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**Precision Teaching and Dance Instruction**

A thesis submitted in partial fulfillment of the requirements for the degree of Master of  
Arts in Psychology

by

Marisela Pallares

Dr. Patrick M. Ghezzi/Thesis Advisor

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We recommend that the thesis  
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**MARISELA PALLARES**

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Patrick M. Ghezzi, Advisor

Linda Parrot Hayes , Committee Member

Stephen Rock, Graduate School Representative

David W. Zeh, Ph.D., Dean, Graduate School

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## Abstract

The history of behavioral coaching in sports dates back four decades and includes the use of behavioral techniques to enhance the performance of athletes in a variety of sports. Despite the amount of literature in this area, there are few studies that target dance and only one of these that evaluate fluency outcomes. Moreover, there is a need for a better understanding of fluency outcomes regarding motor behavior. Given the scarcity of sports performance research targeting dance and the scarcity of fluency-based approaches to sports performance and motor behavior in general, the study evaluated the effects on fluency outcomes, as a function of practicing basic tap-dancing steps. Results demonstrated emergence of fluency outcomes and generative effects across the training sequence.

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## Table of Contents

List of Tables .....	ix
List of Figures .....	ix
Introduction.....	1
Literature Review.....	2
Precision Teaching.....	4
Precision Teaching and Motor Behavior .....	6
Purpose.....	7
Methods.....	8
Experimental Design.....	8
Participants, Setting, and Materials .....	9
Response Targets .....	9
Tap Dance Analysis Software/Apparatus .....	10
General Procedures .....	12
Baseline.....	14
Frequency Building (FB) .....	14
Weekly Probes .....	16
Application Probes (Component/Composite Probes).....	16
Stability Probes .....	16
Endurance probes.....	17
Retention Probes .....	17
Behavioral Definitions .....	17

Data Analysis .....	18
Treatment Fidelity.....	20
Interobserver Agreement .....	21
Results and Discussion .....	21
Daisy .....	22
Andy.....	43
Tina .....	63
Berry .....	82
Jack .....	96
General Discussion .....	100
References.....	105
APPENDIX A.....	110
APPENDIX B .....	111
APPENDIX C .....	112
APPENDIX E .....	113
APPENDIX F.....	114
APPENDIX G.....	115
APPENDIX H.....	116

## List of Tables

Table 1. Tap Dance Steps Terminology .....	10
Table 2. Normative Sampling Data .....	13
Table 3. Daisy Pair 1 Outcomes .....	24
Table 4. Daisy Pair 2 Outcomes .....	27
Table 5. Daisy Pair 3 Outcomes .....	30
Table 6. Daisy Pair 4 Outcomes .....	34
Table 7. Daisy Endurance Outcomes.....	38
Table 8. Daisy Stability Outcomes .....	40
Table 9. Daisy Application Outcomes .....	42
Table 10. Andy Pair 1 Outcomes.....	45
Table 11. Andy Pair 2 Outcomes.....	47
Table 12. Andy Pair 3 Outcomes.....	50
Table 13. Andy Pair 4 Outcomes.....	54
Table 14. Andy Endurance Outcomes .....	59
Table 15. Andy Stability Outcomes.....	61
Table 16. Andy Application Outcomes .....	63
Table 17. Tina Pair 1 Outcomes .....	65
Table 18. Tina Pair 2 Outcomes .....	68
Table 19. Tina Pair 3 Outcomes .....	73
Table 20. Tina Pair 4 Outcomes .....	76
Table 21. Tina Endurance Outcomes.....	78

Table 22. Tina Stability Outcomes .....	80
Table 23. Tina Application Outcomes .....	82
Table 24. Berry Pair 1 Outcomes.....	84
Table 25. Berry Pair 2 Outcomes.....	86
Table 26. Berry Pair 3 Outcomes.....	89
Table 27. Berry Pair 4 Outcomes.....	91
Table 28. Berry Endurance Outcomes .....	93
Table 29. Berry Stability Outcomes.....	94
Table 30. Berry Application Outcomes .....	96
Table 31. Jack Constant Series Outcomes .....	97
Table 32. Constant Series Comparison: Exercise 6.....	99
Table 33. Constant Series Comparison: Exercise 8.....	99

## List of Figures

Figure 1. Tap Analysis Software Screen.....	12
Figure 2. Celerations and Classifications.....	20
Figure 3. Daisy Toe Taps.....	23
Figure 4. Daisy Heel Taps .....	24
Figure 5. Daisy Tip Steps.....	25
Figure 6. Daisy Dig Steps .....	26
Figure 7. Daisy Shuffle Steps .....	27
Figure 8. Daisy Windshield Wipers.....	29
Figure 9. Daisy Shuffles Right.....	32
Figure 10. Daisy Shuffles Left.....	32
Figure 11. Daisy Shuffle Steps-2.....	35
Figure 12. Daisy Windshield Wipers-2 .....	36
Figure 13. Daisy Endurance Probes.....	38
Figure 14. Daisy Stability Probes .....	40
Figure 15. Daisy Application Probes .....	42
Figure 16. Andy Toe Taps .....	43
Figure 17. Andy Heel Taps.....	44
Figure 18. Andy Tip Steps .....	46
Figure 19. Andy Dig Steps .....	46
Figure 20. Andy Shuffle Steps.....	48
Figure 21. Andy Windshield Wipers .....	49

Figure 22. Andy Shuffles Right .....	51
Figure 23. Andy Shuffles Left .....	53
Figure 24. Andy Shuffles Steps-2.....	55
Figure 25. Andy Windshield Wipers-2.....	56
Figure 26. Andy Endurance Probes .....	58
Figure 27. Andy Stability Probes.....	60
Figure 28. Andy Application Probes .....	62
Figure 29. Tina Toe Taps.....	64
Figure 30. Tina Heel Taps .....	65
Figure 31. Tina Tip Steps.....	67
Figure 32. Tina Dig Steps .....	67
Figure 33. Tina Shuffles Right.....	70
Figure 34. Tina Shuffles Left.....	71
Figure 35. Tina Shuffle Steps .....	74
Figure 36. Tina Windshield Wipers.....	75
Figure 37. Tina Endurance Probes.....	77
Figure 38. Tina Stability Probes .....	79
Figure 39. Tina Application Probes .....	81
Figure 40. Berry Toe Taps .....	83
Figure 41. Berry Heel Taps.....	83
Figure 42. Berry Tip Steps.....	85
Figure 43. Berry Dig Steps .....	85
Figure 44. Berry Shuffles Right.....	87

Figure 45. Berry Shuffles Left ..... 88

Figure 46. Berry Shuffle Steps..... 90

Figure 47. Berry Windshield Wipers ..... 91

Figure 48. Berry Endurance Probes ..... 92

Figure 49. Berry Stability Probes..... 94

Figure 50. Berry Application Probes ..... 95

Figure 51. Jack Constant Series Probes ..... 97

## Introduction

The history of behavioral coaching covers approximately four decades of utilizing behavioral techniques to enhance the training and performance of athletes in a long list of sports. The list includes football (Allison & Ayllon, 1980; Komaki & Barnett, 1977; Smith & Ward, 2006; Ward & Carnes, 2002), tennis (Allison & Ayllon, 1980; Ziegler, 1987), swimming (Hume & Crossman, 1992; Koop & Martin, 1983), soccer (Brobst & Ward, 2002; Ziegler, 1994), gymnastics (Allison & Ayllon, 1980), track and field, (Scott & Scott, 1997), in-line speed skating (Anderson & Kirkpatrick, 2002), basketball (Kladopoulos & McComas, 2001), martial arts (Harding, Wacker, Berg, Rick, & Lee, 2004), rugby (Mellalieu, Hanton, & O'brien, 2006) and many more.

Behavioral techniques have enhanced skills across a wide variety of sports and skill sets, and with a wide variety of intervention packages. Intervention packages have used positive reinforcement, descriptive feedback, video modeling, teaching with acoustical guidance (TAG), public posting, goal setting, and error-correction procedures among others (Luiselli & Reed, 2011). Despite the volume of literature on behavioral coaching and sports, there are just six published studies in dance, the topic of interest in this study.

Two of the six studies focus on teaching a beginning dancer how to perform a given step or sequence of steps (Quinn, Miltenberger, & Fogel, Victoria, 2015; Vintere & Poulson, 2004). Three of the studies focus on correcting the steps made by experienced dancers (Fitterling & Ayllon, 1983; Lokke, Lokke, & Arntzen, 2008; Vintere & Poulson, 2015). The one remaining study, which is only tangentially relevant to the present study,

focused on teaching leisure-dance skills to adults with developmental disabilities in service of integrating them into community living (Lagomarcino, Reid, Ivancic, & Faw, 1984).

### Literature Review

Vintere and colleagues (2004) compared the effects of two “teaching packages” on preschool-aged children who were just learning how to perform a few basic dance steps. One package included a teacher modeling a dance step and then praising each student for imitating the same step. The second package included the model + praise elements plus a third element, self-instruction, in which a young dancer was asked to repeat a phrase specific to the dance step as a means of improving the accuracy of the step. While the dancers in each condition eventually mastered the steps, the children receiving the self-instruction element learned the steps quicker than the other children.

A study by Quinn, Miltenberger, and Fogel (2015) used a procedure known as “TAG teach” to teach young dancers how to turn, leap and kick. Apropos to the TAG teach protocol, a “pinpoint response” (i.e., a given turn, leap or kick) was selected for each child and then “tagged” (i.e., reinforced with a sound) when it occurred. The results showed that the percentage of responses performed correctly increased for all dancers when and only when the TAG teach protocol was introduced.

The study by Fitterling and Ayllon (1983), which focused on correcting errors made by experienced dancers, was a replication of an earlier study by Allison and Ayllon (1980). In that earlier study, an error correction procedure was used with football players, tennis players and gymnasts. Each athlete was praised for “freezing,” which

meant standing still and attending to the coach while he or she modeled a correct response. The decrease in errors seen by Allison and Ayllon with their crop of athletes led the researchers (Fitterling & Ayllon, 1983) to use the same procedure with classical ballet dancers to correct the errors they made in executing four basic ballet movements: *degage*, *frappe*, *developpe*, and *grand batteman*. In addition to eliminating the errors made in these steps with their “freezing” protocol, the authors also discovered instances of stimulus generalization: the improvements the dancers made during instruction in their bar exercises generalized to floor exercises involving the same movements.

More recently, Vintere and Poulson (2015) built upon a previous error correction procedure used by Koop and Martin (1983) to reduce errors in swimming strokes. Vintere and Poulson’s “behavior movement-training (BMT)” included modeling, physical guidance, corrective feedback, and practice of correct and incorrect movements. The study used the BMT package to remediate a series of ballet movements for three female college students. Results showed an increase in accuracy across training sessions. The study also included maintenance and generalization probes of the ballet skills and in both cases, accuracy of the movements increased.

