioral mechanisms accounting for the effects of high-p sequences may be difficult to isolate because of a confound between a high rate of reinforcement (the reinforcers associated with the high-p requests) and a high rate of compliant responding (compliance with a series of high-p requests). This issue is both conceptual and applied in nature. That is, conceptual to the extent that it poses the question, if behavioral persistence can be produced by delivering a high rate of reinforcement in the presence of a given stimulus, this could be accomplished by delivering response-independent reinforcers. The goal of the study herein is to determine if a schedule of noncontingent reinforcement (creating a more favorable environment) would be sufficient to obtain compliance to a low-p target command and to compare the effects of this intervention to that of the high-p treatment.

This is a particularly important issue from an applied perspective. That is, it may be easier to deliver preferred stimuli on a response-independent schedule than it is to identify and deliver an entire sequence of high-p response requests. Therefore, the present study seeks to further elucidate high-p behavior change mechanisms through the manipulation of reinforcement and response rate variables. The specific aim is to determine whether increases in compliance to low-p requests can be obtained with either the high-p sequence or with the delivery of preferred stimuli. The following proposed arrangement involves a fixed-time based schedule of reinforcement whereby arbitrary reinforcing stimuli are being correlated with that particular stimulus condition, which will be compared to the high-p application wherein reinforcement is contingent on compliance. This arrangement may permit us to separate the effects of establishing a high-rate of reinforcement from the effects of generating a high rate of behavior in order to evaluate the primary mechanism(s) contributing to the treatment effect(s).

Method

Participants

Three typically developing males, Jason, Alex, and Kevin (not their real names), ages 10, 10, and 11, respectively, participated in this experiment. All three children were nominated by their after school classroom teacher for help with following instructions to engage in academic tasks. In a pretest, all three participants demonstrated the ability to perform the math problems used in this study. Consent of parents and assent of children were obtained prior to the experiment (see Appendix B), and the following criteria for inclusion were met: (1) all children were screened for three or more requests with which they showed low levels of compliance (a relative frequency of compliance at 50% or less); (2) a pool of high-p requests for which they showed a level of compliance at or above 90% was identified; and (3) a small variety of preferred stimulus items for use during the experimental phases were identified.

Setting

All experimental sessions took place in a classroom at an after-school day care program that was adjacent to their regular school, and attended by all of the participants. Experimental sessions were conducted in a section of the classroom that contained a table and chairs and was separated from the main classroom by two low book cases. An experimenter and one observer were present during sessions.

Apparatus / materials

The experimenter collected data on the dependent and independent variables using paper and pencil, and arithmetic worksheets or 3 x 5 index cards (see description of use below) that contained written answers from the participants. The experimental space was equipped with furniture (e.g., table and chairs), instructional materials relevant to each child's academic curricula, and distracter items (i.e., toys), for use during baseline and experimental phases. The purpose of having the distracter items available to the participants during sessions was to more closely approximate a naturalistic setting wherein alternative and/or competing stimuli and responses – other than compliance to requests – are available to the learner. Specific materials included those that were unique to each child's high-p and low-p requests. Instructional stimuli that were presented consisted of math worksheets (high-p/low-p assessment) or 3x5 problem (index) cards (baseline/experimental conditions) containing math problems (e.g., 745 x 794, 7 x 4) similar to that used in prior research (Belfiore et al., 1997). The tokens used during experimental sessions were obtained from a local restaurant that had video-game and token purchasing machines.

Dependent Variable

Response Definitions

Compliance was defined as the initiation of a task within 5 seconds (s) (Shriver & Allen, 1997) of an experimenter's request and full task completion within 60 s. Initiation was defined as the motoric response of lifting the pencil, pointing it towards the problem card, and then contacting the card with the pencil. Task completion was defined as initiation of the response and correct completion of the problem. The primary dependent variable of interest was the percentage of compliance to low-p requests, although the percentage of compliance to high-p requests was also monitored. Because there are two requirements (initiation and completion) to meet the definition of compliance, and because initiation of task requests is also an important part of a learner's repertoire, both initiation compliance and completion compliance were independently scored. Low-p requests were those requests that resulted in less than 50% completion compliance for a particular child as determined by an assessment of such requests prior to the baseline phase. High-p requests were defined as those requests that resulted in compliance at least 90% of the time for a particular child as determined by the same pre-baseline assessment.

High-p and Low-p Assessment

Prior to baseline data collection, an assessment of high-p and low-p requests was conducted. The experimenter generated an initial list that consisted of a minimum of five low-p requests by: (1) asking school staff who work with the children for their opinion; (2) making informal observations; (3) by reviewing each child's current mathematic curriculum; and (4) by ruling out requests for which lack of compliance was due to a skill deficit. The low-p status of each request was then verified by occasioning 5-10 opportunities to complete a low-p request worksheet via a forced-choice procedure. That is, similar to the procedures used in Belfiore et al. (1997, 2002) nominated children were given a choice to complete one of two academic tasks within a specific area of study (e.g., sheet of single-digit multiplication or addition problems or a sheet of multiple-digit multiplication or addition problems) in order to determine each child's preference regarding a particular set of problems. This forced-choice procedure was the basis for forming the pool of high-probability and low-probability requests. Based on completion compliance those requests for which the child failed to respond less than 50% of the time constituted the pool of low-p math problems used during all phases of the study. Procedures for identifying high-p requests were identical to those for the low-p requests with the criterion for selection as a high-p math problem being a 90% or higher response rate. During this phase, there were no programmed consequences for compliance or noncompliance.

A pool of potential math problems was developed using a table of random numbers omitting the numerals 0, 1, and 2 to better control the difficulty level of the task (see Belfiore, et al., 1997). The total number of digits required to complete each worksheet was equated so that worksheet preference was a function of digit configuration (e.g., single versus multiple-digit multiplication problems), rather than the number of digits to complete the worksheet.

Assessment procedures. The experimenter placed one single-digit and one multiple-digit worksheet on a table in front of each student, and asked them to select one worksheet and complete all of the problems. It should be noted that for the first trial of the forced-choice assessment students were asked to complete both worksheets, and then place an "X" on the one they preferred (e.g., Hutchinson & Belfiore, 1998). This was done in part to confirm (again) that lack of preference was not due to students being unable to complete the problems and to verify that participants had sampled each response option prior to making a choice. The location (left/right) of the single-digit worksheets as they were placed in front of the participants was counterbalanced across trials. There were three forced-choice assessment sessions conducted each day over a three-day period for a total of nine trials. A 5-min intertrial interval was maintained between trials. These assessment units were then used during the intervention phases of the study, wherein participants were given a series of highly preferred academic tasks prior to the presentation of a less-preferred task. Problem cards (on 3x5 index cards), each containing either one high-p or one low-p problem per card, were developed using information obtained from the forced-choice assessment for use during baseline and experimental sessions.

Data Collection

The experimenter collected data on the dependent and independent variables using paper and pencil. During the high-p / low-p forced-choice assessment procedure, the experimenter marked the math worksheets (see Appendix C) either "preferred" or "non-preferred" on the basis of learner selection. During baseline and experimental sessions, the experimenter and an observer collected data on the dependent variables from 3x5 index cards that contained the participants' written answers (given they wrote anything).

Data collectors were trained undergraduate and graduate students. Training was accomplished by (1) reading a description of the recording procedures to the observer, (2) having the observer practice recording data in a role-play situation with the experimenter and (3) by receiving performance feedback. Interobserver agreement and procedural integrity data were collected using checklists during each of three 5-10 minute sessions per day an average of three days per week. Inducements arranged for observers included academic credit or a letter of recommendation for school or work.

Interobserver agreement. Agreement was assessed on 33% of intervention sessions. An agreement was calculated for responses to high-p and low-p requests by dividing the number of agreements by the number of agreements plus disagreements and multiplying by 100. An agreement was scored if both observers scored a response as occurring or as not occurring and as correct or incorrect for any given problem. That is, both had to agree that a response had been emitted via a number written under the problem in the answer space, and also had to agree that any and all digits written as an answer were indeed correct. Agreement data were calculated for dependent variables under each of the experimental conditions for all participants, and yielded agreements of 100%. Appendix D provides a sample checklist that was used by a second observer to score both Interobserver agreement and procedural integrity data.

