Effects of Fluency Building on Performance over “Long” Durations and in the Presence of a Distracting Social Stimulus

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The present study attempts to conduct and develop a systematic way of setting a frequency level that would allow an individual to perform a task for long durations and in the presence of a distracting social stimulus. Hindi speakers determined where to set frequency levels that could possibly lead to fluent performance on the endurance of a reading task. The same frequency level obtained by Hindi speakers served as a criterion in which undergraduate students read Hindi characters. For all three undergraduate participants, a steady rate of responding occurred while assessing endurance during 20-min timings. This suggests that performance for long durations without a significant reduction in responding may be a characteristic of fluent outcomes. During the distracting-stimulus phase, however, the data produced inconclusive results.

Two fundamental determinants of academic achievement include the amount of time that students actively engage on a task and the degree of success they experience with that task (Fisher, C. W., Berliner, D., C., Filby, N. N., Marlavi, R., Cahen, L. S., Dishaw, M.M., & Moore, J.E., 1978). Some of the behaviors that enable a student to perform well in school settings include attention to a task, staying on a task for extended periods of time, and performance in the presence of everyday distractors. Kafis and Stokes (1978), for example, examined the effectiveness of a preschool peer-tutor in facilitating generalized responding occurred function. On some days, normal preschool children took up to eight times as long to complete the same discrimination task in the presence of a peer tutor relative to in its absence. The implication in the literature suggests that small changes in the environment can produce significant changes in the completion of the task. In a typical school setting, students must stay on task for ling durations in an environment consisting of multiple distracting stimuli. A mastery criterion that facilitates on-task behavior and performance in the presence of everyday distracters may increase a student’s performance over time. Distractions may alter the performance of a task, depending on the different response class involved in the specific task. Margolin Griebel, and Wolford (1982) instructed undergraduate students to perform two distracting tasks independently (i.e., counting aloud and responding to a threshold shock) while reading or listening to a word or phrase.
The authors reported that both distracting tasks led to higher on-task performance for a listening task relative to a reading task. Other studies have shown that susceptibility to a distracting stimulus may be related to the difficulty level of the primary task. If a reduction in the difficulty level of the task occurs, then a distracting stimulus might not interfere with the primary task. Students with developmental disabilities often engage in inappropriate behaviors when performance drops significantly for long periods of time. A technique that allows an increase in attention to a task while simultaneously decreasing the frequency of inappropriate behaviors would provide practical implications for classroom instruction. By varying practice and measurement durations, teachers may better predict performance over long durations and performance in the presence of everyday distracters. Binder (1996) discussed two unpublished pilot-data sets as templates for future research on the persistence of responding across various conditions. In the first study, Binder (1984) observed students in kindergarten through eighth grade practicing writing math digits 0 through 9 as rapidly as possible. Teachers changed the duration of timing while keeping all other conditions constant. Students wrote for 15 s, 30 s, 1 min, 2 min, 4 min, 8 min, or 16 min.

The students who reached a rate of 70 responses per minute performed at the same level regardless of whether the duration was 15 s or 16 min. In contrast, some students who wrote at about 20 digits per min actually stopped writing before the end of 16 min. These observations suggest that students who have not yet attained minimal levels of performance necessary for a particular skill could not be expected to continue for longer than a brief duration without considerably slowing down.

In the second pilot study, Binder (1979) taught college students to say specific numbers to the point of 100% accuracy when presented with a printed Hebrew character. The students listened through headphones to a voice reciting random numbers as they performed the task. This auditory distracter inhibited task performance for participants with low-frequency levels. For some participants, the addition of the auditory distracter caused responding to stop completely. However, when the participant said the numbers paired with Hebrew characters at a high rate, the performance of the participant in the presence of the distracter was consistently paced. Binder concluded that after sufficient amounts of practice beyond a 100% accuracy, people could respond quickly and accurately without being distracted or slowed down by unexpected actions of the experimenter. In the behavioral literature, fluency can be defined functionally as a skill performed at a speed that produces REAPS outcomes (Binder, 1988; Binder, C., Haughton, E., Van Eyk, D., 1990). The literature suggests that individuals fluent at a skill enjoy several benefits. First, fluency can be characterized as a greater ability to maintain a response over time (i.e., retention) (Olander, Collins, McArthur, Watts, & McDade, 1986; Orgel, 1984). Orgel (1984) found that college students who showed high frequencies of correct responses performed twice as accurately on calculus formulas at a six-week follow-up than did students who did not obtain high frequencies. Second, fluency allows
a person to perform for extended periods of time and in the face of a distracting stimulus (i.e., endurance) (Binder et al., 1990).