A study by (Lokke et al., 2008) centered on a 9-year-old ballet dancer who was performing a particular movement within a dance routine so poorly that it affected all other movements throughout the routine. The moves consisted of a sequence of three jumps on the left foot that culminated in a 90-degree turn. Researchers developed a correction procedure whereby the jumps and turn were removed from the dancer’s routine. Practice sessions were implemented wherein the dancer performed the movement as fast as possible during a series of 15s time periods. At baseline, the dancer

made 80 correct movements and four incorrect movements per minute. Nine days and 21 practice periods later, the dancer's correct movements increased to 188 correct jumps per minute with no errors. Researchers provided praise and approval along the way for surpassing the frequency of correct jumps while keeping the frequency of incorrect jumps at a minimum. When the jumps were re-introduced into the dance routine once more, the dancer was able to perform the move without error and without disruption to the overall dance routine.

The importance of the study by Lokke et al (2008) is that it introduced fluency-based instruction and a measurement system known as "precision teaching" to dance instruction. The literature on precision teaching and fluency has ardently demonstrated that taking a component-composite analysis approach and building skills to fluency in a hierarchical fashion with complex repertoires leads to faster skill acquisition and favorable outcomes (Binder, 1996a; Binder, Haughton, & Bateman, 2002; E. Haughton, 1972; McDowell & Keenan, 2001). Moreover, it has demonstrated that this approach can prevent cumulative dysfluency and produce generative learning, which involves applying fluent skills to new contexts and in new combinations with little to no instruction (Johnson & Layng, 1994).

### Precision Teaching

Precision teaching is the practice of basing instructional decisions on continuous performance frequencies displayed on the standard celeration chart (Lindsley, 1991, 1992). The practice is further associated with instructional strategies, which include timed practice as a means of achieving accurate and frequent responding plus

performance feedback, also known as frequency building (Kubina & Yurich, 2012).

Frequency building is one way of practicing that is efficient and effective (Kubina, 2005).

*Standard Celeration Chart (SCC).* Ogden Lindsley developed the SCC on the basis of Skinner's cumulative recorder (Binder, 1996a; Lindsley, 1991). As with the cumulative recorder, the SCC yields an exact count of behavior in real time (Binder, 1996b). Both axes of the SCC have a standard scale. Along the x-axis is an equal-interval scale expressed in successive calendar times (days, weeks, months, years) and along the y-axis is an equal-ratio scale expressed in frequencies of responding. The SCC can display frequencies (i.e., rates) ranging from 0.001 responses per minute (or 1 response per day) to 1000 responses per minute.

Changes in the frequency of behavior over time are called either (1) accelerations, which increase and thereby multiply in frequency over time, or decelerations, which decrease and thereby divide in frequency over time (Binder, 1996b). The major advantage of the SCC, according to Kubina & Yurich (2012), is that it depicts the absolute and relative amount of behavior change, the frequency and rate of behavior change, the proportion of behavior change, and the quantity of variability in behavior.

*Fluency.* Anyone who has played a sport, learned a musical instrument, or danced recognizes the importance of practice in order to master the skills of those domains (Binder, 1996b). In precision teaching, practice usually involves establishing a correct or appropriate response at a specified frequency aim range while concurrently lowering the frequency of incorrect or inappropriate responses (Kubina & Yurich, 2012). Practicing in this manner typically leads to behavior that is characterized as effortless,

automatic, or masterful as well as other desirable outcomes (Binder, 1996a; E. Haughton, 1972).

*Fluency Outcomes.* Johnson & Layng (Johnson & Layng, 1996) coined the term “RESA,” previously known as REAPS, to abbreviate the outcomes of fluency. *Retention* refers to the degree to which behavior persists despite relatively long periods of time without practice. *Endurance* is the degree to which behavior is sustained for relatively long periods of time without rest. *Stability* refers to the perseverance of behavior in the face of distractions. *Application* refers to the ability to combine component skills to perform related complex skills with little to no instruction. These five outcomes, according to Johnson and Layng (1996), define what it means to be fluent; indeed, behavior is not considered fluent until or unless each outcome is achieved. This concept of “functional mastery” is missing in sports instruction in general and dance in particular.

#### Precision Teaching and Motor Behavior

The majority of the literature on behavioral fluency has focused on academic skills (Berens, Boyce, Berens, Doney, & Kenzer, 2003; Brady & Kubina, 2010; Brooks Newsome, Nix Berens, Ghezzi, Aninao, & Newsome, 2014; Johnson & Layng, 1992, 1994; Luciano, C., Rodriguez, M., Manas, Ruiz, F., Berens, N. M., Valdivia-Salas, 2009; McTiernan, Holloway, Healy, & Hogan, 2016). Only a small minority of studies have focused on motor behavior.

The most widely targeted motor repertoires in the precision teaching literature are fine motor skills related to handwriting and the Big 6+6, pioneered by Haughton and his colleagues (Binder, 1996b; E. Haughton, 1972). The Big 6+6 consist of a set of 12 fine-

motor skills (reach, touch, point, grasp, place, release, push, pull, shake, squeeze, tap, twist), which have been identified as essential to complex motor behavior (Binder, 1996b).

Twarek, Cihon, & Eshleman (2010) demonstrated that young children with autism could perform composite Activities of Daily Living such as putting on a shirt, underwear, or socks with higher accuracy and decreasing duration after timed practice of the Big 6+6. Similarly, Fabrizio and colleagues (2007) taught a young boy the skill of squeezing, a deficit that prevented him from playing with certain toys that required the skill, using timed practice and reinforcement. The Big 6+6 approach has also been helpful in improving hand dexterity for sign language purposes with people suffering from traumatic brain injury (Chapman, Ewing, & Mozzoni, 2005; Eastridge & Mozzoni, 2005).

More recently, examples of training sports related behaviors through the lens of fluency building and the use of precision measurement are beginning to emerge, such as the study by Lokke and colleagues. Another example is that of McDowell and colleagues (2002), a study in which they employed time-based practice to build the rates of two component golf skills, which lead to better game performance for the participant and a drop in his handicap score.

### Purpose

Because it is a complicated repertoire of gross and fine-motor behaviors involving strength, flexibility, quickness, coordination and a high degree of cardiovascular and respiratory activity (Clarkson & Skrinar, 1988), dance serves as an ideal medium for

evaluating the relationship between component motor skills and composite motor skills (application) as well as the three additional outcomes of fluency (retention, endurance, and stability). The purpose of the current study, then, was to evaluate whether the outcomes of fluency emerge as a function of building high rates of fine motor behavior of the feet. To that end, the present study sought to teach basic tap steps to novice tap dancers while examining the effects on retention, endurance, stability, and application.

## Methods

### Experimental Design

The study utilized a multi-element, multiple-baseline across responses single-subject design with multiple probes (Horner & Baer, 1978) for examining fluency outcomes (i.e. RESA). The design included one constant-series baseline to compare the effects of intervention to what occurred without it and for the application probe series only. All steps entered Baseline (A) at the same time. Once the steps satisfied the inclusion criteria, a pair of steps entered Frequency Building (B). At this point, the next step pair underwent weekly application probes. Once the training step pair met the mastery criteria, the pair entered Retention Probe (C). In addition, probes for Application (of composite sequences), Endurance, and Stability were conducted at the end of training for each pair of steps and before the beginning of training for the next pair. Every pair followed this same progression until all pairs were taught with the exception of the composite combinations, which underwent application probes only.

The constant series participant underwent application probes for the composite combinations only.

## Participants, Setting, and Materials

The study included five adults. Two females, both 23-years old, and two males, ages 25 and 20, participated in all phases of the study, while the fifth adult, an 18-year-old male, participated in the constant series probe only. In addition to no dance instruction and apart from the 25 years old male in the study who played trumpet in grade school, no one reported any music instruction of any kind. Each participant reported that they played organized sports as children and teenagers, and only one (25-year-old male-Andy) continues to play as an adult.

All sessions took place at the Nelson Building property of the University of Nevada, Reno in a dance room equipped with one wall lined with mirrors and a wooden dance floor. Materials include data collection sheets, writing utensils, a video camera, scripts for the instructor, tap dance shoes for the participants and the instructor, and a Think Pad laptop computer with Tap Dance Analysis software.

## Response Targets

The tap dance steps were selected from the beginning curriculum at Fascinating Rhythm School of Performing Arts (FRSPA). These steps were organized in pairs and placed in a sequence of increasing complexity. The list includes four pairs that were trained and two longer sequences that were used to test for component/composite relations. The two longer sequences include combinations of the four training pairs and/or other basic tap steps.

Table 1 contains detailed descriptions of the selected target responses. It should be noted that not all training steps are included in the composite steps.

Table 1. Tap Dance Steps Terminology

Response	Description
Basic Terminology	
Heel Tap	Lifting heel from the ground and allowing it to drop to the floor without lifting any other part of the foot
Toe Tap	Lifting toe from the ground and allowing it to drop to the floor without lifting any other part of the foot
Dig	Jabbing the heel into the floor
Tip	Jabbing the toe into the floor
Brush	Striking ball of the foot in a forward motion
Spank	Striking ball of the foot in a backward motion
Step	Stepping on the ball of the foot with full weight
Basic Combinations	
Flap	[Brush + Step] traveling forward or backward
Shuffle	[Brush +Spank] remaining stationary
Split Shuffle	[Shuffle] with the accent on the front beat a slight pause between the brush and the spank
Experimental Responses	
Toe Taps	[Toe taps] alternating from one foot to the other
Heel Taps	[Heel taps] alternating from one foot to the other
Dig Step	[Dig + Step] alternating from one foot to the other
Tip Step	[Tip + Step] alternating from one foot to the other
Shuffles Right	[Shuffles] continuous on the right foot while balancing on the left foot
Shuffles Left	[Shuffles] continuous on the left foot while balancing on the right
Shuffle step	[Shuffle + Step] alternating from one foot to the other
Windshield Wipers	[Toe tap (outward) + Toe Tap (inward) + Heel Tap (outward) + Heel Tap (inward)] alternating from one foot to the other
Application Checks	
Exercise 6 (Traveling)	[Shuffle] + [Heel] + [Flap + Heel] traveling forward and backward
Exercise 8 (Stationary)	[Split Shuffle + Shuffle + Step + Heel] + Dig

*Definitions of basic terminology are provided first in the table. Then the names of these basic terms are used to explain basic combinations, experimental responses, and application probes. Brackets indicate movement on the same foot. A change in bracket would indicate a change to the other foot. Addition signs indicate the next movement in the sequence.*

### Tap Dance Analysis Software/Apparatus

A software program was designed to capture and analyze the sound of the taps and was used as well to provide performance feedback to a participant. The apparatus audio-recorded each tap and counted the total number of taps that occurred during a

timing. Because the software did not count the absence of a tap or count a tap that occurred when it should not have occurred, trained observers counted the total number of incorrect taps.