<u>Preference for experimental conditions.</u> Participants' preferences for the various interventions were evaluated as a measure of social validity. Some researchers have shown that consumers of behavioral interventions can choose among treatment alternatives designed to decrease problem behavior (e.g., Hanley, Piazza, Fisher, Contrucci, & Maglieri, 1997). Hanley et al. (1997) showed that individuals with developmental disabilities could participate in the treatment selection process, which is an important part of balancing an individual's need for treatment with their right to choose (Bannerman, Sheldon, Sherman, & Harchik, 1990). In this case, typically developing children were simply asked which treatment they preferred. That is, per the treatment protocol, 5 trials (each consisting of one high-p series / low-p request set) were implemented under each experimental condition, and then the participants were asked to partake in one extra trial in the condition of their choice. Specifically, following the three experimental sessions on the last 8 days of data collection, the experimenter told the participants, "Now I am going to give you one more multiple-digit problem to do, but you can choose whether you are in the 'red,' 'yellow,' or 'blue' condition. Tell me which one you choose today?" The participants then verbally indicated

(or in some cases, physically manipulated the colored poster board themselves as an indicator of preference) which condition was chosen to provide the context for the extra trial. It was hoped that this would provide meaningful information as to the social acceptability of the interventions.

General Procedures

During all phases and prior to formal data collection, participants received general instructions from the experimenter that indicated the beginning of a session. A brief instruction was issued to each participant, such as, "Please come with me to the table." When the experimenter received the child's assent, the dyad sat down at the table, and a statement describing the particular condition e.g., "We are in the blue (or red or yellow) condition," was made by the experimenter in order to enhance discrimination between the experimental conditions. During all experimental sessions, the procedure for delivering requests was identical. That is, at the start of each trial, the experimenter sat within 1 meter (m) of the participant, established attending behavior (i.e., eye contact), and then issued a request in a neutral tone of voice. Subsequent to baseline observations, the intervention phase began at which point three different interventions were compared. All three interventions were implemented each day of observations. Intervention conditions were implemented an equal number of times across each of the sessions of administration. Each session involved delivering 5 low-p requests, each one written on a 3x5 index card, which had space for the participants to record their responses. This procedure lasted approximately 5-8 minutes. Though sessions were to be terminated in the event that a participant exhibited excess behavior that may have been harmful to himself or to the observer or refused to continue participating in trials, these criteria were actually never met.

Experimental Design and Conditions

Baseline. During baseline, each participant was asked to complete a series of five low-p problem cards. The experimenter made the following statement: "I am going to give you five problems to complete, one at a time. I will tell you when you can begin each problem." Table 1 shows the pool of multiple-digit math problems identified during the forced-choice preference assessment from which the experimenter randomly selected low-p requests. The experimenter issued requests on a variable-interval 60-second (VI 60 s) schedule. When/if the participant's response met the definition of compliance, the experimenter delivered verbal praise (i.e., "Good job – you got it right!). There were no programmed consequences for noncompliance. That is, noncompliance was followed by an intertrial interval of 30 s during which time the experimenter looked away from the participant and avoided eye contact. When this interval was up, the next low-p request was delivered. Sessions were terminated after 5 low-p requests had been issued.

Reinforcer administration. During the experimental phase, all children received tokens either contingent on compliance to high-p and low-p requests, or independent of their responding (when dictated by a particular condition's protocol). The tokens were later exchanged for various edibles, materials, and activities that the participants reported were of their current interest. This exchange of tokens occurred following daily sessions. Specific items selected for

Table 1

Low-Probability Requests

Kevin	Jason	Alex
876 x 985	756849 395867 + 475569	756849 395867 + 475569
836 x 546	867954 379485 + 836957	867954 379485 + 836957
345 x 583	867954 636799 + 495867	867954 636799 + 495867
485 x 793	459768 997636 + 768594	459768 997636 + 768594
837 x 583	958673 647398 + 998346	958673 647398 + 998346
678 x 958	567453 867954 + 836957	567453 867954 + 836957
498 x 387	998346 475569 + 756849	998346 475569 + 756849
584 x 397	647398 567453 + 836957	647398 567453 + 836957
985 x 876	998346 636799 + 395867	998346 636799 + 395867

Table 1 Continued

745 x 794	756849 647398 + 475569	756849 647398 + 475569
745 x 836	567453 495867 + 958673	567453 495867 + 958673
547 x 638	379485 958673 + 395867	379485 958673 + 395867
738 x 385	643899 965574 + 948656	643899 965574 + 948656
876 x 859	893746 354765 + 759638	893746 354765 + 759638
894 x 783	584973 376859 + 768593	584973 376859 + 768593
	379485 495867 + 636799	379485 495867 + 636799

back-ups were based on verbal statements made by the participants, and varied accordingly on a session-by-session basis (see Appendix E). Following baseline data collection, three interventions were implemented using a multi-element design.

High-probability request sequence. In the high-probability request sequence (HPR) condition (red condition), procedures were identical to those used during baseline, with the exception that each low-p problem was preceded by a series of three high-p problems, delivered in rapid succession (i.e., within 5 s of one another). High-p requests were randomly selected from a pool of 15-16 requests (see Table 2) identified during the forced-choice assessment. As in Belfiore et al. (1997; 2002) there were no contrived reinforcers for high-p compliance. In other words, problem completion (or lack thereof) was presumably the only immediate consequence for high-p responding. Following three consecutive successful responses to a high-p request, a low-p request was delivered within 5 s of the participant's response to the last high-p request in the series. As in baseline, low-p compliance was followed by verbal praise. If a participant did not respond to a high-p request, the experimenter continued to deliver high-p requests until three consecutive responses were obtained (e.g., Mace & Belfiore, 1990). However, if a participant failed to comply with more than two consecutive high-p requests, the trial was terminated and the next one initiated within 5 s. A high-p request was to be permanently dropped from the pool when compliance to any such request fell below 80%. However, this never happened during the course of the experiment, nor were any trials terminated due to high-p noncompliance. In order to maintain the defining features of successful high-p sequences (Davis & Reichle, 1996), high and low-p requests were randomly selected for each trial to produce a variant request sequence.

High-p request sequence plus token feedback. In the high-p request sequence plus token reinforcement (HPR-Tokens) condition (yellow condition),

Table 2

High-Probability Requests

Kevin	Jason	Alex
9 x 5	6 + 6	6 + 6
4 x 5	7 + 7	7 + 7
7 x 6	9 + 9	9 + 9
3 x 9	3 + 4	3 + 4
8 x 6	3 + 5	3 + 5
3 x 8	9 + 7	9 + 7
9 x 6	3 + 6	3 + 6
3 x 7	8 + 7	8 + 7
8 x 7	9 + 6	9 + 6
3 x 6	3 + 8	3 + 8
9 x 7	8 + 6	8 + 6
3 x 5	3 + 9	3 + 9
9 x 8	4 + 5	4 + 5

Table 2 Continued

3 x 4	9 + 5	9 + 5
9 x 9	4 + 6	4 + 6
7 x 7	8 + 5	8 + 5
6 x 6	4 + 8	4 + 8
4 x 6	8 + 8	8 + 8
8 x 5	4 + 4	4 + 4
4 x 7	6 + 9	6 + 9
7 x 5	5 + 3	5 + 3
4 x 8	7 + 8	7 + 8
6 x 5	6 + 8	6 + 8
4 x 9	6 + 4	6 + 4
9 x 4	7 + 9	7 + 9
5 x 6	5 + 9	5 + 9
8 x 8	5 + 4	5 + 4
6 x 9	5 + 5	5 + 5

Table 2 Continued

5 x 3	6 + 3	6 + 3
8 x 9	5 + 8	5 + 8
	8 + 3	8 + 3
	9 + 3	9 + 3

trials proceeded as stated above for the HPR condition, though the participants also received tokens contingent on compliant responses to both high-p and low-p requests. When the criteria for compliance were met (to three consecutive high-p requests), a randomly selected low-p request was issued within 5 s of delivering a preferred stimulus for compliance to the most recent high-p request in the series. Compliance to the low-p request also resulted in the delivery of a token on a continuous reinforcement (CRF) schedule.

Noncontingent reinforcement. The third experimental condition involved the delivery of tokens on a noncontingent (NCR) or fixed-time schedule (blue condition). This consisted of delivering a sequence of tokens (presumably a reinforcer based on preference assessments) in rapid succession (i.e., within 5 s) of one another such that the timing of stimulus delivery approximated the timing of token delivery in the HPR-Tokens condition. That is, the experimenter presented a token to the participant independent of the participant's behavior (high-p problems were not presented in this phase – just tokens followed by the low-p math problems), and in intervals such that the rate of token delivery matched that achieved during the previous high-p request sequence condition (e.g., FT 5 s). This occurred on a trial-by-trial basis in order to control for effects of reinforcement rate. If a participant failed to accept a token, such as by turning away from the table, the experimenter paused, and then delivered the next token, aiming for three consecutive acceptances. Within 5 s of the last stimulus acceptance, the experimenter issued a randomly selected low-p request to the participant. Compliance to the low-p request also resulted in the presentation of a token.

As in all conditions, participants had 60 s to complete the low-p request. Noncompliance was followed by a 30-second time out interval in which the experimenter looked away from the student and prepared to deliver the next sequence.