Third, fluency may improve the combination of complex skills (i.e., adduction), (Binder, 1987; Evans, Mercer, & Evans, 1983). A crucial feature of fluency training depends on how to set a frequency level that will enable one to be fluent. Therefore, research investigating how to set levels and testing outcomes systematically to ensure fluency should be investigated in detail. Johnson and Layng (1992) illustrated the complex relations between retention, endurance, and fluency. The authors found that on a multiplication task, a student’s frequency of writing answers to a long multiplication task equaled 50 correct answers per min. When tested 30 days later her correct answers per min remained the same. However, when the 1-min timing was extended to a 5-min timing, the number of correct answers dropped to 10 per min with the occurrence of many errors. When the 1-min performance increased to 70 correct answers per minute, her performance remained at 70 per minute a month later during a 5-min timing. Johnson and Layng concluded that teachers need to adjust the retention aim to build endurance. For example, by increasing the number of correct answers written per minute on a multiplication task, students performed better over a longer timing. By investigating these outcomes individually, one may better select a frequency level that leads to fluent performance in specific areas.

The present study attempts to develop a systematic method for establishing frequency levels that allows an individual to perform a task for long durations and in the presence of a distracting stimulus. Undergraduate participants read Hindi characters at the same frequency level obtained from expert Hindi-readers. The undergraduate participants determined if the frequency level resulted in greater endurance on an identical task on a 20-min timing and in the presence of a distracting stimulus.

**METHOD**

**Participants and Setting**
Three female undergraduate students (Lynn, Cassie, and Helen) between the ages of 20 to 30 years and in their third or fourth year of undergraduate training served as participants. The participants solicited from the psychology classes had no prior history reading Hindi characters. A screening process ensured that the participants said sounds correctly and accurately and moved flash cards from one stack to another with ease. All sessions conducted in a classroom on a university campus consisted of 8 large tables, 20 chairs, and a dry-erase board in the front of the room. All sessions included a participant, experimenter, and another individual videotaping.

**Data Collection and Dependent Variables**
The dependent variables included the number of correct and incorrect responses per minute of saying the English translation when presented with a Hindi character on a flash card.
A response considered correct consisted of the participant saying the exact pronunciation of the Hindi character. A response considered incorrect consisted of the participant saying the wrong name or if the participant turned the flash card over to read the correct answer. The experimenters counted and graphed correct and incorrect responses and conducted the experimental conditions on consecutive days. The task of reading Hindi cards eliminated any confounds that occurred in which college students may have had prior exposure to this particular task. The experimenter conducted all sessions at approximately the same time each day. Trained undergraduate observers recorded correct and incorrect videotaped responses and used a counter to record the number of correct and incorrect responses for each minute within the session. The experimenter counted and reported correct and incorrect responses as count per minute.

**Inter-observer Agreement**

Research assistants conducted interobserver agreement checks for 30% on skill acquisition and 25% on the endurance tests. Minute-by-minute IOA calculation consisted of dividing the number of agreements by the number of agreements plus disagreements and multiplying by 100%. Mean IOA for Lynn, Cassie, and Helen, respectively, for each phase are as follows: (1) acquisition 99.6% (spread, 98% to 100%), 99.2% (spread, 97% to 100%), and 99.5% (spread, 98% to 100%), and (2) experimental phases 95.9% (spread, 89% to 100%), 96.2% (spread, 90% to 100%), and 98.9% (spread, 93% to 100%).

