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ORIGINAL PAPER

Using a High Probability Command Sequence to Increase Classroom Compliance: The Role of Behavioral Momentum

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Abstract One of the most problematic behaviors in children with developmental disabilities is noncompliance. Although behavioral research has provided strategies to impact noncompliance, oftentimes the methodologies are consequent techniques, which may not be conducive to implementation by the classroom teacher. In this teacher-designed and implemented study, a sequence of high-probability instructional commands preceded the targeted low-probability command, in an attempt to increase compliance to the low-probability command. Results, discussed within the body of behavioral momentum research, showed an increase in compliance to low-probability classroom commands for a seven year-old student with moderate mental retardation and Down Syndrome. Results are discussed as (a) an effective, antecedent approach to classroom compliance and (b) re-connecting the gap between applied behavioral research and experimentally controlled classroom practice.

Keywords Command compliance · Behavioral momentum · Down syndrome developmental disabilities · High-probability command sequence

Noncompliance is one of the most problematic behaviors in students with developmental disabilities, as well as one of the more pervasive problems in the general school setting (Lee et al. 2004; Mace et al. 1988). Noncompliance may be defined as (a) the failure to initiate an assigned task or demand in a timely manner

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(as measured by latency), or (b) the failure to complete an assigned task or demand within a given time period (as measured by frequency, rate, percentage, or duration). When excessive amounts of the school day must be spent dealing with student noncompliance to classroom requests, academic and social instructional time is lost. At the most basic level, noncompliance in the classroom disrupts the temporal contiguity of pedagogical practices. The more time spent addressing noncompliance, and then re-directing the target student and the class back to school task at hand, the less time spent engaged in academic and social requirements of the classroom.

Unfortunately, many methods of addressing noncompliance make use of aversive strategies, including behavior reduction techniques such as teacher disapproval, verbal reprimands, and classroom exclusion (i.e., exclusionary time out) (Ducharme and DiAdamo 2005; Olmi et al. 1997). Although often effective in the short term, these behavior reduction techniques, acting as consequent strategies, require noncompliance to occur before implementation of techniques can occur. With such consequent strategies, teachers only react once noncompliance occurs. In such cases, little emphasis is placed on re-arranging/re-designing the classroom environment or the instructional format thereby reducing the likelihood of noncompliance in the first place.

Although aversive strategies may result in a decrease in noncompliance, they do not always produce an increase in compliance, and may result in an escalation in confrontation between teacher and student (Lee et al. in press). Aversive strategies may also inadvertently reinforce noncompliance, resulting in increased or maintained noncompliant behavior. For example, using time-out as a consequent for noncompliance may allow students to escape an aversive situation, and verbal reprimands following noncompliance may provide positive attention to the behavior.

A more efficacious strategy to deal with noncompliance would be to explore methods of increasing classroom compliance through antecedent (often instructional) strategies, rather than attempting to decrease classroom noncompliance through the use of consequent (often punitive) strategies. Increasing student compliance in the classroom, allows students to be exposed to a greater amount of academic content because more time is now available for instruction. Using preventive (i.e., antecedent) strategies, the environment is arranged in such a way that the opportunities for noncompliance are minimized, therefore focusing intervention efforts on task compliance, which can then be reinforced. By re-focusing educational efforts on increasing task compliance, teachers establish an environment richer in positive reward thus increasing the likelihood of increased compliance in the future. Applied behavioral research has demonstrated that antecedent strategies designed to increase command compliance (a) increases academic time on learning task, (b) decreases transition time between learning tasks, (c) decreases time required to complete learning tasks, (d) promotes overall positive learning, and (e) minimizes difficulties in other academic areas, (Ardoin et al. 1999; Belfiore et al. 2002; Hutchinson and Belfiore 1998; Lee et al. 2006; Mace et al. 1988).