Procedural integrity. The integrity of the independent variable(s) was assessed on approximately 33% of sessions in order to ensure that the experimenter accurately implemented the treatment protocol. The delivery of high-p and low-p requests, the timing of low-p request issuance, and the respective consequences delivered by the experimenter were recorded via a checklist (see appendix D) by a trained independent observer. Like agreement data, treatment integrity was also 100%.

Alternating-treatments design. The relative effects of both the high-p treatment (with and without token reinforcement) and the fixed-time comparison condition were evaluated using an alternating treatments design. Table 3 depicts a summary of intervention conditions. In general, participants were exposed to a series of phases, which included (in order): (a) a prebaseline assessment of requests with which the participant's did (high-p) or did not (low-p) comply; (b) an assessment to identify potential back-up reinforcers, which were to be available in post-session exchanges for tokens earned during the experimental phases; (c) a baseline phase to determine baseline levels of compliance to low-p requests; and (d) an intervention phase, which compared the high-p treatment (with and without token reinforcement) and the delivery of NCR on a FT schedule. A choice component was added during the last 8 sessions in order to evaluate the participants' preferences for intervention conditions.

Table 3

Summary of All Three Experimental Conditions

High-Probability Request Sequence (HPR)	High-Probability Request Sequence + Tokens (HPR-Tokens)	Noncontingent Reinforcement (NCR)
Three high-p requests were delivered (compliance did not produced any socially-mediated consequences). A low-p request was then delivered with social praise contingent on compliance	Identical to HPR, except that in addition, tokens were delivered contingent on both high-p and low-p requests	Three tokens were delivered independent of responding on a FT 5s schedule. After 3 acceptances a low-p request was delivered. Compliance produced another token.

The interventions, the order of which was randomly determined for each participant, were implemented three to five days a week across three distinct conditions. The interventions were also balanced across this phase; each one was administered under each condition an equal number of times. To minimize potential carry-over effects with this particular design, the experimenter attempted to enhance the distinguishing characteristics of each intervention condition by telling each participant, “we are now in the red condition” prior to the high-p application (HPR) (and “blue” for NCR and “yellow” for HPR-Tokens conditions, respectively). Colored poster boards were posted on the wall above the table where the children worked to further distinguish the different conditions.

Results

High-p / Low-p Assessment

The results of the forced-choice preference assessment showed that all of the participants selected the single-digit worksheet more often than the multiple-digit worksheet. Jason and Alex selected the single-digit addition worksheet on 10 of the 10 trials and Kevin selected the single-digit multiplication worksheet on 9 of the 10 trials. These results validate the classification of both single-digit addition and multiplication problems and multiple-digit addition and multiplication problems as “high-p” and “low-p” requests, respectively.

Baseline and Experimental Sessions

Jason. The top panel of Figure 1 shows that during baseline, Jason’s percentage of completion compliance to low-p problems was low ($\underline{M}$ = 8.9%, range, 0% to 20%). The implementation of the high-p request sequence plus token reinforcement (HPR-Tokens) and the NCR conditions resulted in increases in the mean percentage of completion compliance. In the HPR-Tokens condition, the mean increased to 88.9% (range, 60% to 100%). The NCR condition produced a mean of 91.1% (range 60% to 100%), whereas the high-probability request sequence (HPR) condition did not generate any meaningful increases in compliance. For Jason, the mean level of responding remained unchanged from baseline, though was slightly more variable, at least initially ($\underline{M}$ = 8.9%, range 0% to 80%).

As depicted in the top panel Figure 2, Jason's initiation compliance percentages increased during all intervention conditions. That is, the mean percentage of initiation compliance for Jason increased from 22.2% (range, 0% to 40%) during baseline, to 97.8% (range 60% to 100%) in the HPR-Tokens condition; to 96.7% (range, 40% to 100%) in the NCR condition; and was slightly more variable ($\underline{M}$ = 75.6%, range 0% to100%) in the HPR condition. It is important to mention that although initiation compliance levels were relatively high in the HPR condition compared to baseline overall low-p compliance was relatively low. During sessions, the experimenter noted that although Jason initiated low-p problems in the HPR condition, he was likely to do one of two things: either (1) quit working on the problem shortly after initiation, or (2) initiate the problem using random numbers for answers (e.g., "000000"), which he would sometimes write from right to left as if doing the addition calculations. It became quite clear after several sessions that the session length of the "red condition"

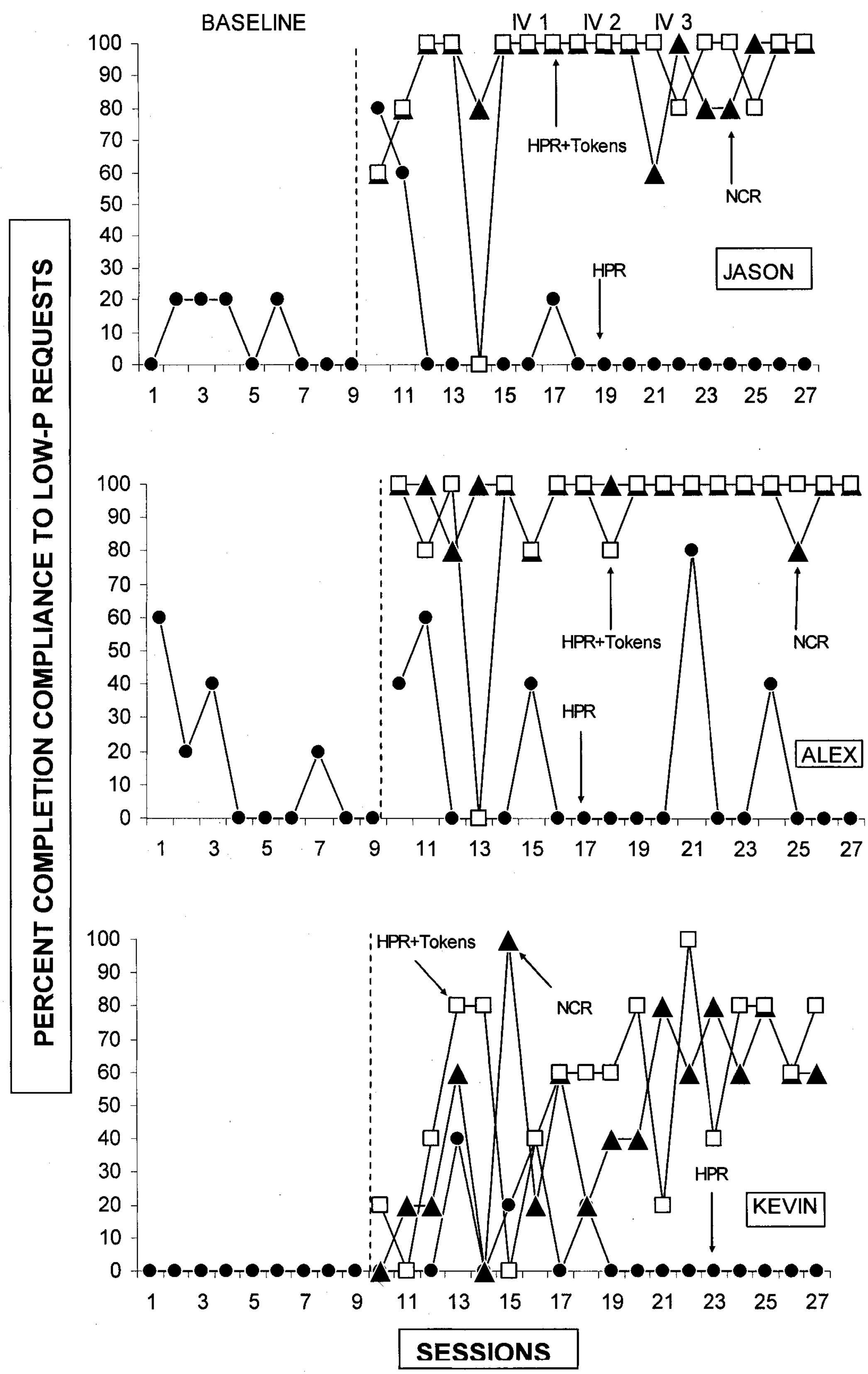

Figure 1. Percentage of completion compliance to low-probability requests during baseline and intervention for all three participants.