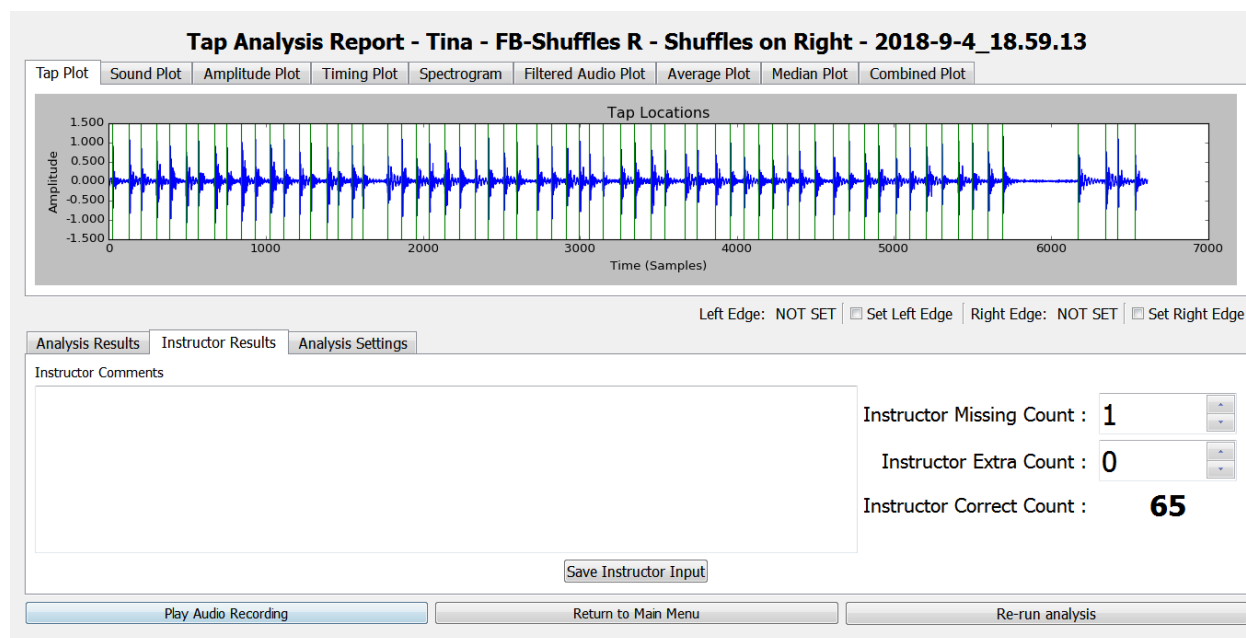
The software program provided a prompt after each timing so that the experimenter could enter the number of errors made. The software then calculated the total number of correct responses and total number of incorrect responses based on the total number of taps recorded and the total number of incorrect taps inputted by the experimenter.

The software gave a visual display of the number of total taps, number of correct taps, and the number of extra or missing taps. Figure 1 shows an example of the screen the experimenter (and the participant only in the frequency building condition) saw at the end of a timing. The sound wave produced by the taps is in blue. Green lines are overlaid on the sound wave to indicate the position of the taps. The closer the green lines are, the faster the participant tapped. The further apart the lines are, the slower the participant tapped. Evenly spaced lines indicate a steady pace, and unevenly spaced lines indicate a variable pace.

The distance between the green lines revealed whether the participant tapped with the appropriate timing. In the case of shuffles, for example, a participant was required to do a syncopation. If the participant executed the timing with accuracy, the pattern of syncopation would appear like the one in Figure 1, where two green lines (taps) are close together (a syncopated shuffle), followed by a comparatively larger gap in which the time between the end of a shuffle and the beginning of the next shuffle is seen.

The display also revealed whether a participant paused, missed a sound, or made an extra sound during a timing. This was helpful in providing the participant with feedback regarding their inter-timing performance. During feedback, the visual display was used to point out where the participant may have slowed down, sped up, maintained or fell out of the rhythm along with their performance feedback in terms of number of correctly executed tap steps and the number of missing and/or extra sounds.

Figure 1. Tap Analysis Software Screen.



*The screen shows what the participant and the experimenter saw at the end of the timing. The green lines overlaid on the blue sound wave represent taps.*

## General Procedures

*Normative sampling.* Ten experienced tap dancers enrolled in advanced tap classes and either competing on a tap dance team or working as a tap dance instructor were chosen to establish performance aims for all the dance step pairs used in the current study. The dancers executed two 15s timings for all the tap steps and sequences. For each

step, the average frequency was calculated for the normative sampling group. Aim ranges were set from 10% below the average frequency to 10% above the average frequency. Normative sampling data were also charted on the standard celeration charts to ensure that the ranges set according to this protocol were appropriate and attainable. Table 2 shows the aim ranges as well as the baseline criterion (60%) of aim for each step.

Table 2. Normative Sampling Data

Tap Step	Ave Frequency	Lower End	Upper End	60% of Aim
Toe Taps	360	324	396	216
Heel Taps	400	360	440	240
Tip Steps	300	270	330	180
Dig Steps	300	270	330	180
Shuffles Right	320	288	352	192
Shuffles Left	320	288	352	192
Shuffle Steps	360	324	396	216
Windshield Wipers	260	234	286	156
Exercise 6	320	288	352	192
Exercise 8	280	252	308	168

*Data from the 10 normative sampling dancers were averaged across each step. The lower end of the aim range was determined reducing the average by 10% and the upper end by increasing the average by 10%. The inclusion criterion for steps entering training is 60% or below. The table shows where those frequencies would have to fall to meet this criterion.*

*Sessions.* The experimenter served as instructor and conducted sessions four times per week at the Nelson Building. All sessions started with scripted instructions that described the step and its important features to the participant (tell), modeled the step for the participant (show), and then asked the participant to engage in the step (do). The instructor would then provide praise or corrective feedback to the participant after he/she engaged in the step. Once the participant had executed the step correctly and the participant did not have any questions, timings would begin. (See Appendices A, B, and C for detailed scripts).

*Timings.* When a participant was ready to engage in a timing, the software would start a countdown that entailed four tones plus the visual 3-2-1-0. The participant began tapping at the fourth tone for the length appropriate to the condition. The software would indicate the end of a timing with another tone. At this time, the participant would or would not receive feedback, depending on the particulars relevant to the condition.

### Baseline

Baseline sessions included three 15s timings for each step of a given pair of steps. The experimenter provided praise, corrective feedback, or performance feedback to the participant following the timings. The phase continued until one or all of the following four conditions were met: (1) The celeration of correct steps was equal to or less than X1.2; (2) Variability was equal to or greater than X2.0; (3) Relatively high rates of inaccurate or steps; or (4) frequencies were 60% or below the average aim.

### Frequency Building (FB)

Frequency Building (FB) sessions included three 15s timings for each step of a given pair of steps. The experimenter supplied either positive (praise) or corrective feedback contingent on the participant's performance (Appendix F). Additional details of this phase are described below.

Goal setting. A dancer's goal was established according to his/her overall performance in the study. Standard goal setting involved using the "personal best strategy" in which the individual's goal was to improve upon their best performance to date for a given step. Personal best goals could be set for increasing the frequency of correct steps, decreasing the frequency of incorrect steps, or the combination of the two.

There were times throughout the study, denoted on the individual figures and described below, where goal manipulation occurred as an intervention.

Goal failures. When a dancer failed to meet his/her goal for all three timings for one session, a modification was made. This included introducing a prompt, isolating a component of the failed step(s), shortening the timing length, or revising a goal.

The nature of the step(s) that led to a failed goal determined the modification(s). Prompts were used for correcting or improving a step that was impeding an increase in the frequency of correct steps and consequently the frequency of positive feedback. A commonly used prompt in the present study involved a metronome that gave participants a model of the speed and pace required to meet a goal.

If high errors occurred due to a specific component of step, then that component would be isolated and practiced in the timings. Once the isolated component reached its frequency aim, timings of the target step would resume. If a step occurred at a high rate at the beginning of a timing but slowed down at the end of the timing, or vice versa, or if high and low rates occurred sporadically throughout a timing, then the timing length was shortened.

Once the participant reached the frequency aim with the modification in place, it was removed, and sessions returned to normal.

Mastery. Mastery was achieved once the step reached the frequency aim range across two or more timings for three consecutive sessions. On some occasions, however, steps were considered mastered before meeting the aim range based on significant improvements in the weekly probes. In any case, once a step achieved mastery, it entered the Retention Probe stage.

## Weekly Probes

Weekly probes consisted of two 15s timings with no programmed feedback. These probes were conducted on all pairs except the first pair. The purpose of these probes was to evaluate generativity across subsequent step pairs following training in previous pairs in the sequence.

Schedule. The step pair the followed the training step pair was probed once a week, while the training step pair was in the frequency-building phase. Once the training step pair mastered the frequency-building phase, the pair experiencing weekly probes entered frequency-building, and the subsequent step pair into weekly probes.

## Application Probes (Component/Composite Probes)

The purpose of this probe was to test for composite and component relations between the training pairs and the composite sequences. Application probes consisted of two 15s timings with no programmed feedback.

Schedule. These pair probes occurred before baseline, following mastery of each training step pair, and at the end of the study.

## Stability Probes

The purpose of this probe was to test the degree to which the dance step frequencies persisted in the face of distractions that are similar to those present during performances. Stability probes consisted of two 15s timings with no programmed feedback. During each timing, the participant wore headphones that projected a tap choreography with music that differed from the rhythm of the target step. Wireless headphones and an iPhone with cellular functions turned off were used. The playlist was

set to shuffle for the duration of the session. In addition, the participants faced in the opposite direction of the mirror and toward the experimenter to simulate stage-like conditions.

Schedule. Stability probes occurred before baseline, following the mastery of each training step pair, and at the end of the study.

#### Endurance probes

The purpose of this probe was to test whether the tap step frequencies would persist at a timing length that was twice as long as the one used in baseline and training, i.e., from 15s to 30s. Endurance probes consisted of two 30s timings with no programmed feedback.

Schedule. Endurance probes occurred before baseline, following the mastery of each training step pair, and at the end of the study.

#### Retention Probes

The purpose of this probe was to test whether the step frequencies achieved in training persisted after a period of no practice. Retention probes consisted of two 15s timings with no programmed feedback. Probes included timings of the step that was mastered in Phase B. Schedule. Retention probes occurred 2 weeks and again at 4 weeks following the completion of Phase B for each training step pair.

#### Behavioral Definitions

The frequency (number per minute) of correct and incorrect responses was collected during each session. The total number of taps that occurred were audio-

recorded and counted by the software program. Errors fell into two categories, missing sounds and extra sounds. A missing sound was counted when a participant attempted a step but did not make contact with the floor and therefore failed to make the sound associated with a given step. A missing step was also counted when a step did not occur. If a participant made an error and restarted a sequence, the steps that would have followed were not counted as errors. An extra sound was counted when a dancer produced a sound that was supplementary given a particular sequence.

### Data Analysis

Frequencies were charted on a timing charts each session. The frequencies were then transferred either to a daily per minute chart, a weekly per minute chart, or a monthly chart. The step pair in FB and the following step pair being probed on a weekly basis were both transferred to the same daily per minute chart. Once a pair exited the weekly probe phase and entered FB, frequencies were transferred to a weekly per minute chart.