One such antecedent technique, the high-probability command sequence (HPCS), has been shown to increase task compliance across a wide variety of behaviors, individuals, and settings. Lee (2006) categorizes research on high-probability command sequences as those studies examining (a) between-task transitions, and (b) within-task transitions. *Between-task transition* may be identified as a student transition from teacher-centered instruction to independent work, and is often considered a restricted operant because the teacher or researcher controls the delivery of the high and low probability commands, as well as the reinforcement accompanying compliance to the commands (Lee et al. 2006). Research examining between-task transition often focuses on a teacher-delivered series of three to five brief commands with a high probability of compliance (e.g., "give me five."), followed by a teacher-delivered low probability command (e.g., Austin and Agar 2005; Mace and Belfiore 1990).

Within-task transition may be identified as a student transition from question to question on a written academic assignment, and is often considered a free operant in that the individual controls the delivery of the high and low probability commands, as well as the reinforcement for command completion (Lee et al. 2006). Research examining within-task transitions often has focused on in-seat, academic assignments designed to increase behavioral fluency where the student establishes (a) the pace of instruction through high-probability problems (e.g. 1 + 1, 2 + 2) followed by a low-probability problem (697 × 1,843) and (b) the delivery of reinforcement following problem completion (e.g., Hutchison and Belfiore 1998; Lee et al. 2006).

The HPCS provides multiple high-probability requests directly preceding low-probability requests, which in turn, establishes a high rate of responding and reinforcement antecedent to the low-probability request. The purpose of this study was to replicate and extend previous HPCS research targeting noncompliance in the classroom setting. Specifically, we demonstrated that a teacher-designed and teacher-delivered strategy could be experimentally valid (i.e., establishing experimental control) within the general classroom structure. Once intervention effects were verified experimentally, a fading procedure (from three high-probability commands to a more natural one high-probability command) was implemented, adding to the literature on applied intervention as well. Finally, the experimental design employed allowed for additional evidence and opportunities for theoretical discussions of the role of behavioral momentum in producing behavior change.

Method

Participant and Setting

Jeff, a 7-year-old, first grade Caucasian boy with Down syndrome, functioning in the moderate range of mental retardation, served as the participant for this study. Jeff communicated with one to two word phrases and with the assistance of an augmentative communication device. In addition, Jeff understood simple one-step requests, and demonstrated compliance to some preferred activities and commands (e.g., "Close the door," "Turn on/off the lights," "Clap you hands"). Jeff also demonstrated non-compliance to many classroom requests (e.g., "Sit down," "Go to your desk"). The teacher often had to physically prompt Jeff using hand over hand guidance to complete many classroom requests. The teacher also noted that her proximity did not seem to have an effect on compliance. Although Jeff was frequently non-compliant to classroom requests, he did not engage in any aggressive or self-injurious behaviors. In addition, Jeff had been diagnosed with attention deficit hyperactivity disorder (ADHD) and was often extremely excitable and fidgety. His task refusal often resulted in his saying “no,” or ignoring the request altogether.

Jeff was enrolled in a life skills program located in a general education elementary school. The life skills class included students from kindergarten through fifth grade with mild to moderate developmental disabilities. The classroom had nine students, one teacher, and two educational assistants. All observations and data collection took place in this self-contained classroom. All commands were given within the context of on-going classroom activities and not during transition from non-instructional activities (e.g., playground) to the classroom activities. All sessions were conducted by the classroom teacher (the second author). The classroom teacher was dually certified to teach elementary and special education and held Master of Science degree in special education. She had been teaching in this classroom, with these students, for the past 2 years.

The classroom teacher trained the two educational assistants to accurately record the dependent variable and steps for procedural integrity. Educational assistants observed the classroom teacher for 5 days, practicing data collection and determining locations for observations. During this training week data were compared for accuracy until agreement was 100% between the classroom teacher’s data and the educational assistant’s data. Both educational assistants reached 100% agreement with the classroom teacher by the end of the training week.

Experimental Design

A single subject withdrawal design (Barlow and Hersen 1984) was used to determine the effect of the HPCS on student compliance to low probability requests. In the first phase of the design (baseline), the teacher presented only the low-probability commands without the HPCS. The second phase introduced the intervention of the HPCS. The third phase returned to baseline, while the fourth phase replicated intervention. Follow-up was conducted 7 days after the last intervention session. During the course of the Follow-up phase, Jeff was prescribed Ritalin, so additional Baseline, Intervention, and Fading phases were implemented 2-weeks after the introduction of Ritalin. These additional phases allowed us to briefly examine the effect of Ritalin on request compliance and intervention effectiveness.