**Experimental Design**

Skill acquisition employed practice sessions of 1-min timings in which the experimenter recorded and graphed answers until the participant's reached the mastery criterion of 90 to 100 flash cards per min. The first condition after skill acquisition involved a fluency check. The fluency check ensured that the participants reached the criterion of 90 to 100 flash cards per minute before conducting endurance tests. The first condition consisted of assessing endurance during 20-min timings, followed by another fluency check, and finally ending with assessing endurance with distraction condition. The experimenter employed a multiple-treatment reversal design (ABAC) in the present study.

**Setting Frequency Levels**

Three Hindi speakers 20 to 30 years of age with at least 10 years of experience speaking and reading Hindi characters established the frequency goal for the participants. These three individuals could say Hindi phonics sounds at 80 responses per minute. The three individuals moved flash cards from one stack to another saying the English translation when presented with a Hindi character during two 20-min assessments. Undergraduate observers recorded correct and incorrect videotaped responses. Trained observers used a counter to determine the number of correct and incorrect responses for each minute within the session. Observers counted correct and incorrect responses and reported them as responses per minute. The Hindi-speakers used a stack of laminated flash cards with 25 different randomly chosen Hindi characters. The stack consisted of
200 flash cards on which 8 sets of 25 characters were written. The participants moved the flash cards from one stack to another as fast as they could and said the English translation during a 1-min timing. Several practice trials (e.g., 3 to 7) allowed speakers to orient themselves with and feel comfortable with the task. Three 1-min timings ensured that no warm-up effects occurred. Following the 1-min timing, the readers moved the flash cards for a 20-min timing. The observer recorded the number of correct and incorrect responses per minute during a 20-min timing. In another session, two additional individuals were present as Hindi readers entered the room. The additional individuals practiced a phonics task in which another student said Hindi phonic sounds as fast as possible while being timed by another individual. These individuals served as a possible visual and auditory distracter throughout the entire session. Three 1-min timings ensured that no warm-up effects occurred and determined the Hindi reader's performance following the introduction of a distracting stimulus (i.e., the two additional individuals). The timing involved a 20-min timing with the addition of the distracting stimulus. The highest number of correct responses during the I-min and 20-min timing for each participant equaled 90 answers per minute. The spread was set at 90 to 100 correct answers per minute and served as the criterion for undergraduate participants.

PROCEDURE

Skill Acquisition.
The participants first practiced 8 flash cards, and then learned another set of 8 cards. The participants now practiced these 16 learned flash cards together. Next, they practiced a final set of 9 new flash cards. The performance standard that allowed a participant to move to new flashcards equaled 90 to 100 correct answers per minute with 25 flash cards for three consecutive sessions. During skill acquisition with I-min timings, the experimenter modeled the correct pronunciation of the character and instructed the participant to repeat the sound three times for all of the flash cards. The experimenter gave the participant a stack of laminated Hindi flash cards and told her that if she was unsure of the sound that was paired with the character, she was permitted to flip the flash cards to see the answer. Therefore, the skill acquisition phase consisted of a self-feedback and correction method in which participants used flash cards by responding and checking their answers as they went through the flash cards. For all phase, a 1-min timing began once the participant read the flash cards. The experimenter gave the participants a stack of laminated Hindi flash cards and told her that if she was unsure of the sound that was paired with the character, she was permitted to flip the flash cards to see the answer. The highest number of correct responses during the I-min and 20-min timing for each participant equaled 90 answers per minute. The spread was set at 90 to 100 correct answers per minute and served as the criterion for undergraduate participants.
The distracting stimulus condition consisted of having two other individuals present in the room performing a similar phonics task. The additional individuals engaged in a phonics task that involved a teacher timing a student. The phonics task consisted of having another student say the Hindi phonic sound as fast as she could while being timed by another individual. The fifth timing was chosen because each participant's performance had stabilized by this point in the experiment. In addition, the participant would not have achieved a fluent performance by this time. The criterion for passing the acquisition phase for the participant included 3 consecutive minutes of reaching or surpassing the frequency level of 90 to 100 correct answers per minute. The participants moved to the second phase of the experiment, assessing endurance, after achieving the selected frequency level.