Retention probes were recorded on the same daily per minute chart that was used in FB in order to compare them to the frequencies achieved in Phase B. Frequencies for the remaining probes (stability, endurance, application, retention) were recorded on monthly per minute charts.

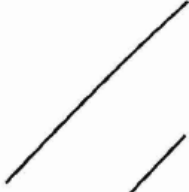
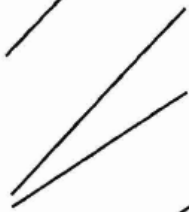




*Celeration.* While frequency is the occurrence of a given response over time, celeration is the change in frequencies of responding over time. In precision teaching, the most common use of this measure is to describe the rate of change per week when charting responses on the daily per minute chart. This study, in addition, utilized weekly

per minute charts for weekly probes and monthly per minute charts for endurance, stability, and application probes. Celeration values for these were calculated as a rate of change per month, and a rate of change per year respectively. Celeration values are expressed as a multiplication (X) if the response is increasing (acceleration) or as a division ( $\div$ ) if the response is decreasing (deceleration). Figure 2 shows classifications of celeration values useful in referencing the magnitude of change.

*Level Change.* The level change evaluates the value of change between one condition and the next. In the present study, the geometric mean was used to determine the level of each condition. To calculate the level change, the value of the second condition was divided by the value of the first condition yielding either a whole number or a decimal. A whole number indicates a rise in level, while a decimal indicates a decrease in level.

*Improvement Index.* The Improvement Index (Kubina & Yurich, 2012) measures the overall improvement of learning over time by combining the celeration value of the acceleration pinpoint (correct responses) and the celeration value of the deceleration pinpoint (incorrect responses) to produce a ratio. Expressed as a multiplicative (X) or divisional ( $\div$ ) value, it indicates improving or deteriorating performance over time.

Figure 2. Celerations and Classifications.

<u>Celeration lines</u>	<u>Celeration values range</u>	<u>Percentage weekly growth</u>	<u>Growth classifications</u>
	x3.0+	201%+ weekly growth	Super-massive growth celerations
	x2.0 - x3.0	101-200% weekly growth	Massive growth celerations
	x1.8 - x2.0	80-100% weekly growth	Exceptional growth celerations
	x1.4 - x1.8	41-79% weekly growth	Robust growth celerations
	x1.25 - x1.4	25-40% weekly growth	Acceptable growth celerations
	x1.0 - x1.25	0-24% weekly growth	Unacceptable growth celerations

*Though growth is expressed per week here, growth over any period of time can be calculated. Taken from The Precision Teaching Book (Kubina & Yurich, 2012).*

### Treatment Fidelity

Checklists were developed to assess for treatment fidelity (see Appendices G, H, & I). Trained observers completed the checklists for 25% of the sessions. “Y” indicated a correct procedural step, “N” indicated an incorrect step, and N/A indicated the step on the checklist was not applicable during the session. A fidelity score was calculated by dividing the total number of Y selections by the total number of selections and multiplying by 100%. On average, the experimenter demonstrated 99.5% fidelity (range of 82.2%-100%) regarding implementation of study procedures.

## Interobserver Agreement

The experimenter conducted sessions and collected the error data (discussed previously) that the software did not collect. Sessions were video recorded for purposes of assessing inter-observer agreement (IOA) on those data. Trained secondary observers viewed videos of the sessions and collected the data independently of the experimenter. IOA was collected for 25% of all sessions per step per participant. IOA was calculated by dividing the number of exact agreements for each timing by the total number of agreements plus disagreements and multiplying by 100%. The average IOA for each step is as follows: toe taps, 88.8% (83.3%-91.7%); heel taps, 84.7% (72%-93.3%); tip steps, 97.5% (90%-100%); dig steps, 84.2% (63.3%-93.3%); shuffles right, 67.1% (36.7%-61.3%); shuffles left, 59.1% (36.7%-80%); shuffles steps, 71.7% (61.7%-76.7%); windshield wipers, 80.4% (68.3%-86.7%); Exercise 6, 70% (33.3%-100%); Exercise 8, 52.7% (30%-63.3%). The high degree of variability in IOA for errors is a limitation of this study. Future studies should investigate better ways of measuring behaviors that occur at such high rates. Presumably, this will involve advances in technology since it is extremely difficult to hand count behaviors that occur in the 6<sup>th</sup> log of the SCC (100-1000 per minute).

## Results and Discussion

Though the family of standard celeration charts was used for analysis during the study, continuous line graphs showing the rate (i.e. frequency) of corrects and incorrect steps will be used to demonstrate the results in service of effectively communicating results to a non-precision teaching audience in a concise manner. The graphs will show

first-timing data. This measure was selected because it is the most conservative measure of changes in frequency from one session to the next. The results are presented in terms of each participant's performance, starting with Daisy and followed by Andy, Tina, Berry and then Jack, the constant series probe participant.

Daisy

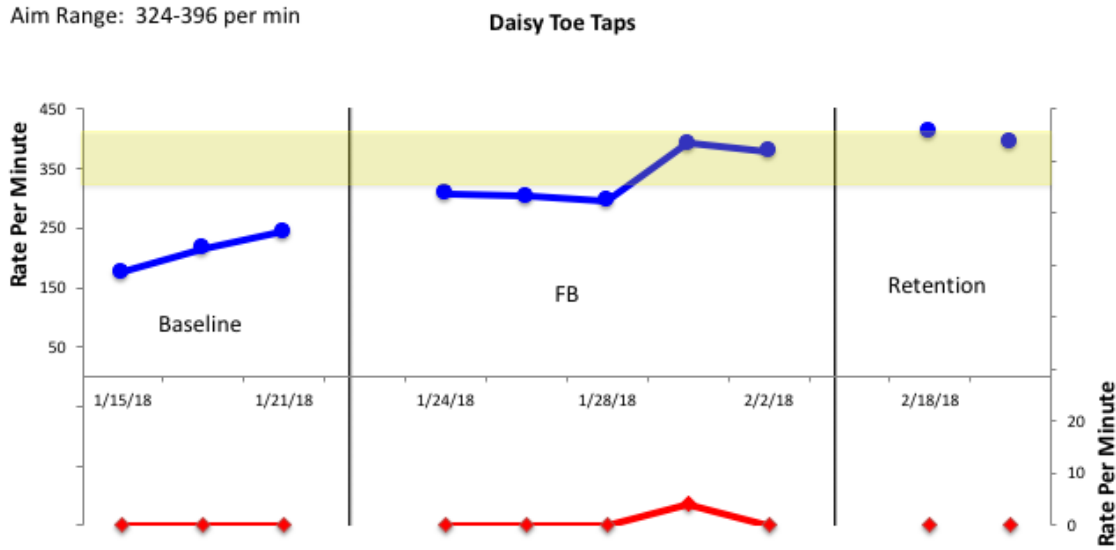
*Pair 1: Toe Taps and Heel Taps*

Figure 3 shows the toe tap data for Daisy. Toe taps during Baseline accelerated at a rate of X1.42 yet remained well below the aim range. No incorrect toe taps were recorded during this time. A change in level occurred from Baseline to FB whereby the rate of toe taps in the latter phase moved into the lower region of the aim range and remained there for three sessions until rising to the upper region for the final two sessions. A short-lived rise in incorrect toe taps occurred in the fourth session of FB. The retention probes for correct toe taps remained within the aim range, and no incorrect toe taps were recorded.

Daisy's heel tap data are shown in Figure 4. Heel taps remained within about 60% of the frequency aim range in Baseline and accelerated at rate of a X1.29 per week. No errors occurred this phase. When heel taps entered FB, the frequency of correct heel taps increased from 244 per minute in the last session of Baseline to 308 in the first session of FB. The frequency of correct heel taps accelerated at a rate of X1.23 during Phase B, while incorrect heel taps remained at zero. Heel taps met the mastery criteria within 5 sessions. During retention probes, correct heel taps were at or above the aim range, with no errors.

Figure 3. Daisy Toe Taps

Aim Range: 324-396 per min

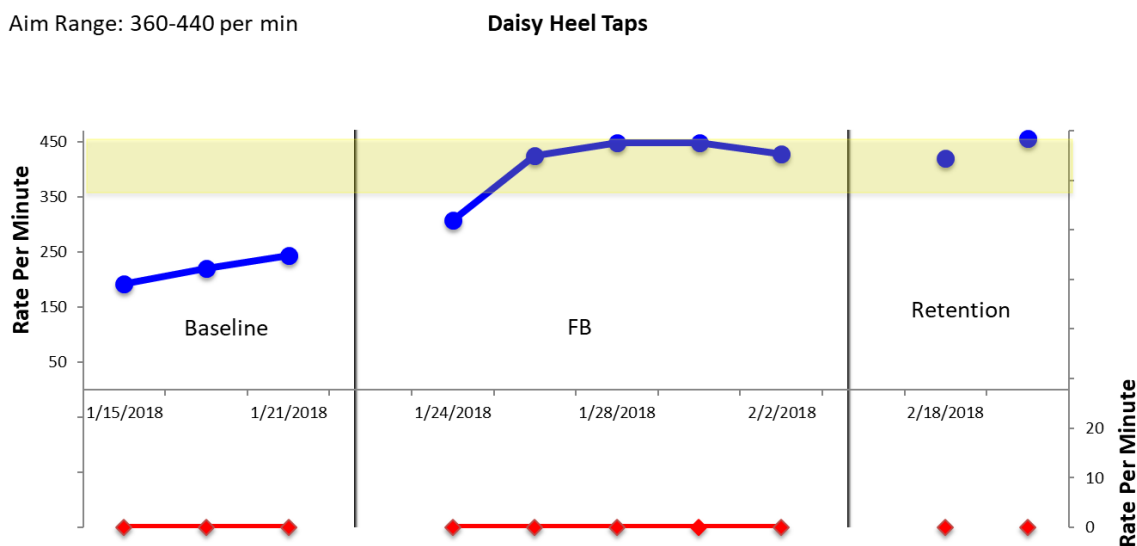


*The blue data series represents the frequency of correct steps (primary axis). The red data series represents the frequency of incorrect steps (secondary axis). The yellow band indicates the aim range. Both data sets are expressed as a rate per minute.*

To summarize, the frequency of Daisy's toe and heel taps were both below their respective aim ranges in Baseline, and both accelerated during this time at a modest rate, but a significant level change occurred from Baseline to FB, which put toe taps and heel taps in the aim range almost immediately. There was only one session when incorrect steps were recorded at a rate of 4 per minute. During all other FB sessions, no errors occurred. Toe and heel taps met mastery criteria quickly, and retention emerged, as evidenced by the fact that frequencies for both steps remained at aim during Retention probes. Table 3 shows additional data regarding Daisy's toe and heel tap performance.

Figure 4. Daisy Heel Taps

Aim Range: 360-440 per min



The blue data series represents the frequency of correct steps (primary axis). The red data series represents the frequency of incorrect steps (secondary axis). The yellow band indicates the aim range. Both data sets are expressed as a rate per minute.