Procedure

Prior to the baseline, preliminary data were collected to empirically validate a list of high probability and low probability commands. The student had the ability to complete all commands on the list independently. The classroom teacher created a list of 18 common classroom commands. The teacher then issued each command randomly, 10 times, throughout a 2-week period. A percentage of compliance was determined for each individual command. Commands that the student complied to 80% (8/10) of the time or greater were determined to be high probability commands. Commands the student complied to 40% (4/10) of the time or less were determined to be low probability commands (Mace et al. 1988). Commands that the student complied 50% (5/10) to 70% (7/10) of the time were determined to be neither high nor low probability commands and were eliminated from the study. Of the original list of 18 commands, 15 commands met the criteria for either high or low probability. These 15 commands, and the percentage compliance during this 2-week period, are listed on Table 1.

Baseline

Two, 2-hour sessions per day (a morning session and an afternoon session) were observed, with each session consisting of a teacher-presentation of 10 random low probability commands. The 2-hour session time frame allowed the teacher to incorporate the commands into the natural context of a typical school day. The session ended when the tenth low-probability command was delivered; therefore, some sessions did not last the entire 2 h (average session time was 90 min). In each baseline session, the teacher delivered ten low probability commands chosen from

Table 1 Percentage of compliance with commands at screening

Classroom	Command percent compliance at screening (%)
LP	
Come here	10
Sit down	20
Go to your desk	10
Stand up	40
Get work from the box	40
Look at me	40
HP	
Clap your hands	100
Touch your toes	80
Raise your hand	80
Touch your head	90
Give me a high-five	90
Close the door	90
Jump up	100
Turn the lights on/off	90
Touch your belly	100

the list of low probability requests. The teacher stated the students' name, followed by the low probability command (e.g., "Jeff, sit down."). Following each low probability command, the teacher waited 10 s to record compliance or non-compliance. Non-compliance was ignored and compliance was verbally praised (e.g., "Good job sitting down."). The teacher waited at least one minute before asking the next low-probability command.

Intervention

Following baseline, intervention was introduced. Intervention sessions were similar to baseline except that each low probability command (LP) was preceded by three to five high probability commands (HP), randomly drawn from the preliminary list of commands (i.e., HP-HP-HP-HP-LP). The latency from the end of compliance to the HP and the delivery of the next HP, or the end of compliance to the HP and the delivery of the LP was no more than 5 s. For each high probability command given in the sequence, the teacher immediately praised the student for compliance (e.g., "Jeff, raise your hand," "Good job raising your hand.") and ignored non-compliance. Anecdotally, as reported by the teacher, high probability commands rarely (less than 10%) resulted in non-compliance. Similar to baseline, the teacher praised compliance and ignored non-compliance to the low probability command. The teacher waited at least one minute before initiating another HPCS.

Follow-up

Follow-up data were collected one week after the end of intervention. Procedures during this phase of the study were similar to those carried out during the intervention phase of the study. The student began taking Ritalin (10 mg daily; 5 mg 2 × day, am and pm) during the Follow-up phase.

Return to Baseline

Return to baseline occurred 2-weeks after Ritalin was begun. To begin to assess the effects of medication on command compliance and intervention effectiveness, two baseline sessions were conducted. Procedures during the return to Baseline were similar to the original Baseline phase; the teacher gave only one low probability command and recorded results as compliant or non-compliant.

Return to Intervention

After the return to Baseline, one intervention session of was run, using similar procedures as the original Intervention phase. The teacher gave three to five high probability commands followed by one low probability command.

Fading

Following the return to Intervention, three additional sessions were completed. During these sessions, the teacher used only one high probability command followed by one low probability command. This was done to determine if the percentage of compliance to low probability commands would remain as high as when the HPCS was used. Using a single high probability command prior to the low probability command was also a more classroom-natural procedure.