Assessing endurance during 20-min timings.

The experimenter told the participants that the new timings would be longer than the 1-min timings. The experimenter recorded the number of correct and incorrect responses per min during a 20-min timing. If the performance did not equal 90 to 100 correct responses per min, additional timings conducted allowed the participant to reach this fluency level for three consecutive sessions.

Assessing endurance with distraction

This condition used the same procedures as described under "assessing endurance during 20-min timings", with the exception that another student read Hindi characters as fast as she could while being timed by another teacher. The additional teacher and student served as a possible visual and auditory distraction throughout the 20-min performance of the three participants.

RESULTS

The results for Lynn are shown in Charts 1 to 3. Lynn's total acquisition and experimental sessions lasted approximately 4.5 hours. During skill acquisition, a steady acceleration in correct responding occurred with a subsequent deceleration in the number of errors until she reached the fluency level. Lynn's number of correct responses per min decelerated with the distracting stimulus (i.e., additional student and teacher) but had no effect on the frequency of errors. In the second acquisition phase, Lynn produced similar frequencies and errors upon completion of the mastery criterion. There was no apparent effect on the frequency of correct and incorrect responses with the reintroduction of the additional student and teacher in the third phase. The total acquisition (i.e., 25 flash cards) results showed similar outcomes to previous sessions in which the number of correct responses accelerated steadily and the errors subsequently decelerated to near no occurrences when the criterion of 90 to 100 correct answers per min was reached.

Stability was seen during the first and third phase, "Assessing Endurance during a 20-min timing". In the second phase, an initial deceleration in frequency occurred with the introduction of the distracting stimulus (i.e., additional student/teacher). A stable rate of responding was observed throughout the
Chart 1

Set One (8 cards)

Set Two (8 Cards)

Combined Set (16 Cards)

*=Distracting Stimulus

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Lynn

S/S Hindi Cards
fourth phase. In all of the experimental phases, there was slight bounce and low levels of errors.

The results for Cassie are shown in Charts 4 to 7. Cassie's total acquisition and experimental sessions lasted approximately 5 hrs. During skill acquisition, there was a steady acceleration in correct responding and a subsequent deceleration in number of errors until the fluency level was achieved. The introduction of the distracting stimulus accelerated Cassie's correct responses with a corresponding acceleration in errors. The total acquisition (i.e., 25 flash cards) results showed similar outcomes to previous sessions in which the number of correct responses accelerated steadily, and the errors subsequently decelerated to near no occurrences when the criterion of 90 to 100 correct answers per min was reached. There was no apparent effect on the number of correct responses with the introduction of the distracting stimulus in the second acquisition phase. The final distracting stimulus produced results similar to the first acquisition phase in which the number of correct responses accelerated with an acceleration in error rate. Upon completion of skill acquisition, the endurance tests produced stable rates across the two conditions. Few errors were seen across the four phases.

The results for Helen are shown in Charts 8 to 10. Helen's total acquisition and experimental sessions took approximately 4 hours to complete. During skill acquisition, there was a steady acceleration in the correct responding and a subsequent deceleration in the number of errors until the fluency level was reached. The distracting stimulus did not have an effect on the rate of correct and incorrect responding for the first phase (8 cards). The second and third distractions in acquisition showed a deceleration in the rate of correct responses. Upon completion of skill acquisition, the endurance tests produced stable rates across the two conditions. An acceleration in the number of errors was observed across the endurance tests.