Table 3. Daisy Pair 1 Outcomes

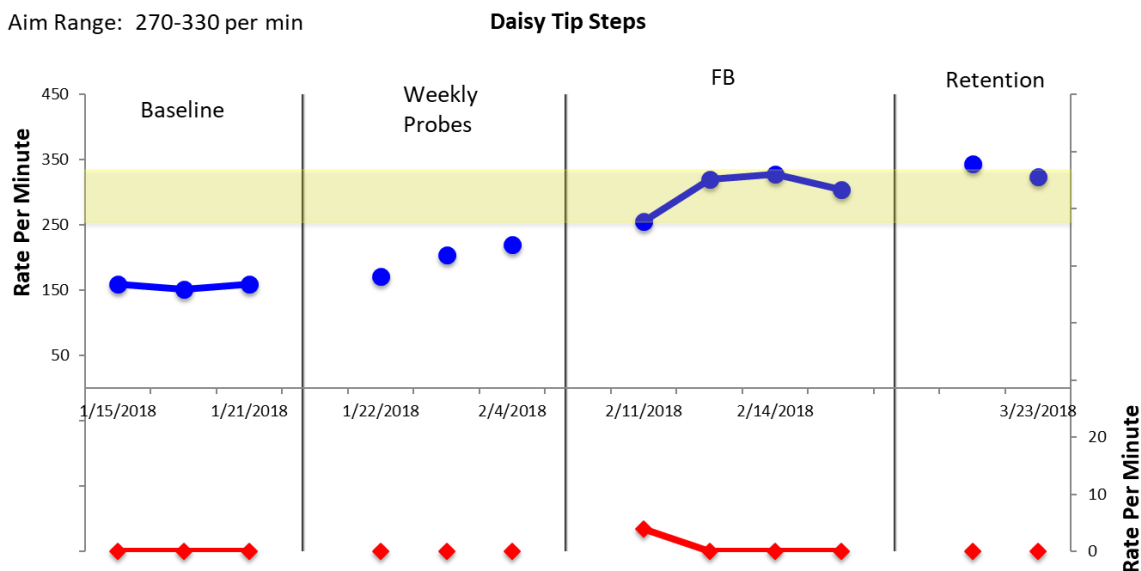
	Celeration		Growth/Decay (-)		Level Change		Improvement Index
	Accel	Decel	Accel	Decel	Accel	Decel	Overall
<b>Toe Taps</b>							
Baseline	X 1.42	X 1	33%	0%	-	-	X 1.42
Frequency	X 1.24	X 1.27	11%	17%	1.6	1.1	÷ 1.02
Retention	-	-	-	-	-	-	÷ 1.02
<b>Heel Taps</b>							
Baseline	X 1.29	X 1	29%	0%	-	-	X 1.29
Frequency	X 1.23	X 1	23%	0%	1.9	1.1	X 1.23
Retention	-	-	-	-	-	-	X 1.04

The metrics of celeration, percent growth and decay, level change from previous condition, and the overall improvement index for Daisy's Pair 1 per phase are shown above. For celeration and improvement index, an increasing value (acceleration) is indicated by a multiplication symbol (X) and a decreasing value (deceleration) is indicated by a division symbol (÷). For percent growth or decay, growth is shown as a positive number with no symbol and decay is shown as a negative number with a subtraction symbol (-). For level change, a whole number indicates a rise in level. The greater the number, the greater the level change. Decimals smaller than 1 indicate a decrease in level. Dashes (-) indicate one of two things: (1) there was no change in the metric or (2) the metric does not apply to the data set. Measures reflect the change per week for all conditions except for weekly probes, which is expressed as change per month (\*).

*Pair 2: Tip Steps and Dig Steps*

Figure 5 shows the data for Daisy's tip steps. All three baseline data points for correct tip steps fell below 60% of the aim range, and the frequency of correct tip steps decelerated by a  $\div 1.02$  per week. No errors were observed during Baseline. In the Weekly Probe phase, the frequency of correct tips accelerated by a  $\times 1.85$  per month. No incorrect tips were recorded during this phase. The frequency of correct tip steps increased from 220 to 256 per minute from the last Weekly Probe to the first FB session. The frequency of correct tip steps accelerated by a  $\times 1.1$  per week, while the errors decelerated by  $\div 1.59$  per week in FB. Tip steps met mastery criteria within 4 sessions. During retention probes, tips remained at or above the aim range with no errors.

Figure 5. Daisy Tip Steps

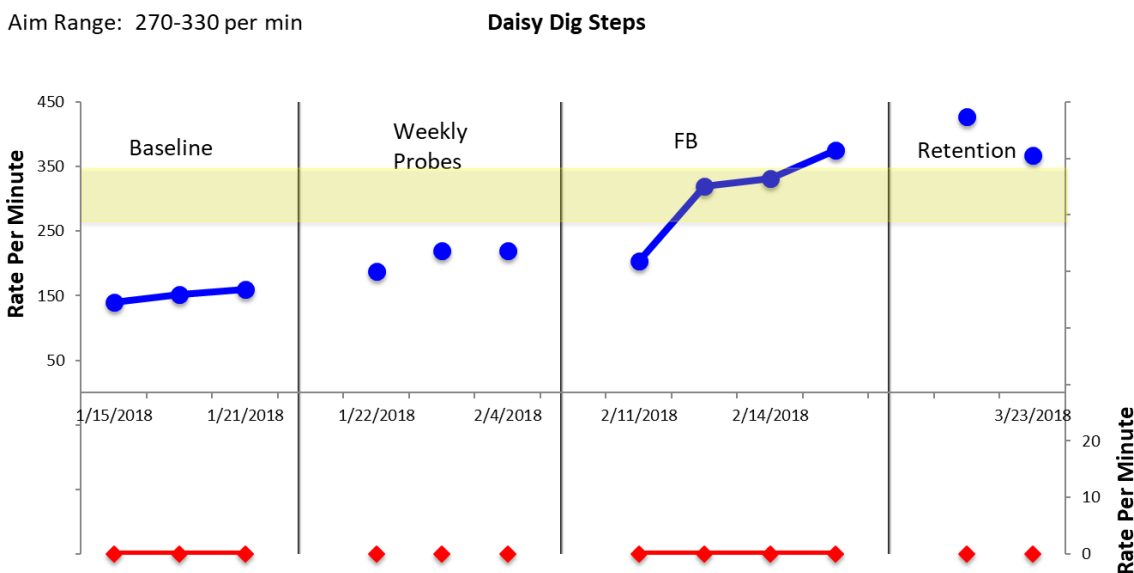


*The blue data series represents the frequency of correct steps (primary axis). The red data series represents the frequency of incorrect steps (secondary axis). The yellow band indicates the aim range. Both data sets are expressed as a rate per minute.*

Figure 6 shows the data for Daisy's dig steps. The baseline data points for correct dig steps all fell below 60% of the frequency aim with an acceleration of  $\times 1.15$  per week. No errors were observed during Baseline. In the Weekly Probe phase, the frequency of correct dig steps accelerated by a  $\times 1.48$  per month. No errors occurred during the probe phase. The frequency of

correct dig steps increased quickly throughout FB and met or exceeded the aim range during the last three (of four) sessions. The frequency of correct steps accelerated by a X1.6 per week, and no errors were observed. Dig steps met mastery criteria within 4 sessions and, during retention probes, the steps remained above the aim range without errors. Table 4 shows additional details of Daisy's tip and dig step performance.

Figure 6. Daisy Dig Steps



*The blue data series represents the frequency of correct responses (primary axis). The red data series represents the frequency of errors (secondary axis). The yellow band indicates the aim range. FB is a shortened label for frequency building. Both data sets are expressed as a rate per minute.*

To summarize, tip steps and dig steps showed little change in Baseline. The Weekly Probes, which coincided with the training of toe taps and heel taps, showed that the frequency of correct dig steps clearly increased. This suggests that application occurred for tip steps and digs steps as a function of training toe taps and heel taps. Moreover, there was a significant level change from the Weekly Probes to FB, suggesting that the components of the frequency building condition led to rapid mastery of the tip and dig steps. The frequency of both steps during the

Retention probes remaining at or above the top of the aim for both steps demonstrated maintenance across the span of one month without practice.

Table 4. Daisy Pair 2 Outcomes

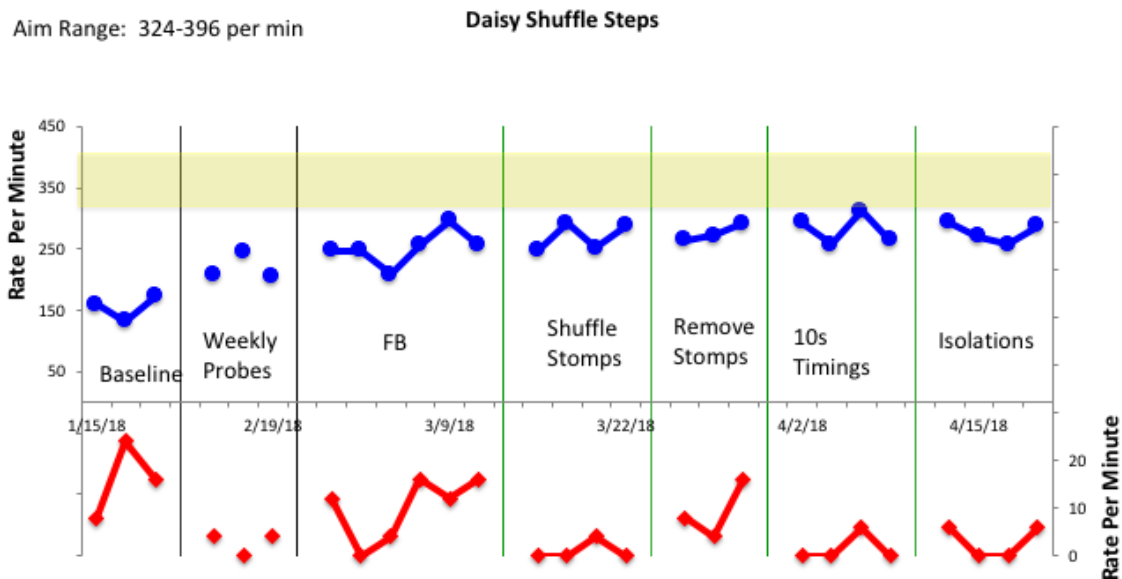
	Celeration		Growth/Decay (-)		Level Change		Improvement Index
	Accel	Decel	Accel	Decel	Accel	Decel	Overall
<b>Tip Steps</b>							
Baseline	÷ 1.02	X 1	-2%	0%	-	-	÷ 1.02
Weekly Probes*	X 1.85	X 1	85%	0%	1.3	1	X 1.85
Frequency	X 1.1	÷ 1.59	10%	-37%	1.5	1.2	X 1.75
Retention	-	-	-	-	-	-	÷ 1.02
<b>Dig Steps</b>							
Baseline	X 1.15	X 1	15%	0%	-	-	X 1.15
Weekly Probes*	X 1.48	X 1	48%	0%	1.4	1	X 1.48
Frequency	X 1.6	X 1	60%	0%	1.4	1	X 1.6
Retention	-	-	-	-	-	-	÷ 1.06

The metrics of celeration, percent growth and decay, level change from previous condition, and the overall improvement index for Daisy's Pair 3 per phase are shown above. For celeration and improvement index, an increasing value (acceleration) is indicated by a multiplication symbol (X) and a decreasing value (deceleration) is indicated by a division symbol (÷). For percent growth or decay, growth is shown as a positive number with no symbol and decay is shown as a negative number with a subtraction symbol (-). For level change, a whole number indicates a rise in level. The greater the number, the greater the level change. Decimals smaller than 1 indicate a decrease in level. Dashes (-) indicate one of two things: (1) there was no change in the metric or (2) the metric does not apply to the data set. Measures reflect the change per week for all conditions except for weekly probes, which is expressed as change per month (\*).