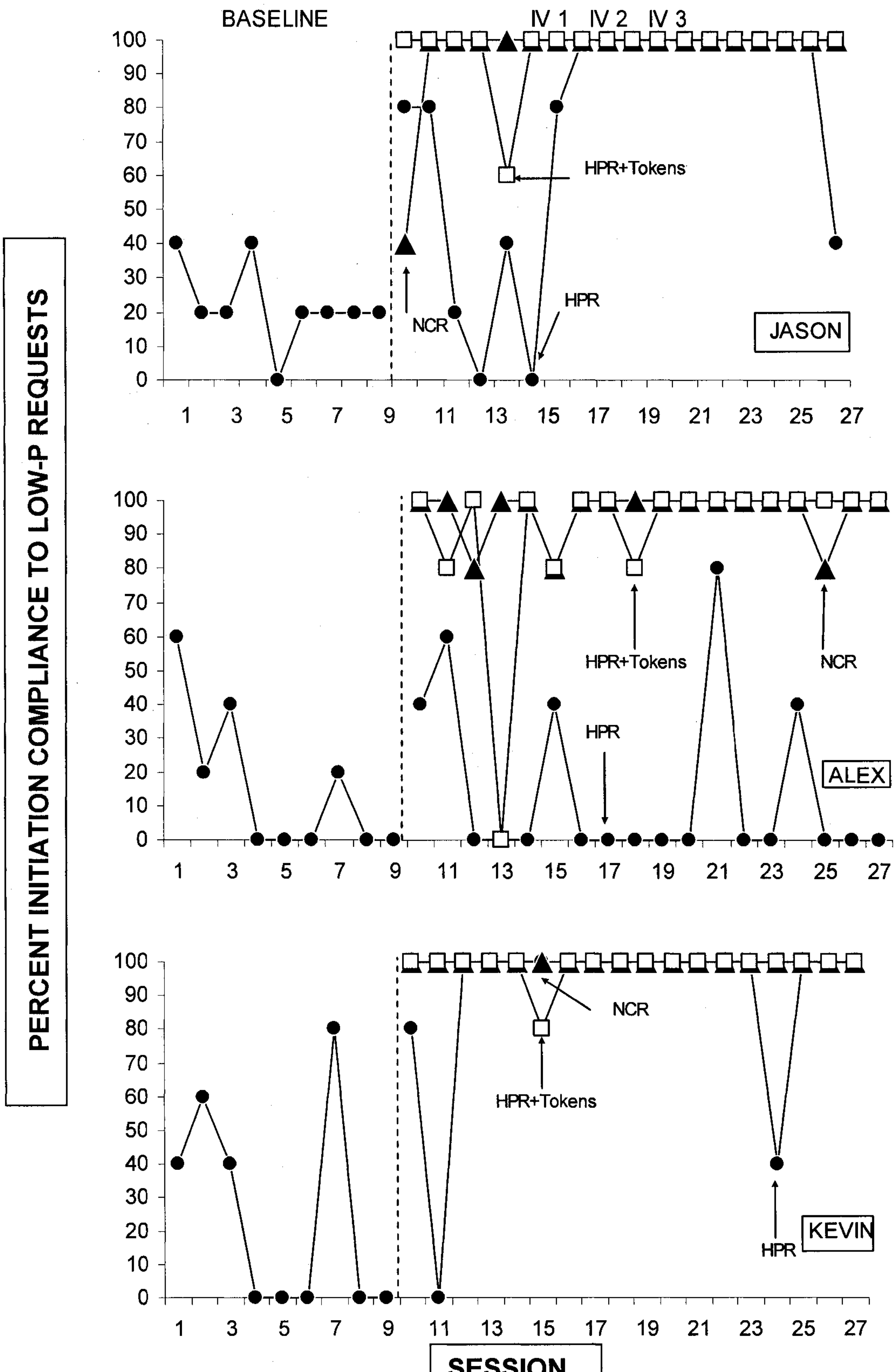

Figure 2. Percentage of initiation compliance to low-probability requests during baseline and intervention for all three participants.

was shorter if Jason initiated the low-p problems and then quit, in lieu of outright refusing to initiate or work on the low-p problem, which resulted in a 30 s time-out interval while the experimenter prepared to deliver the next sequence. This was confirmed anecdotally in that Jason stated, “The red condition goes by faster if I act like I'm going to do the problem and then just put fake numbers down!”

The top panel of Figure 3 shows that during baseline, out of a possible 35 digits per session, the mean number of low-p digits that Jason completed was 16.3 (range, 0 to 25). The implementation of all experimental conditions resulted in an increase in the mean number of low-p digits completed. In the HPR-Tokens condition, Jason's mean increased to 34.5 (range, 26 to 35), while the NCR condition produced a mean of 35 (100%). In the HPR condition, Jason's mean level of responding was more variable, but was also higher compared to baseline (M = 28.4, range, 0 to 41). It should be noted here that although the number of low-p digits completed was higher in the HPR condition than in baseline, the number of low-p digits correct was much lower (because as observed and reported, Jason used “fake” numbers to initiate problems, but did not correctly complete them during in the HPR (red) condition).

As depicted in the top panel of Figure 4, Jason's number of digits correct for low-p problems increased during the HPR-Tokens and NCR conditions. That is, the mean number of digits correct for Jason increased from 15.2 (range, 0 to 22) during baseline to 33.1 (range 8 to 35) in the HPR-Tokens condition; to 34.5 (range, 32 to 35) in the NCR condition; and decreased (M = 9.7, range 0 to 31)

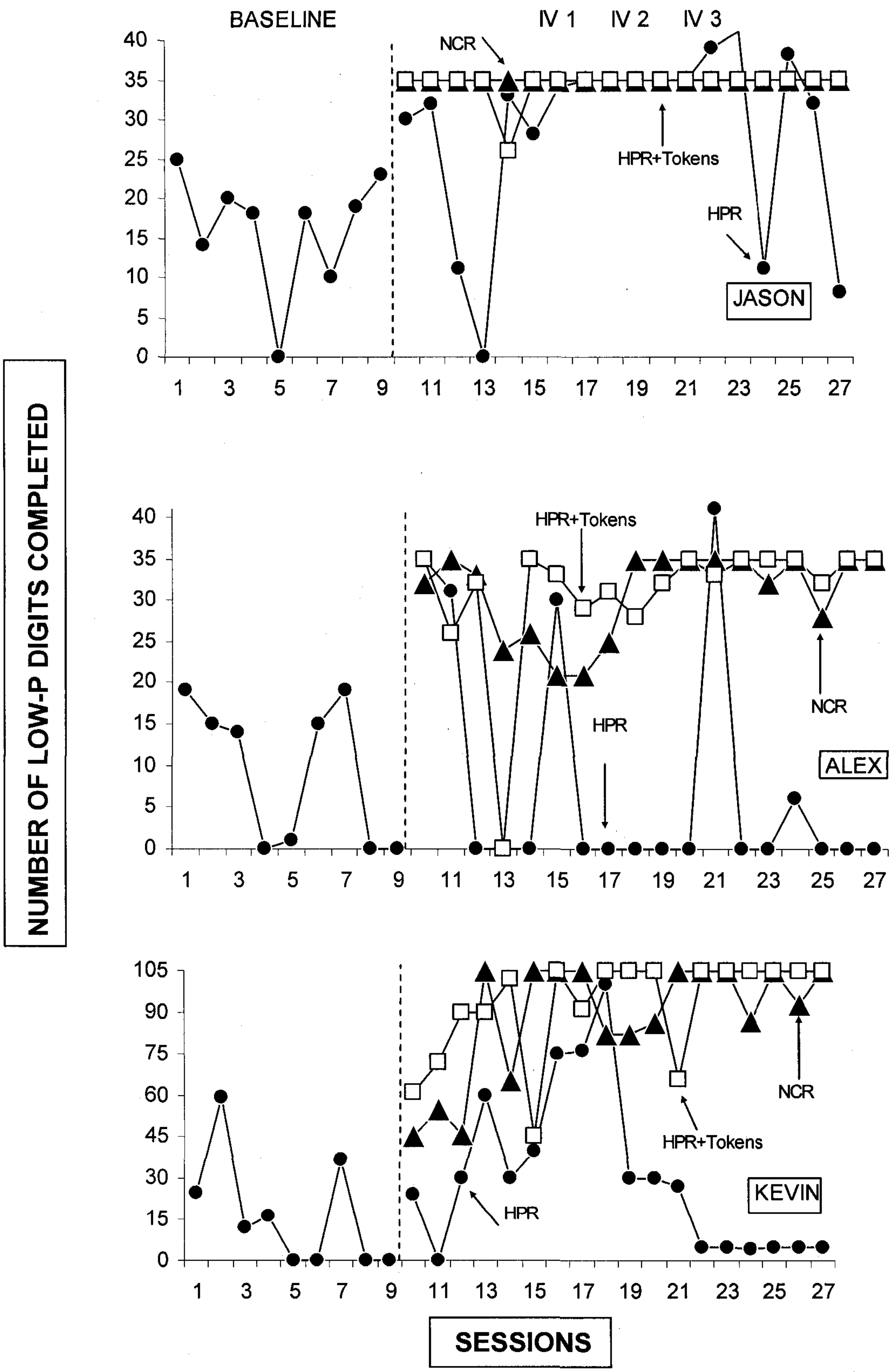

Figure 3. Number of low-probability digits completed during baseline and intervention for all three participants.