Measurement and Data Collection

The dependent variable was percentage compliance to a low probability command (e.g., "Go to your desk," "Sit down."). Compliance to low probability commands was defined as completion of the command within 10 s of end of the teacher request. Compliance to the HPCS (e.g., "Touch head," "Give me high five," "Clap your hands") was also monitored to ensure the command requests remained at a high level of compliance throughout the study. Compliance to both low and high probability requests was praised (e.g., "Good job."), while non-compliance to requests was ignored by the classroom teacher.

Inter-Observer Agreement and Procedural Integrity

Inter-observer agreement for low probability compliance was assessed through the use of the classroom educational assistant independently observing 29% of the sessions across baseline and intervention phases. Percentage of agreement was calculated by agreements over agreements plus disagreement and then multiplying by 100. Inter-observer agreement was 100% during the observed sessions.

The classroom educational assistant also monitored procedural integrity during 42% of all of the intervention sessions. A procedural checklist outlining steps performed by the teacher was used to monitor procedural integrity. The procedures monitored included, (a) teacher delivering three to five high probability requests followed by one low probability request in immediate succession, (b) teacher waiting 10 s to determine compliance to low-probability command, (c) teacher waiting at least one minute before giving another HPCS, (d) teacher using only the determined high probability and low probability commands, (e) teacher using student name before stating the commands, (f) teacher ignoring student noncompliance, and (g) teacher praising student after compliance to each of the high probability and low probability command. Procedural integrity was 98% across all intervention sessions observed.

Results

Figure 1 shows the percentage of compliance to low probability classroom commands through baseline, intervention, and fading phases. During the first

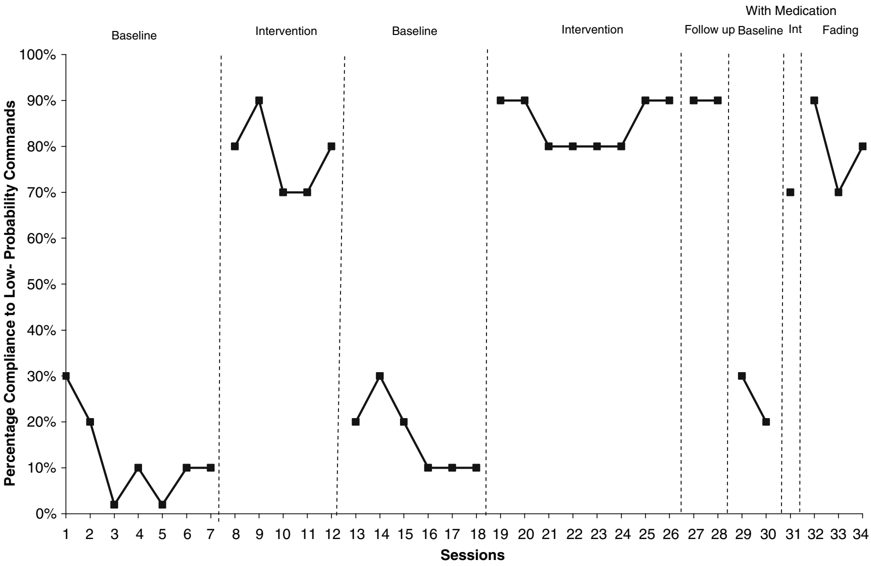

Fig. 1 The percentage compliance to low-probability commands

baseline phase, mean compliance to low probability commands was 13%, with a range of 0–30% compliance. During the first intervention phase, compliance immediately increased, and remained high at a mean of 78%, with a range of 70–90%. Upon the removal of intervention, the data immediately decreased and stabilized at levels similar to the initial baseline. During the return to baseline, mean compliance to low probability commands returned to a low level of 17% compliance, ranging from 10% to 30% compliance. When the intervention phase was re-introduced, mean compliance increased to 85%, ranging from 80% to 90% compliance. During the follow-up phase, 7 days following intervention, compliance to low-probability commands remained high at 90% for both sessions.

During the return to baseline phase (with Ritalin), mean compliance to low-probability commands returned to a mean of 25%, ranging from 20% to 30% compliance. A return to intervention phase was completed to ensure that the intervention remained effective. Jeff was compliant with 70% of low-probability commands presented during the intervention phase. During the HPCS fading phase, compliance to low probability commands remained high, with a mean percentage of 77%, ranging from 70% to 90%.