### Pair 3: Shuffle Steps and Windshield Wipers

The data for Daisy's shuffle steps is shown in Figure 7. Shuffle steps fell 60% below the frequency aim range throughout Baseline. The frequency of correct shuffle steps decelerated by a ÷1.03 per week, while the frequency of incorrect shuffle steps accelerated by a X2.84 per week. During the Weekly Probes, the frequency of correct shuffle steps continued to decelerate by a ÷1.05 per month, with no change in the celeration of incorrect shuffle steps. The frequency of correct shuffle steps accelerated by a X1.14 per week in FB, however, incorrect shuffle steps also accelerated by a X2.06 per week and, at one point, occurred at 16 incorrect shuffle steps per minute.

Figure 7. Daisy Shuffle Steps



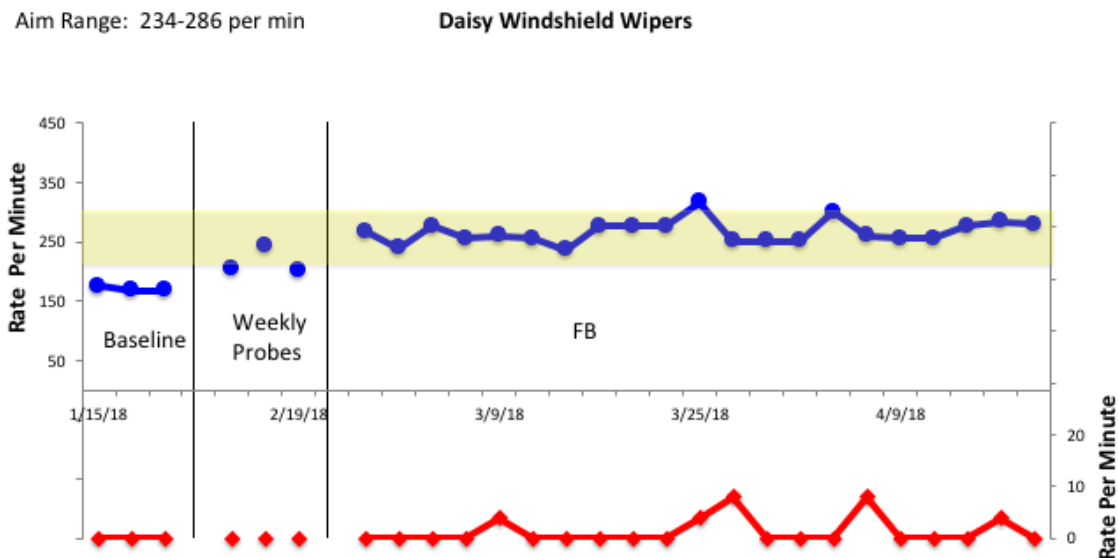
The blue data series represents the frequency of correct steps (primary axis). The red data series represents the frequency of incorrect steps (secondary axis). The yellow band indicates the aim range. Both data sets are expressed as a rate per minute.

Given this increase in incorrect shuffles, an intervention was introduced whereby Daisy practiced shuffle stomps (a stomp requires the full foot to meet the ground) for the first 2 timings and performed one timing of shuffle steps. The intervention produced a deceleration of  $\div 1.75$  per week in the frequency of incorrect shuffle steps and reduced the frequency to under 10 per minute. Once the intervention was removed, the frequency of correct shuffles accelerated at a rate of  $\times 1.27$  per week, yet incorrect shuffles also accelerated at a rate of  $\times 8$  per week. This necessitated a second intervention, which was reducing the timing length to 10s (10s Timings in Figure 9 and Table 5.) This reduction lowered the frequency of incorrect shuffle steps.

The frequency of correct shuffle steps remained steady at just below the aim during these two interventions, which called for a third intervention whereby Daisy practiced shuffle steps in isolation on the right and the left foot before a timing. This intervention was ineffective, as the acceleration of correct steps was unchanged at  $\times 1.01$  per week. Instead of attempting another

intervention, shuffle steps (along with its partner-windshield wipers) returned to Weekly Probes, and the next pair, shuffles right and left, entered FB.

Figure 8. Daisy Windshield Wipers



The blue data series represents the frequency of correct steps (primary axis). The red data series represents the frequency of incorrect steps (secondary axis). The yellow band indicates the aim range. Both data sets are expressed as a rate per minute.

The data on Daisy's windshield wipers are shown in Figure 8. The frequency of her wipers was just below the aim during baseline and decelerated ( $\div 1.06$  per week) during this period. No errors were observed during Baseline. A significant level change in the frequency of correct wipers occurred from Baseline to the Weekly Probe condition, within which the frequency of correct steps fell just within the aim range. No errors were observed during the probe phase. The frequency of correct wipers increased to within the aim range immediately upon entering FB and stabilized within the aim range with little change ( $\times 1.01$  per week). Incorrect steps occurred at times in FB, however, the acceleration values remained low ( $\times 1.04$  per week). Windshield wipers met the mastery criteria within the first three sessions of FB. Additional details regarding Daisy's shuffle steps and windshield wipers performance are shown in Table 5.

Table 5. Daisy Pair 3 Outcomes

	Celeration		Growth/Decay (-)		Level Change		Improvement Index
	Accel	Decel	Accel	Decel	Accel	Decel	Overall
<b>Shuffle Steps</b>							
Baseline	÷ 1.03	X 2.84	-3%	184%	-	-	÷ 2.93
Weekly Probes*	÷ 1.05	X 1	-5%	0%	1.4	0.22	÷ 1.05
Frequency	X 1.14	X 2.06	14%	106%	1.1	2.2	÷ 1.81
Shuffle Stomps	X 1.05	÷ 1.75	5%	-43%	1.1	0.5	X 1.84
Remove Stomps	X 1.27	X 8	27%	700%	1	2.3	÷ 6.31
10s	÷ 1.05	X 1.15	5%	15%	1	0.4	÷ 1.21
Isolations	÷ 1.04	X 1	-4%	0%	1	1.2	÷ 1.04
Weekly Probes 2*	X 1.02	÷ 1.3	2%	-23%	0.9	1.7	X 1.33
Frequency 2	÷ 1.05	÷ 1.22	-5%	-18%	1.3	0.7	X 1.17
Retention	-	-	-	-	-	-	X 1.84
<b>Windshield</b>							
<b>Wipers</b>							
Baseline	÷ 1.06	X 1	-6%	0%	-	-	÷ 1.06
Weekly Probes*	÷ 1.05	X 1	-5%	0%	1.3	1	÷ 1.05
Frequency	X 1.01	X 1.04	1%	4%	1.2	1.3	÷ 1.03
Weekly Probes 2*	÷ 1.02	X 1.09	-2%	-9%	1	1	÷ 1.12
Frequency 2	X 1.01	÷ 1	1%	0%	1.1	0.8	X 1.01
Retention	-	-	-	-	-	-	X 1.02

The metrics of celeration, percent growth and decay, level change from previous condition, and the overall improvement index for Daisy's Pair 3 per phase are shown above. For celeration and improvement index, an increasing value (acceleration) is indicated by a multiplication symbol (X) and a decreasing value (deceleration) is indicated by a division symbol (÷). For percent growth or decay, growth is shown as a positive number with no symbol and decay is shown as a negative number with a subtraction symbol (-). For level change, a whole number indicates a rise in level. The greater the number, the greater the level change. Decimals smaller than 1 indicate a decrease in level. Dashes (-) indicate one of two things: (1) there was no change in the metric or (2) the metric does not apply to the data set. Measures reflect the change per week for all conditions except for weekly probes, which is expressed as change per month (\*).

Because the design of the study required training pairs of steps, and in order to maintain an equal number of timings over sessions, windshield wipers continued until a change was achieved in its paired partner, shuffle steps. This presented the opportunity to track the long-term maintenance of windshield wipers. As with shuffle steps, wipers returned to Weekly Probes while the fourth pair of steps was in training.

The data on shuffle steps, in contrast to wipers, were problematic in that no celeration occurred once the weekly probes ended and FB began, and the interventions designed to boost

the frequency of shuffles failed. Shuffle steps, evidently, were in the wrong location in the training sequence, and alternative steps thus needed to be trained and acquired before shuffle steps. This led to the conclusion that “shuffles right and left” may be the component steps within the shuffle steps composite, and not the other way around.

*Pair 4: Shuffles Right and Shuffles Left*

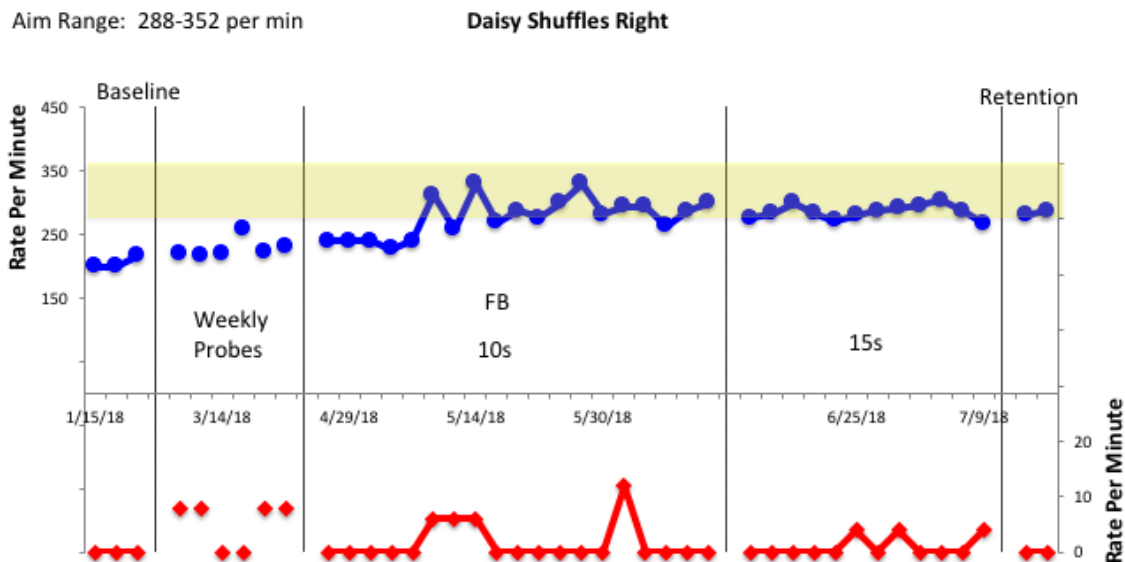
Figures 9 and 10 show the data for Daisy’s right and left shuffles, respectively. The baseline frequency for shuffles right was just above 60% of the aim. The frequency of correct steps accelerated at a rate of X1.06 per week, and no incorrect steps were recorded during this time. There was minimal acceleration during the Weekly Probes for correct steps (X1.06 per month) as well as for incorrect steps (X1.1 per month).