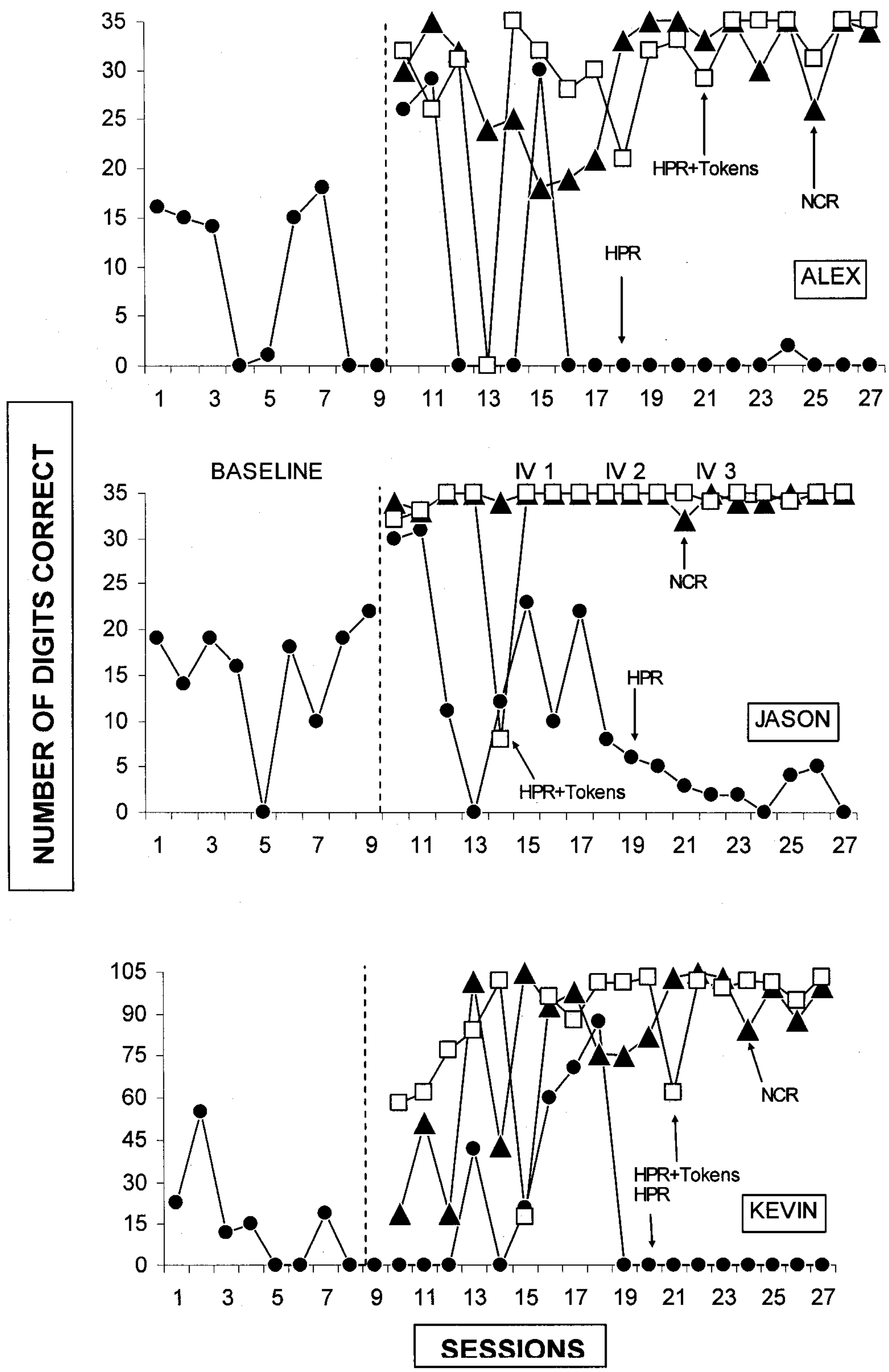

Figure 4. Number of low-probability digits correct during baseline and intervention for all three participants.

during the HPR condition. It should be noted that there were several occasions wherein Jason's response of "000000" resulted in a correct number just by chance.

Alex. The middle panel of Figure 1 shows that during baseline, Alex's percentage of completion compliance to low-p problems was at zero levels. The implementation of the HPR-Tokens and the NCR conditions resulted in increases in the mean percentage of completion compliance. In the HPR-Tokens condition, the mean increased to 71.1% (range, 0% to 100%). The NCR condition produced a mean of 64.4% (range, 0% to 100%), whereas the HPR condition did not generate any meaningful increases in compliance (M = 4.4% (range 0% to 40%).

As depicted in the middle panel of Figure 2, Alex's initiation compliance percentages increased in the HPR-token and NCR conditions, but decreased in HPR sessions. That is, the mean percentage of initiation compliance for Alex increased from 15.6% (range, 0 to 60%) during baseline to 91.1% (range 0% to 100%) in the HPR-Tokens condition and to 96.7% (range, 80% to 100%) in the NCR condition. Initiation compliance levels were slightly lower during the HPR condition (M =14.4%, range 0% to 80%) as compared to baseline.

The middle panel of Figure 3 shows that during baseline, out of a possible 35 digits per session, the mean number of low-p digits that Alex completed was 9.2 (range, 0 to 19). The implementation of the HPR-Tokens and NCR conditions resulted in an increase in the mean number of low-p digits completed. In the HPR-Tokens condition, Alex's mean increased to 30.9 (range, 0 to 35) and the NCR condition also produced a mean of 30.9 (range, 21 to 35). In the HPR condition, Alex's level of responding was lower than baseline (M = 7.9, range, 0 to 35) levels.

As depicted in the middle panel of Figure 4, Alex's mean number of digits correct increased from 8.8 (range, 0 to 18) during baseline to 29.7 (range 0 to 35) in the HPR-Tokens condition and to 29.7 (range, 18 to 35) in the NCR condition. The number of digits correct dropped during the HPR condition to a mean of 4.8 (range 0 to 30).

Kevin. The bottom panel of Figure 1 shows that during baseline, Kevin's percentage of completion compliance to low-p problems was 0%. The implementation of the HPR-Tokens and the NCR conditions resulted in increases in the mean percentage of completion compliance. In the HPR-Tokens condition, the mean increased to 52.2% (range, 0% to 80%). The NCR condition produced a mean of 50% (range, 0% to 100%), whereas the HPR condition did not generate any meaningful increases in compliance. For Kevin, the mean level of completion compliance during these sessions remained low at 6.7% (range 0% to 40%).

As depicted in the bottom panel of Figure 2, Kevin's initiation compliance percentages increased during all experimental conditions. That is, the mean percentage of initiation compliance for Kevin increased from a baseline mean of 24% (range 0% to 80%) to means of 98.9% (range 80% to 100%) in the HPR-Tokens condition; 100% in the NCR condition; and 90% (range 0% to 100%) in the HPR condition. As was the case with Jason, it is important to mention that although initiation compliance levels were relatively high in the HPR condition compared to baseline overall low-p compliance was low. Although Kevin initiated low-p problems in the HPR condition, he consistently initiated the problem using a particular sequence of numbers for answers (e.g., "123456"). Kevin also made mention that the "red condition" went by faster if he readily initiated the low-p problems irrespective of the correctness of the answer.

The bottom panel of Figure 3 shows that during baseline, out of a possible 105 digits per session, the mean number of low-p digits that Kevin completed was 16.6 (range, 0 to 59). The implementation of all experimental conditions resulted in an increase in the mean number of low-p digits completed. In the HPR-Tokens condition, Kevin's mean increased to 92.6 (range, 45 to 105) and the NCR condition produced a mean of 88.1 (range, 45 to 105). In the HPR condition, Kevin's data shows that the number of digits completed increased from baseline initially, and then decreased to zero levels (M = 30.6, range 0 to 100). Again, as was the case with Jason, it should be noted here that for Kevin the number of low-p digits completed was much more variable in the HPR condition. Moreover, Kevin began this experimental phase with an initial attempt at working through the low-p problems and then, in order to (presumably, due to observations and verbal reports) reduce session length, recall that he consistently used "123456" as his answer to these problems. Thus, although he was completing six digits in this case, none of them were correct.

As depicted in the bottom panel of Figure 4, Kevin's number of low-p digits correct increased from a baseline mean of 13.7 (range 0 to 35) to significantly higher means of 86.3 (range 18 to 105) in the HPR-Tokens condition, and 80.4

(range, 19 to 105) in the NCR condition. The HPR condition produced a mean of 15.6 (range 0 to 71), which was only a slight improvement over baseline.

Tables 4, 5, and 6 provide summaries of the data from experimental conditions for the mean percentages of high-p compliance during HPR and HPR-Tokens conditions, low-p completion and initiation compliance, and the number of low-p digits completed and correct for all three children, respectively.