**DISCUSSION**

All three of the non-fluent speaking participants developed stable responding across the three experimental conditions. This suggests that one characteristic of fluent performance is one can perform for long durations without a major reduction in responding. Assessments that included distractions, however, produced inconclusive results. These inconclusive data do not answer questions concerning the role of distraction with the performance of a fluent participant. The results of this study demonstrated a systematic way to set a frequency goal on a particular task in which a fluent performance is critical. The frequency level of non-fluent participants following practice in the experimental conditions matched the frequency of fluent-speaking participants. A systematic method in which an average frequency level of three fluent-speaking participants may establish an expert base rate for use with novices to produce similar performances.

In addition, this study contributes to the literature by providing further research on the use of a naturalistic distracter in a
Chart 5

Set Two (8 Cards)

Combined Set (16 Cards)

Set Three (9 cards)

* = Distracting Stimulus

Christine Kim

Cassie

S/S Hindi Cards

Shelly Bird  Shelly Bird
classroom setting. Many studies (Margolin, C., Griebel, B., & Wolford, G., 1982) employ loud noises as possible distracters; however, they are arbitrarily chosen and are not representative of a typical classroom setting. The distractions that were chosen for this study provided an analogous situation to an educational setting. This study presents an initial investigation in the area of fluency and endurance and the results should be interpreted with caution. It is imperative to acknowledge some caveats and issues that together may be considered limitations in this study. First, the distractions during skill acquisition showed a corresponding deceleration in correct responses per min for only four of the nine assessments with distractions across participants. Therefore, it is not entirely clear as to the effects of the distractions on the performances of the participants. This study might have better tested the distracters before the experimental phases were conducted to ensure that the condition chosen served a distracting function. Future studies must address this issue to determine what the role of fluency has on the performance of an individual in the presence of everyday distracters. A second limitation of this study is the use of an “error-ful” method, which was used in the acquisition phase to teach the non-fluent speaking participants the Hindi characters. The experimenters choose an error-ful method because it consists of teaching in a more natural way in which students typically learn. The literature suggests both positive and negative attributes when using the error-ful method compared to the error-less method for acquisition (e.g., Jones & Eayrs, 1992). Future studies might replicate this study by using errorless method procedures in the acquisition phase to determine whether this may affect results.

Third, the experimenters noted a reduction in responding in the 20-min timings immediately following a fluency check. During the acquisition phase, the participants needed to meet a mastery criterion of 90-100 correct responses per min before moving on to the next acquisition phase. During the experimental conditions, however, the experimenters did not tell the participants their rate for each minute since it was a 20-min timing. The condition preceding assessing endurance during a 20-min timing closely resembled the condition during the fluency check; therefore, there should not have been a sharp reduction immediately following the first experimental condition. There may have been a lack of motivation to “go fast” during these conditions because there were no social contingencies present during these phases in which an experimenter said the rate for each minute. In addition, the experimenter did not present a criterion to be reached during these conditions. Fourth, the present study might have incorporated control participants responding at lower levels to determine if fluency affected the performance. Future studies might conduct control conditions in which participants are trained to different frequency levels to determine the effect that a specific rate has on the performance over long durations and in the presence of everyday distracters. Studying different rates in fluency research will determine a critical frequency level that would lead to optimal performance. A sequence-effect confound may be another limitation of
the present study. All experimental sessions started with assessing endurance during a 20-min timing followed by assessing endurance with distraction condition for two times with each participant. Future studies might switch the order of the design to determine if the sequence of the design affected the individual's performance. Future research might also examine specific mechanisms that may be responsible for fluent performance. Specific variables might be studied in greater detail to determine what feature of fluency training leads to greater performance standards. Perhaps the rate of responding is what leads to expert performance. Another hypothesis might be that individuals who are fluent have more practice on a particular task. Therefore, practice effects may be responsible for optimal performance. This study serves as a model for preliminary research in the area of fluency and endurance. There has been a dearth of research thus far that addresses issues of endurance systematically and that are fundamental to our understanding of this concept. More research should be conducted to extend the literature on fluency training in greater detail.

REFERENCES


Christine Kim is affiliated with the Ohio State University; James E. Carr is affiliated with Western Michigan University; and Amy Templeton is affiliated with University of Nevada, Reno.