Since little improvement occurred during Weekly Probes, FB began with an intervention that reduced the timing from 15 sec to 10 sec. No change in the frequency of correct and incorrect steps was seen for the first five sessions. The frequency of correct steps increased in the sixth FB session, as did the frequency of incorrect steps. After the sixth session, the frequency of correct steps stabilized at the lower end of aim. Apart from the rise in incorrect steps during sessions 6-9 and again at session 15, the remaining sessions were free of errors. The frequency of correct steps accelerated at a rate of X1.01 per week during FB, while incorrect steps decelerated at a rate of  $\div 1.03$  per week.

Once shuffles right stabilized, the standard 15 sec timing was implemented. Correct shuffles right remained within or near the aim range during this time, and errors stayed within a 0-4 per minute rate. The mastery criteria for shuffles right was achieved within the first 3 sessions after introducing 15s timings. However, because the design required training pairs of steps, and to maintain equal numbers of timings throughout sessions, shuffles right continued

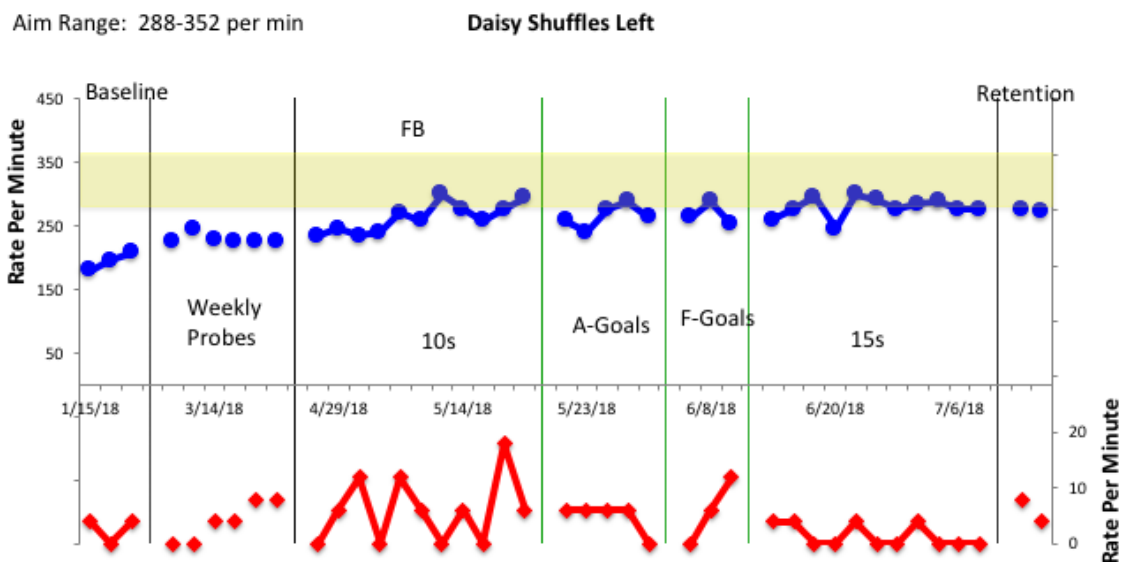
until its partner (shuffles left) also reached mastery criteria. The frequency of correct steps remained near aim during Retention probes, while errors remained at zero levels.

Figure 9. Daisy Shuffles Right



The blue data series represents the frequency of correct steps (primary axis). The red data series represents the frequency of incorrect steps (secondary axis). The yellow band indicates the aim range. Both data sets are expressed as a rate per minute.

Figure 10. Daisy Shuffles Left



The blue data series represents the frequency of correct steps (primary axis). The red data series represents the frequency of incorrect steps (secondary axis). The yellow band indicates the aim range. Both data sets are expressed as a rate per minute.

Figure 10 shows the data for Daisy's shuffles left. Her baseline level started below 60% of the frequency aim with the first data point, however, the final two data points in baseline were slightly above the inclusion criterion. The frequency of correct shuffles left accelerated at a rate of X1.17 per week during baseline, which satisfied the inclusion criteria. No errors were observed during baseline.

The frequency of correct shuffles left during Weekly Probes decelerated at a rate of  $\div 1.01$  per month, while incorrect shuffles left accelerated at a rate of X2.32 per month. Given this increase in errors, FB started with an intervention that enforced a 10 sec timing length. Once shuffles left entered FB, the frequency of correct steps accelerated at a X1.05 per week. Incorrect steps accelerated by X1.16 per week, reaching a mark of 18 per minute during session 18.

Since incorrect shuffles left was increasing at a higher rate than correct shuffles left, an intervention was instituted whereby goals for accuracy were established (A-Goals). Setting these goals resulted in a deceleration of incorrect shuffles left of  $\div 1.21$  per week.

Once Daisy met her accuracy goals, she resumed FB and began making errors that accelerated steeply at a rate of X22.6 per week. Since her errors during this time were restricted to the first timing (she was error-free for last two timings of a session), the decision was to move forward with the standard 15 sec timing length. Incorrect shuffles left decreased to a range of 0-4 per minute, while the frequency of correct shuffles left remained at or near the aim range. The frequency of correct shuffles left remained near aim during the retention probes, while errors continued at a rate of 4-8 incorrect step per minute. Additional details regarding Daisy's performance on shuffles right and left are shown in Table 6.

Table 6. Daisy Pair 4 Outcomes

	Celeration		Growth/Decay (-)		Level Change		Improvement Index
	Accel	Decel	Accel	Decel	Accel	Decel	Overall
<b><i>Shuffles Right</i></b>							
Baseline	X 1.06	X 1	6%	0%	-	-	X 1.06
Weekly Probes*	X 1.06	X 1.1	6%	10%	1.1	2.5	÷ 1.04
Frequency	X 1.03	X 1.01	3%	1%	1.2	0.7	X 1.02
15s	X 1	X 1.08	0%	8%	1	0.7	÷ 1.08
Retention	-	-	-	-	-	-	X 1.02
<b><i>Shuffles Left</i></b>							
Baseline	X 1.17	÷ 1.37	17%	-27%	-	-	X 1.59
Weekly Probes*	÷ 1.01	X 2.32	-1%	132%	1.2	1.4	÷ 2.34
Frequency (10s)	X 1.05	X 1.16	5%	16%	1.2	1.3	÷ 1.11
A-Goals	X 1.02	÷ 1.21	2%	-18%	1	0.9	X 1.24
F-Goals	÷ 1.05	X 22.6	5%	2163%	1	0.6	÷ 23.8
15s	X 1.01	÷ 1.18	1	-16%	1.6	0.7	X 1.2
Retention	-	-	-	-	-	-	X 1.49

The metrics of celeration, percent growth and decay, level change from previous condition, and the overall improvement index for Daisy's Pair 3 per phase are shown above. For celeration and improvement index, an increasing value (acceleration) is indicated by a multiplication symbol (X) and a decreasing value (deceleration) is indicated by a division symbol (÷). For percent growth or decay, growth is shown as a positive number with no symbol and decay is shown as a negative number with a subtraction symbol (-). For level change, a whole number indicates a rise in level. The greater the number, the greater the level change. Decimals smaller than 1 indicate a decrease in level. Dashes (-) indicate one of two things: (1) there was no change in the metric or (2) the metric does not apply to the data set. Measures reflect the change per week for all conditions except for weekly probes, which is expressed as change per month (\*).

To summarize, shuffles right and shuffles left, as with shuffles, did not improve during Weekly Probes and, in fact, there was a marked increase in incorrect steps. These results suggest again that shuffles right and left were placed in the wrong order in the training sequence. It is likely that attempting to train shuffle steps before shuffles right and left may have produced a history of incorrect steps that inhibited mastery. Nonetheless, once the two steps reached the mastery criteria, the fluency outcome of retention emerged.

#### *Return to Pair 3: Shuffle Steps and Windshield Wipers*

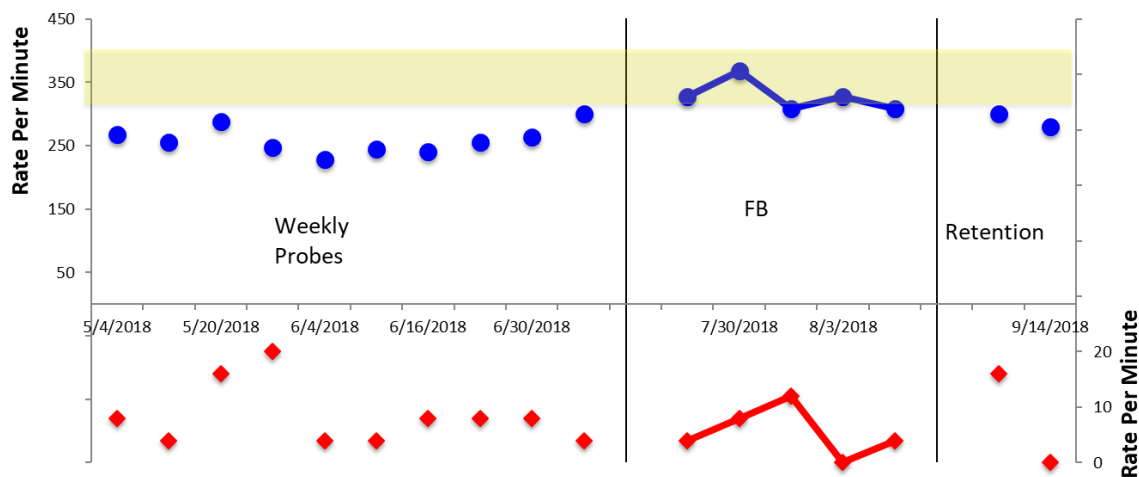
Figure 11 shows the data for Daisy's shuffle steps. As stated previously, shuffle steps returned to the probe phase while the fourth pair entered FB. During the second round of probes, the frequency of correct shuffle steps decreased, and the frequency of incorrect steps increased.

Toward the end of FB, however, this pattern was reversed. The frequency of correct steps had a celeration value of X1.02 per month and incorrect steps during this time decelerated at a rate of  $\div 1.13$  per month. The frequency of correct shuffle steps fell within the aim range immediately upon entering FB for a second time. An increase in the frequency of incorrect steps occurred during the first three sessions, reaching a high of 12 during session three. By the fourth and fifth session, incorrect steps dropped to within 0-4 per minute, while correct steps remained at or near aim. The frequency of correct steps was near aim on the first retention probe, however, incorrect steps were also frequent at 16 per minute. No errors occurred during the second retention probe, yet the frequency of correct steps dropped from 300 per minute during the first probe to 280 per minute during the second probe.