Table 4

Mean Percent Low-P Initiation Compliance (IC) and Completion Compliance (CC) During Experimental Conditions

Participant	HPR		HPR-Tokens		NCR	
	IC	CC	IC	CC	IC	CC
Kevin	90	6.7	98.9	52.2	100	50
Jason	75.6	8.9	97.8	88.9	96.7	91.1
Alex	14.4	4.4	91.1	71.1	96.7	64.4

The choice component data for the last 8 intervention sessions for all participants is depicted in Table 7. The results showed that all participants chose to partake in extra trials under either HPR-Tokens or NCR conditions. Kevin and Jason preferred the NCR condition, whereas Alex preferred the HPR-Tokens condition.

Table 5

Mean Number Digits Completed and Correct for Low-P
Problems During Experimental Conditions

	HPR		HPR-Tokens		NCR	
	Completed	Correct	Completed	Correct	Completed	Correct
Kevin	30.6	15.6	92.6	86.3	88.1	80.4
Jason	28.4	9.7	34.5	33.1	35	34.5
Alex	7.9	4.8	30.9	29.7	30.9	29.7

Table 6

Mean Percent Compliance to High-p Requests
During HPR and HPR-Tokens Conditions

Participant	HPR	HPR-Tokens
Kevin	99.7%	99.7%
Jason	98.4%	99.7%
Alex	98.1%	98.3%

Table 7

Number of Chosen Trials Across Conditions and Participants

Participant	HPR	HPR-Tokens	NCR
Kevin	0	1	7
Jason	0	2	6
Alex	0	6	2

Discussion

High-p request sequences with and without token reinforcement and fixed-time reinforcement schedules were presented in a multielement design to compare their relative effects on compliance to low-probability requests. Each participant was asked to complete math problems that were shown to have a low probability of compliance in terms of both problem initiation and correct problem completion. The data show that for all participants, high-p sequence plus token reinforcement and NCR intervention sessions resulted in increased low-p compliance as compared to both baseline and HPR sequences. Furthermore, these conditions resulted in increases in the overall number of digits completed and correct for all participants.

Due to the relative difficulty of the low-p problems, the children were not necessarily going to achieve 100% levels of completion compliance, and as such, the numbers of digits completed and correct for each problem were evaluated. That is, it was equally important to determine the relative effort, so to speak (as defined by these measures), of each participant even if completion compliance wasn't reached. This held true especially for Kevin, who at age 11 was challenged with multiple-digit (3-digit by 3-digit) multiplication problems. The results indicate that although his mean overall compliance was around 50% during HPR-Tokens and NCR conditions, his mean number of digits correct exceeded 82% and 76% in the two conditions, respectively, compared to a baseline mean of 13%.

Overall, intervention effects showed that following implementation of HPR-Tokens and NCR, all three participants became considerably more successful at completing the more difficult and less preferred low-p problems. For Jason, Alex, and Kevin, performance changes in the dependent variable were highly similar. Patterns of responding in the traditional high-probability request sequence condition were replicated in that these intervention sessions did not generate levels of compliance significantly above baseline levels for any of the participants. In fact, Jason's mean level of compliance during the HPR condition remained the same as baseline. Alex's and Kevin's mean compliance rose slightly during the HPR sessions, but remained very low compared to the HPR-Tokens and NCR conditions as responding dropped to zero levels in the last 9 (Kevin) to 10 (Alex) sessions.

The relative effects of the high-p sequences on low-p compliance were consistent with previously reported results (e.g., Mace et al., 1997) when quality of reinforcement was higher. That is, high-p sequences plus token reinforcement produced higher levels of compliance than did high-p sequences wherein problem completion was presumed to be the reinforcer for high-p requests (as in Belfiore et al., 1997) and contingent verbal praise was used as the reinforcer for low-p requests (consistent with baseline procedures). The current results should be viewed with a degree of caution because the majority of studies on high-p sequences using verbal praise contingent on low-p compliance have shown successful gains in the dependent measures (e.g., Davis et al., 1992; Davis & Reichle, 1996; Ducharme & Worling, 1994). The present results contradict these findings and so the extent to which these reported results are replicable rests in the hands of future researchers. There are a couple of possibilities as to why the HPR sequence in this study did not replicate that of prior studies.

First, previous studies used verbal praise contingent on compliance to high-p requests. The current study used problem completion as a presumed reinforcer as it was consistent with procedures used by Belfiore and Colleagues (1997; 2002) who evaluated a similar topography of behavior (arithmetic) and who used math problems as high-p and low-p requests. A second possibility involves the comparison or contrast rather, with the other experimental conditions relevant to the alternating treatments design. That is, the HPR sequence was much less favorable than the other two interventions that included token deliveries (either contingently or noncontingently). This is exemplified anecdotally as well in that the participants stated on an on-going basis that the "red condition" (HPR) was "by far [the] least favorite" because tokens were not available. If tokens were of current value when the children were exposed to HPR contingencies, being in the "red condition" may have served as an S-delta condition wherein reinforcement is unavailable, yet still valuable.

The extent to which improvements in low-p compliance would have occurred if the HPR condition was the only intervention implemented is not clear. This carry-over effect is one of several procedural difficulties associated with multielement designs. Carry-over effects or multiple-treatment interference (Kazdin, 1982) refers to the potential influence of one intervention on a juxtaposed intervention regardless of sequencing order. Efforts were made to increase the discriminability between the conditions, including counterbalancing interventions, implementing each one at a time, and providing explicit pre-session instructions as to which condition will be administered at any particular time. Further, it is interesting to note that contrary to the effects under HPR sequence conditions, both HPR-Tokens and NCR involved a similarly high rate of reinforcement – and they produced the same impact on overall compliance and digits completed and correct.

One of the main goals of the present paper was to extend research on compliance-based interventions by attempting to separate the effects of two behavioral mechanisms that might account for the impact of the high-p intervention on compliance, including (a) increases in overall rate of reinforcement and (b) increases in the rate of responding upon which reinforcement is contingent. In other words, this study attempted to determine whether behavioral persistence – the extent to which compliant responding continues in spite of a stimulus change – can be accounted for by establishing either a high rate of response-independent reinforcement prior to a change in stimulus conditions or by generating high rates of responding of a given response class (compliance). Given the current data sets, it is also interesting to point out that the HPR sequence in this study did not generate a high level of low-p compliance (though high-p compliance remained above 95% for all participants) whereas NCR did in spite of there being no opportunity to generate a high rate of compliant responding under those circumstances.

In previous investigations, the confound between high rates of reinforcement and high rates of compliant responding in high-p/low-p request sequences has precluded any definitive statements regarding the mechanism(s) responsible for the increases in low-p compliance. The current study has contributed to and extended the research in this area by comparing the relative effects of high-p sequences and NCR schedules. The study's design allowed for a manipulation of reinforcement and response rate variables in order to further evaluate the operative components. As demonstrated in the figures, noncontingent reinforcement was clearly as effective as the high-p sequence when compliant responses were followed by tokens. On the other hand, the HPR sequence wherein problem completion and verbal praise served as consequences for high-p and low-p compliance respectively, did not significantly improve low-p responding. Moreover, although several HPR sessions for each participant resulted in some level of compliance above baseline, responding eventually dropped to zero levels, an effect clearly differentiated from the HPR-Tokens and NCR intervention sessions. The reason for this may be three-fold: (1) problem completion for high-p requests did not serve as an effective source of non-socially mediated reinforcement; (2) verbal praise did not function as reinforcement for low-p responding; and/or (3) the other two alternating treatments produced a behavioral contrast effect. Essentially, from the standpoint of the theory of behavioral momentum (e.g., Nevin, 1996), behavioral persistence, which is functionally related to the “mass” of compliant responding (and determined by stimulus-reinforcer contingencies) was demonstrated to be greater in the two conditions associated with the greatest amounts of reinforcement (HPR-Tokens and NCR). Said another way, the data show that the target behavior did not reap the benefits of behavioral persistence under the HPR sequence condition suggesting that problem completion for high-p responses did not serve to increase the rate of reinforcement associated with that stimulus condition. On the contrary, both HPR-Tokens and NCR intervention sessions produced data sets indicating the strength (e.g., greater mass) of compliant responses when associated with those conditions.

Belfiore et al. (1997) hypothesized that the reinforcers responsible for maintaining compliance levels in the high-p / low-p request sequences are highly individualized and could be either positive or negative. As in the current study, they relied on problem completion, not on contingent verbal praise as the consequence because many academic settings do not permit one-on-one teacher attention. However, the use of problem completion did not make clear the mechanism that was responsible for decrements in their latency-to-initiate measure. That is, in the absence of social reinforcement for completion, latency may have decreased as a function of either positive reinforcement in the form of problem completion, or negative reinforcement in the form of a covert verbal statement such as, “one less problem to go.” For students with a history of noncompliance with math, the provision of escape from aversive math tasks (in the form of crossed out problems on math problem packets preceding low-p problems) may very well function as a higher quality reinforcer than problem completion. Only one study (e.g., Belfiore et al., 2002) has addressed this issue and no differences were found between two interventions comparing the use of problem completion and escape from high-p math problems as potential reinforcers for high-p sequences. This may have been due to the fact that problem completion and escape from low-p problems in the Belfiore et al. (2002) study did not differ in their reinforcing effectiveness or, because the problems were not aversive enough to render escape as valuable. Future studies can further examine this issue of positive versus negative reinforcement for high-p academic tasks.