Discussion

The data presented replicate the finding of previous research examining the effects of (a) the HPCS on low probability command compliance (e.g., Austin and Agar 2005; Mace et al. 1988) and (b) fading the number of delivered high probability commands prior to the presentation of the low probability command (e.g., Ardoin et al. 1999). In addition the data also demonstrate an extension of methodological implementation from researcher-directed to classroom teacher-directed. Although research examining the effects of the HPCS has been conducted in applied settings (e.g., Lee et al. 2006; Mace et al. 1988), often the implementation requires additional support or research personnel to define variables, gather data, implement intervention, and analyze results. This study was initiated as a teacher response to a critical classroom concern, and was then designed, operationalized, and carried out entirely by the classroom teaching staff.

Lee et al. (in press) suggest teachers need interventions that are effective, yet can be implemented by teachers within the context of a busy classroom. In addition to teacher-directed classroom interventions, Belfiore et al. (2002) suggest these classroom interventions be designed and presented in such a way as to establish experimental control by demonstrating a functional relationship between intervention and behavior change. Conducting what Belfiore et al. (2002) describe as *behavioral analytic action research* addresses both the need for practicality of intervention in real world situations (i.e., teacher-friendly), and experimental control (i.e., functional relation). Behavioral analytic action research establishes a link between applied behavioral research and action research, and is (a) predicated on a practical problem, (b) linked to behavioral theory, (c) carried out exclusively by classroom staff/faculty within the context of the general classroom/clinic, (d) utilizing objective/direct methods of data collection, (e) implemented usually within a single subject methodology, and (f) establishes experimental control via demonstrating a functional relationship. Educators working in the context of behavioral analytic action research can (a) further extend the external validity of applied behavioral research, allowing for expanded dissemination of results, as well as (b) call to question some aspects of behavioral research that does not "hold up" when applied within the real world classroom or clinic by classroom or clinic staff (Belfiore et al. 2002).

In the current study, the classroom teacher and two educational assistants documented a practical classroom concern, developed a data collection methodology, and implemented an applied behavioral study in the context of the classroom environment. In addition the classroom teacher established experimental control by following a single subject withdrawal design methodology. Using the behavioral analytic action research model described above, this study further extends the external validity of the HPCS by demonstrating the effectiveness within the general education classroom, implemented solely by the classroom staff.

In addition to providing support for the use of the HPCS in applied settings, the current study also offers data, which contribute to the discussion of the theoretical underpinnings of the HPCS. Several theories have emerged when analyzing the effects of the HPCS on compliance to commands that have a history of non-compliance. For example, one explanation has described the HPCS in reference to establishing operations (motivating operation [MO] as suggested by Laraway et al. 2003), where the success on the HPCS potentiates the reinforcement of complying with low probability requests (Brandon and Houlihan 1997; Wilder and Carr 1998). In general, a MO has two defining effects: (a) altering effectiveness of reinforcers/

punishers (e.g. reinforcer-altering effect) and (b) altering the frequency of operant response classes related to those consequences (e.g., evocative effect) (Laraway et al. 2003). In this explanation, the HPCS, acting as a MO, would either (a) make compliance to low-probability commands more likely by making the reinforcer for compliance to those low-probability commands more powerful when preceded by the HPCS or (b) produce a state of deprivation making compliance to the low-probability request more likely in order to access the reinforcer that follows the request. A concern with the MO explanation is that to alter the value of the reinforcer (i.e., the HPCS, a conditioned reinforcer) the student would need to experience some level of deprivation that would occur prior to the initiation of the HPCS. The evocative effect would depend on some level of deprivation as well. However, the response class of compliance does not occur within such a state of deprivation. In fact, given a series of high and low-probability requests an individual would more likely experience satiation on the conditioned reinforcer associated with compliant behavior, which would result in a decrease in compliance over time (an effect not observed in research on HPCS).