The current study extended the line of inquiry regarding the high-p application’s underlying mechanisms by having compared high-p sequences with and without external sources of reinforcement for high-p requests in addition to comparing the effects with noncontingent reinforcement schedules. From the results we may conclude that because low-p compliance was considerably higher in the condition wherein tokens were delivered contingent on compliance compared to the combined use of problem completion and verbal praise in the HPR sequences, tokens functioned as a more effective (higher quality) form of reinforcement. Additionally, fixed-time schedules of token reinforcement were as effective in generating low-p compliance when compared to high-p sequences plus token reinforcement. This suggests that NCR may produce effects analogous to high-p request sequences in terms of establishing compliance as having greater "mass" and persisting in spite of an unfavorable change in stimulus conditions. There are several limitations that require the use of caution when interpreting these reported results.

Perhaps the greatest limitation rests with the fact that we cannot know for sure whether increased low-p responding during the HPR-Tokens and NCR conditions was the result of the tokens being delivered for low-p responses. In other words, a potential confound exists in that relative to the HPR condition wherein low-p compliance produced verbal praise as a consequence, an additional variable was altered: low-p compliance produced tokens. It is not clear whether similar results would have been obtained with the use of verbal praise as the low-p consequence rather than the delivery of tokens.

In evaluating the primary mechanism(s) contributing to behavioral persistence, the present arrangement permits us to begin separating the effects of establishing a high rate of reinforcement from the effects of generating a high rate of behavior. This is an important issue from an applied perspective because it is in general, easier and more convenient to deliver preferred stimuli on fixed-time schedules than it is to identify and deliver entire sequences of high-p requests. It may also serve as a viable alternative when high-p responses are insufficient – when individuals have relatively limited high-p responses to begin with. Another limitation to the present study exists in that the participants in this study did not have limited repertoires of high-p behaviors. Future studies should attempt to extend findings with children (or adults) that have a relatively low number of possible high-p behaviors at the outset of treatment.

Another important applied issue is relevant to the present study in that fixed-time schedules of reinforcement were very effective and yet did not require either prior identification of high-p requests or ensuring that identified high-p responding continued at a high level of compliance throughout the study. Though high-p sequences were also shown to be effective, the NCR condition in this study was presumably easier to implement in that it did not require a series of requests from the experimenter, nor did it require responses (other than token acceptance) from the participants. These results suggest that fixed-time schedules of reinforcement may be quite useful when training other interventionists in treatment protocols. The extent to which different consumers (e.g., parents, teachers, clinicians) of intervention methods are satisfied with those described herein remains unknown, another limitation of the current study. However, a very meaningful finding resulted from an evaluation of the participants' preference for the different conditions.

The choice-trials data revealed that Kevin and Jason preferred the NCR condition, whereas Alex preferred the HPR-Tokens condition. Kevin and Jason both revealed that they preferred the NCR condition because they received more tokens for less work than in the HPR-Tokens condition. Alex said he chose the HPR-Tokens condition because the "hard problems [were] easier in the yellow than in the blue." It is both interesting and important to note that although Alex perceived the HPR-Tokens condition low-p problems as easier than the problems in the NCR condition, all math problems were randomly chosen from the entire pool of low-p problems before sessions began. In other words, the same low-p problems were inevitably presented in both conditions, and as a result it is not clear as to why Alex preferred the HPR-Tokens condition over the NCR condition. However, it was clear that the all participants preferred either of these conditions over traditional high-p sequences, which sheds some light on the social acceptability of the interventions. The notion of preference is an important applied issue for several reasons: First, when given a choice, participants may be less likely to avoid or escape that particular condition. Second, and perhaps as a result of the first reason, there is seemingly less potential for emotional and/or behavioral side effects (i.e., aggression, tantrums). The participants in this study showed no significant levels of escape or avoidance behavior or said side effects during any of their chosen trials. Finally, interventions with high levels of social acceptability may be substantially easier to disseminate to other practitioners. This seems especially true for NCR protocols which may require less response effort for the person implementing the intervention.

Another line of inquiry that the present study did not address is the potential utility of this intervention in the classroom as run by the participants' teacher(s). In Hutchinson and Belfiore (1998) worksheets for problem completion were designed for students to regulate reinforcement delivery. The teacher did not provide reinforcement or feedback for continued on-task behavior. This feature increased the utility of the intervention for the classroom setting as run by the teacher. Future research should consider evaluating the two successful conditions in this study when run by academic instructors.

Another potential area of investigation involves the issue of whether we need to reinforce every instance of compliance. The present study used a CRF schedule of reinforcement for compliance. Whether or not this is a requirement to achieve results that rival those here remains questionable. Moreover, it is not clear whether or not over time the conditioned reinforcers (tokens) can be faded out to allow a more natural community of reinforcement to foster behavioral maintenance of gains (Baer, Wolfe, & Risley, 1968).

The present study contributed to the high-p sequence literature by showing that reinforcer quality does have an effect on the high-p sequence in academic settings. However, for individuals with severe disabilities, it may be more difficult to establish conditioned reinforcers (e.g., tokens) than it would be to use a choice/preference assessment of potentially reinforcing stimuli to deliver contingent on compliant responding. Future studies should also continue to address the issue of quality of reinforcement with high-p sequences and fixed-time schedules of reinforcement.

Additionally, researchers may choose to further elucidate behavior change mechanisms by examining various presentations of NCR in terms of the varying parameters operating for high-p sequences (e.g., variant or invariant stimulus deliveries, fixed-interval lengths, FT versus VT schedules, etc). High-p sequence research has illuminated some of the intervention's defining features, and the same questions may apply to NCR schedules. Furthermore, not only is it unclear as to whether NCR has the same generalizability or robustness across various populations (i.e., children and adults with and without disabilities), and behavioral topographies (i.e., compliance with medical regimens, conversational skills, academic task compliance, and so on) as do high-p sequences, but it is also unclear as to what behavior (if any) is increased in velocity by the NCR schedule. Future researchers should continue addressing these issues.

In conclusion, the present study found that both high-p request sequences with token reinforcement and sessions with noncontingent reinforcement were effective in improving the compliance of three typical elementary-aged students in an educational setting. The differences between these two experimental conditions were not significant in terms of their effects on low-p responding. The research described herein both replicates (e.g., Mace et al., 1997) and contradicts (e.g., Belfiore et al., 1997) previous findings supporting the usefulness of the high-p request sequence, and suggests the use of caution when interpreting results of studies wherein high-p sequences are juxtaposed to other interventions with higher quality of reinforcement as operationally defined and demonstrated. The high-p sequence literature was extended by (1) the data sets showing that putative reinforcing events delivered on a fixed-time basis prior to a low-p request have an effect comparable to high-p sequences when those same events are delivered contingent on compliant responses; and (2) an evaluation of the underlying processes contributing to the high-p procedures effectiveness. The results lend empirical support to the notion that behavioral persistence in this compliance-based intervention is perhaps a function of establishing a high rate of reinforcement in the presence of a given stimulus (e.g., determined stimulus-reinforcer contingencies). Drawing any definitive conclusions regarding the actual underlying mechanisms should remain contingent on on-going empirical lines of investigation.

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Appendix A

Human Subjects Institutional Review Board Approval Forms

Date: March 17, 2003

To: R. Wayne Fuqua, Principal Investigator
Carrie Coleman, Student Investigator for dissertation

From: Mary Lagerwey, Chair

Re: HSIRB Project Number 02-11-07

This letter will serve as confirmation that your research project entitled "Evaluating the Operative Mechanisms Underlying the High-Probability Request Sequence" has been **approved** under the **full** category of review by the Human Subjects Institutional Review Board. The conditions and duration of this approval are specified in the Policies of Western Michigan University. You may now begin to implement the research as described in the application.

Please note that you may **only** conduct this research exactly in the form it was approved. You must seek specific board approval for any changes in this project. You must also seek reapproval if the project extends beyond the termination date noted below. In addition if there are any unanticipated adverse reactions or unanticipated events associated with the conduct of this research, you should immediately suspend the project and contact the Chair of the HSIRB for consultation.

The Board wishes you success in the pursuit of your research goals.

Approval Termination: January 15, 2004

Date: March 26, 2004

To: R. Wayne Fuqua, Principal Investigator
Carrie Coleman, Student Investigator for dissertation

From: Mary Lagerwey, Chair

Re: HSIRB Project Number: 02-11-07

This letter will serve as confirmation that the changes to your research project "Evaluating the Operative Mechanisms Underlying the High-Probability Request Sequence" dated 3/19/04 and clarified on 3/25/04 have been approved by the Human Subjects Institutional Review Board.

The conditions and the duration of this approval are specified in the Policies of Western Michigan University.

Please note that you may **only** conduct this research exactly in the form it was approved. You must seek specific board approval for any changes in this project. You must also seek reapproval if the project extends beyond the termination date noted below. In addition if there are any unanticipated adverse reactions or unanticipated events associated with the conduct of this research, you should immediately suspend the project and contact the Chair of the HSIRB for consultation.

The Board wishes you success in the pursuit of your research goals.

Approval Termination: December 17, 2004

Appendix B

Informed Consent Forms

WESTERN MICHIGAN UNIVERSITY

Your child is invited to participate in a research project entitled: "Evaluating the Operative Mechanisms Underlying the High-Probability Request Sequence." To fulfill a dissertation requirement at WMU, Carrie Coleman will attempt to determine why this intervention works to improve academic engagement.

We will be delivering instructional requests for which your child often complies, along with those targeted for improved compliance. The requests are relevant to your child's Individualized Education Plan and classroom-based activity. During the intervention, a series of requests with which your child typically complies will be followed by a request with which your child typically does not comply. For example, in other studies of this nature, it is common to present a sequence of three highly preferred math problems (e.g., 2x3, 1x2, 4x4) that is then followed by a less preferred type of math problem (e.g., 357x246). Some of these requests produce high levels of task engagement, while others do not – and those that don't are our intervention targets. The specific requests that we'll use will be determined by an assessment of your child's preference and lack thereof for certain types of academic activity. Problem completion will be followed by a specific form of positive reinforcement for which your approval is requested.

Sessions will take place during the regular school day, within the classroom setting. There will be two sessions a day on a minimum of three days a week, and each session will last 5-10 minutes. Your child's participation may require only three months' time, with a maximum involvement of one year.

Your child will be free at any time, even during the intervention, to refuse to participate, or refuse to answer any question without prejudice, penalty, or risk of any loss of service he or she would otherwise have. If your child refuses or stops participating in the study there will be no negative effect on his or her school programming. The benefits for your child might for participating include increases in compliance, which may improve his/her learning opportunities and ease further skill development. There may eventually be benefits to the school district and other students in educational settings as well.

The data collected on your child's behavior(s) will remain confidential. Your child's name will be omitted from all data sheets and videotapes, and a code number or altered name will be attached. The principal or co-investigator will keep a separate master list with the child's real name and the corresponding code number or altered name. As for the videotapes, only observers, investigators, and Carrie Coleman's doctoral committee (for review of the project) will by privy to viewing them. If the researchers find that the treatment is useful for increasing academic compliance, they will share the results with your child's teacher. Once the data are collected and analyzed, the master list will be destroyed. All other forms, including videotapes, will be retained for a minimum of three years in a locked file in the principal investigator's laboratory. At the end of this three-year period, all videotapes will be destroyed. Further, no individual identifiers will be used if the results are published or reported at a professional meeting.

No risks to your child for participating in this project, beyond those normally experienced in the educational setting are anticipated. However, in the unlikely event that your child becomes distressed, aggressive, or self-injurious as a result of being asked to complete requests, the investigator will follow standard protocol at the Development Center for dealing with such behavior (e.g., terminating the session and notifying the classroom teacher or the teacher's assistant). As in all research, there may be unforeseen risks to the participants. If an accidental injury occurs, appropriate emergency measures will be taken; however, no compensation or treatment will be made available to the participants except as otherwise specified in the consent form.

If you have any questions, please call the researchers at 373-0488 (Carrie Coleman) or 387-4474 (Dr. Wayne Fuqua) at Western Michigan University. You may also contact the Chair of the Human Subjects Institutional Review Board (387-8293), or the Vice President for Research (387-9298) if questions or problems arise during the course of the study.

This consent document has been approved for use for one year by the Human Subjects Institutional Review Board (HSIRB) as indicated by the stamped date and signature of the board chair in the upper right corner of both pages of this document. Do not participate in this study if the stamped date is older than one year.

Your signature below indicates that I, as parent or guardian, can and do give permission for ______________________________ (*child's name*)

- To be assessed for compliant and noncompliant behaviors
- To be assessed for preferences regarding certain items, objects, activities, and edibles for use during the study (please see attached list of potential items).
- To have an experimenter implement the treatment strategy described above in an effort to improve the level of compliance to targeted instructional requests given to him or her in the classroom.
- To be videotaped for purposes of data collection by independent observers and review by investigators.
- For the data to be reported to his/her teacher

Signature Date

Appendix C

Sample Math Worksheets

4 x 5	5 x 7	8 x 9	3 x 5	4 x 7
3 x 4	7 x 7	3 x 6	8 x 7	9 x 7
9 x 6	3 x 8	8 x 6	3 x 9	7 x 6
6 x 6	8 x 5	6 x 4	9 x 3	4 x 8
7 x 5	9 x 8	4 x 6	5 x 8	9 x 4
5 x 6	8 x 4	3 x 7	7 x 4	5 x 9
6 x 5	4 x 9	5 x 4	6 x 7	8 x 3
7 x 8	9 x 5	6 x 9	5 x 3	6 x 8
6 x 3	9 x 9	7 x 3	7 x 9	4 x 3

$$\begin{array}{r} 485 \\ \underline{\times\ 793} \end{array}$$

$$\begin{array}{r} 894 \\ \underline{\times\ 783} \end{array}$$

$$\begin{array}{r} 876 \\ \underline{\times\ 859} \end{array}$$

$$\begin{array}{r} 738 \\ \underline{\times\ 385} \end{array}$$

$$\begin{array}{r} 547 \\ \underline{\times\ 638} \end{array}$$

$\begin{array}{r} 4 \\ \underline{+5} \end{array}$	$\begin{array}{r} 6 \\ \underline{+\ 3} \end{array}$	$\begin{array}{r} 8 \\ \underline{+\ 8} \end{array}$	$\begin{array}{r} 5 \\ \underline{+\ 8} \end{array}$
$\begin{array}{r} 8 \\ \underline{+\ 3} \end{array}$	$\begin{array}{r} 9 \\ \underline{+\ 3} \end{array}$	$\begin{array}{r} 4 \\ \underline{+\ 6} \end{array}$	$\begin{array}{r} 8 \\ \underline{+\ 6} \end{array}$
$\begin{array}{r} 5 \\ \underline{+\ 5} \end{array}$	$\begin{array}{r} 5 \\ \underline{+\ 9} \end{array}$	$\begin{array}{r} 8 \\ \underline{+\ 7} \end{array}$	$\begin{array}{r} 9 \\ \underline{+\ 9} \end{array}$
$\begin{array}{r} 5 \\ \underline{+\ 4} \end{array}$	$\begin{array}{r} 3 \\ \underline{+\ 6} \end{array}$	$\begin{array}{r} 7 \\ \underline{+\ 9} \end{array}$	$\begin{array}{r} 4 \\ \underline{+\ 8} \end{array}$

998346 475569 + 756849
647398 567453 + 836957
379485 958673 + 395867
867954 636799 + 495867

Appendix D

Sample Checklist for Interobserver Agreement and Treatment Integrity Data

Jason	**Trial 1**	**Trial 2**	**Trial 3**	**Trial 4**	**Trial 5**	**RED**
High-p request						
Compliance? IC / CC						
High-p request						
Compliance? IC / CC						
High-p request						
Compliance? IC / CC						
High-p request – extra						
Compliance? IC / CC						
High-p request – extra						
Compliance? IC / CC						
Low-p request						
Within 5 s of response to high-p						
Compliance? IC / CC						

Jason	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	**YELLOW**
High-p request						
Compliance? IC / CC						
Token Delivery						
High-p request						
Compliance? IC / CC						
Token Delivery						
High-p request						
Compliance? IC / CC						
Token Delivery						
High-p request – extra						
Compliance? IC / CC						
Token Delivery						

Low-p request - Within 5 s of response to high-p Compliance? IC / CC	
Token Delivery	

Jason	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	**BLUE**
Token Delivery?						
Acceptance?						
Token Delivery?						
Acceptance?						
Token Delivery?						
Acceptance?						
Token delivery – extra						
Acceptance?						
Token Delivery – extra						
Acceptance?						
Low-p request - Within 5 s of acceptance?						
Compliance? IC / CC						
Token Delivery?						

Appendix E

Token Exchange List

Token exchange items	*Number of tokens required*
Gum	5
Super blow pops	10
Tic Tac's	20
Reese's peanut butter cups	20
M & M's	20
Chips	30
Chips Ahoy	40
Ugioh Trading Card	28
Movie theatre gift certificate	200
Movie coupon	120
Pokemon Trading Card	28