Additionally, Brandon and Houlihan (1997) note that within the HPCS condition, reinforcement associated with compliant responding to high probability commands may function as a conditioned motivating operation (CMO) making more likely all behaviors (including low probability compliance) that have a history of reinforcement by the presenter. This suggests some stimulus control component of the HPCS (given the HPCS results in an increased likelihood of reinforcement), and the transfer of the control from the HPCS to the presenter of the HPCS (Brandon and Houlihan 1997). Austin and Agar (2005) suggest that in this situation the presenter becomes a discriminative stimulus establishing evocative control over low-probability responding due to the student's previous contact with reinforcer associated with compliance to the HPCS in the presence of the presenter.

Two examples work against the CMO explanation. First, if the presenter of the HPCS becomes associated with HPCS reinforcement, then compliant responding to low probability commands should not return to initial baseline levels during the return to baseline phase, if using an ABAB design. This is not the case in the current study, or previous studies (e.g., Austin and Agar 2005; Hutchinson and Belfiore 1998). In the current study, following the initial intervention phase, behavior immediately returned to previous baseline levels when we returned to baseline when the intervention was withdrawn, even though the same intervention agent continued to deliver the low-probability commands. In a second example, Mace and Belfiore (1990), alternating two presenters delivering the HPCS, found that only when the HPCS was in place was there an observed change in compliance to low probability commands. When presenters alternated delivery of the low probability command only, behavior returned to baseline levels. Behavior changed as a result of the HPCS, and not as a result of the presenter. If presenter and HPCS act as a MO/CMO, then the presenter alone should also function in some capacity as a CMO, effecting low probability compliance. This effect was not observed.

As an alternative explanation, Mace and colleagues (1988; 1990) have described the HPCS as having roots in the theory of behavioral momentum. In an effort to quantify the dynamics of behavior, Nevin et al. (1983) proposed a theory of behavioral momentum where operant behavior possesses a momentum that is analogous to physical momentum. In behavioral momentum, rate of responding (i.e., the frequency of behavior within a given response class) is analogous to velocity, and resistance to change (i.e., the persistence of behavior under varying environmental conditions) is analogous to mass (Nevin 1996; Nevin et al. 1983).

Most interventions developed within the behavioral momentum model have focused on increasing velocity (i.e., rate of responding) within a given response class (e.g., compliance). The increased rate, or frequency, of responding (e.g., velocity) results in increased resistance to change, allowing behavior to persist when disruption within the environment occurs (e.g., presentation of the low-probability requests). Increasing the rates of occurrence and reinforcement of members of the response class of compliance makes other members of the response class more probable. Therefore, compliance persists even when exposed to the low probability command. Critical with this description is the increase in local rate of reinforcement resulting from compliance within the HPCS. As reported, although only anecdotally by the classroom teacher, the participant in the current study complied with at least 90% of all high probability commands. Future HPCS research should formally gather levels of compliance to high probability commands, as well as inter-observer agreement data to more accurately reflect increased and consistent compliance within the HPCS. High and consistent levels of compliance within the HPCS establish an environment richer in reinforcement antecedent to the presentation of the low probability command. Within the behavioral momentum theory, the HPCS is only effective if compliant responding within, and associated reinforcement to, the HPCS is high. For example, (a) Davis and Reichle (1996) noted that compliance to low probability commands was less likely when compliance was low within the HPCS, and (b) Mace et al. (1988) found little effect when the three high-probability commands where replaced with three neutral declarative statements (e.g., “You have a nice shirt on today.”) requiring no student response prior to the delivery of the low-probability command. Persistence of compliant responding when faced with a low probability command is compromised when the rate of compliant behavior *and* reinforcement within the HPCS is minimized during the early stages of intervention. Once established, the HPCS can be faded to a more natural, single high probability command, as presented here and elsewhere (e.g., Ardoin et al. 1999).

Moving theory from the experimental laboratory to the applied classroom should result in some level of theory competition, as we attempt to draw connections among theory, basic research, and field applications. Too often applied behavioral research does not engage in such dialog, insulating itself from theoretical and basic research roots, and the field suffers (Mace 1994; Michael 1980). Applied behavioral research does not operate within a vacuum, but rather as an extension of theory and experimentation. One role of applied research is to serve as a link between experimental analysis and intervention generalizability; a link between the basic processes of behavior (the “why”) and the practical application (the “what”). It is within the light of this theory debate that the role of HPCS has been shown to be a useful technology within the field of behavioral sciences.

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