Figure 11. Daisy Shuffle Steps-2

Aim Range: 324-396 per min

**Daisy Shuffles Steps-2**

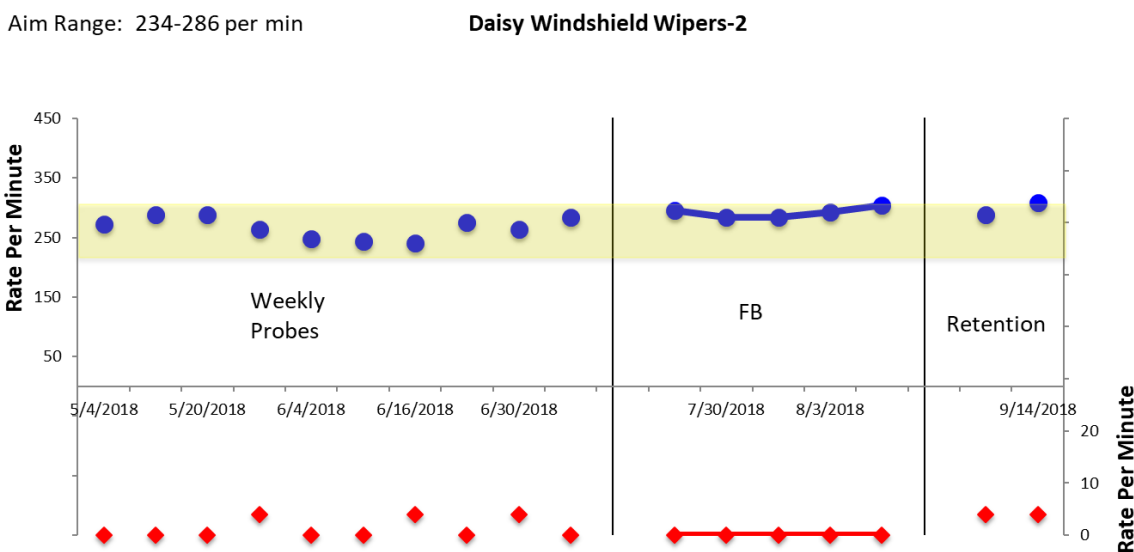


*The blue data series represents the frequency of correct shuffles (primary axis). The red data series represents the frequency of incorrect shuffles (secondary axis). The yellow band indicates the aim range. FB is a shortened label for frequency building. Both data sets are expressed as a rate per minute.*

The upturn in the frequency of correct steps and the downturn in the frequency of incorrect steps seen in the weekly probes for shuffle steps coincides with the later phases of training shuffles right and shuffles left. The improvement in shuffle steps at this time appears to

be a result of improvements in the frequency and accuracy of shuffles right and left. Further, it seems that a more appropriate order for the current training sequence is to teach shuffles right and left before shuffle steps. While retention checks show a downward trend in the frequency of correct shuffle steps, the difference on a standard celeration chart is negligible. It might be appropriate, nonetheless, to conduct retention checks more often, as this would be detected and could be a target for additional training.

Figure 12. Daisy Windshield Wipers-2



*The blue data series represents the frequency of correct windshield wipers (primary axis). The red data series represents the frequency of incorrect windshield wipers (secondary axis). The yellow band indicates the aim range. FB is a shortened label for frequency building. Both data sets are expressed as a rate per minute.*

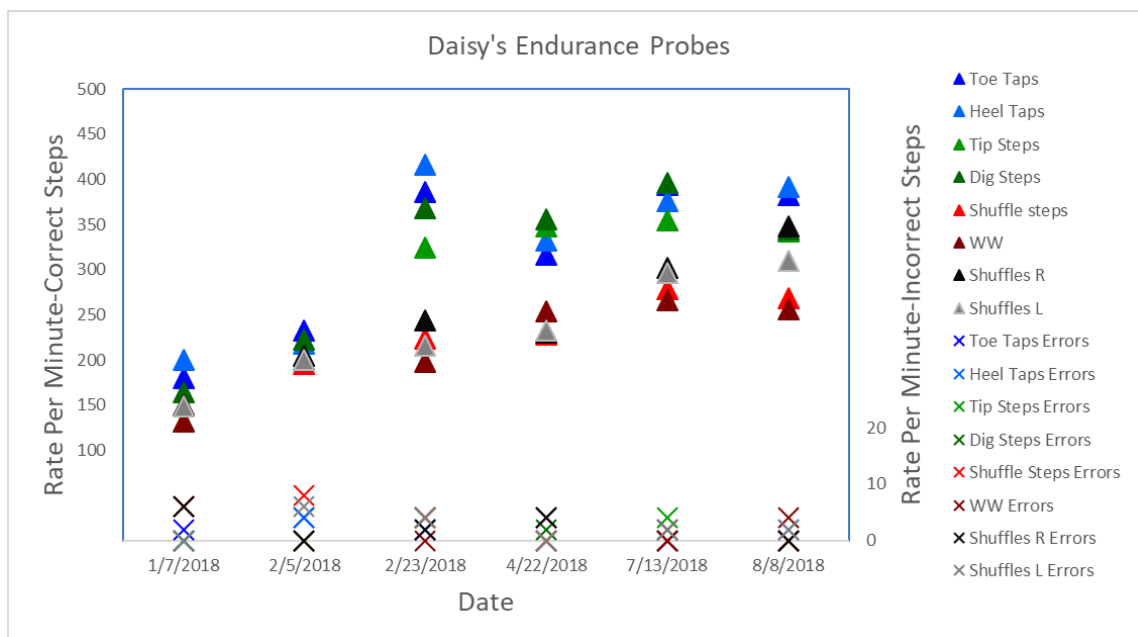
Figure 12 shows the data for Daisy's second round of windshield wipers. Windshield wipers served the unique purpose of providing evidence for the long-term maintenance of a previously mastered step. That windshield wipers remained at aim suggests that the step was fluent; however, Weekly Probes also showed greater variability in the steps within the aim relative to the reduction in variability seen during FB. One way of ensuring more stability in this

regard might be to teach a dancer how to monitor and evaluate their performance objectively and to make the necessary adjustments on that basis.

### *Endurance Probes*

Figure 13 shows the results of Daisy's endurance probes. At baseline (1<sup>st</sup> probe), all of Daisy's endurance probes fell well below their respective aim ranges and her frequency of incorrect steps ranged from 0-6 per minute. Probe frequencies started below 200 per minute in the baseline probe and ended near or above 300 per minute. With the exception of shuffle steps, all steps reached the aim range, typically in the probe following training on the respective step. Once at aim, steps remained there with few exceptions. Though shuffle steps did not reach aim, the probes following training in shuffles right and left and the second round of training in shuffle steps had frequencies that were within approximately 10% of the aim, a negligible difference that may not affect functional mastery. With the exception of shuffles left, which had 4 errors per minute, all other steps had no more than 2 errors per minute in the final probe. Table 7 shows additional details regarding Daisy's performance on endurance probes.

Figure 13. Daisy Endurance Probes



The triangles indicate the frequency of correct steps linked to the primary axis. The X's indicate the frequency of incorrect steps linked to the secondary axis. A legend is provided to indicate the color of the data path that corresponds to each data series.

Table 7. Daisy Endurance Outcomes

	Celeration		Growth/Decay (-)		Improvement Index
	Accel	Decel	Accel	Decel	Overall
Toe Taps	X 1.61	÷ 2.43	61%	-59%	X 3.91
Heel Taps	X 1.52	÷ 1.22	52%	-18%	X 1.86
Tip Steps	X 1.61	X 1.36	61%	36%	X 1.19
Dig Steps	X 1.49	÷ 1.58	49%	-37%	X 2.35
Shuffles Right	X 1.96	÷ 2.2	96%	-55%	X 4.3
Shuffles Left	X 1.62	X 1.01	62%	1%	X 1.61
Shuffle Steps	X 1.44	÷ 4.05	44%	-75%	X 5.84
Windshield Wipers	X 1.44	÷ 1.16	44%	-13%	X 1.66

The metrics of celeration, percent growth and decay and the overall improvement index for Daisy's endurance probes are shown above. For celeration and improvement index, an increasing value (acceleration) is indicated by a multiplication symbol (X) and a decreasing value (deceleration) is indicated by a division symbol (÷). For percent growth or decay, growth is shown as a positive number with no symbol and decay is shown as a negative number with a subtraction symbol (-). Dashes (-) indicate one of two things: (1) there was no change in the metric or (2) the metric does not apply to the data set. Measures reflect the change per month.

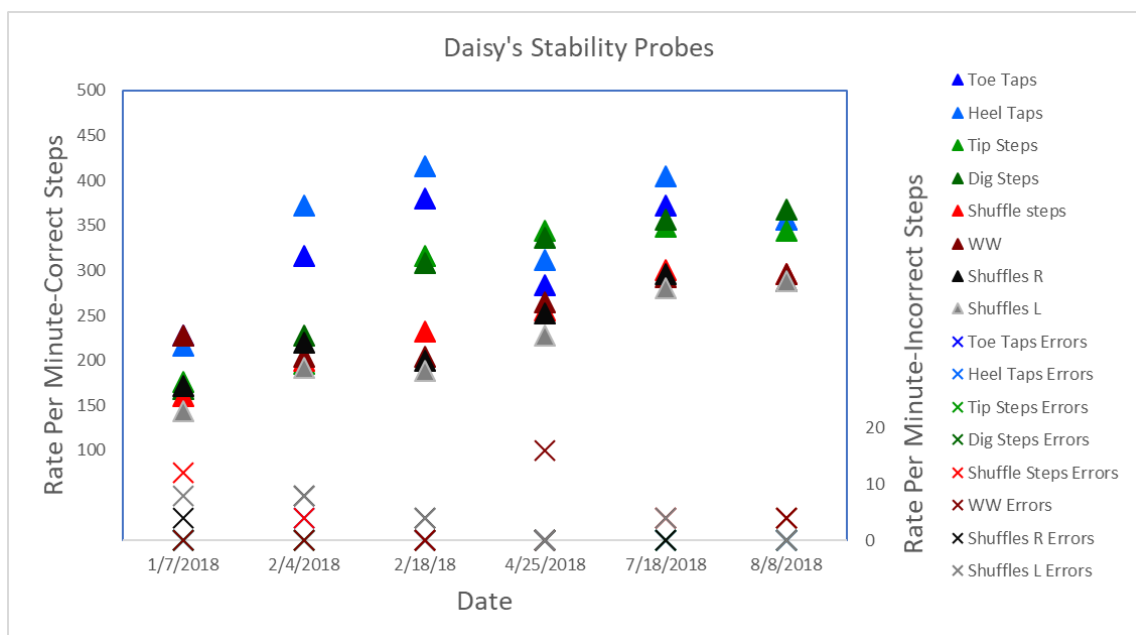
In conclusion, Daisy's probes show that endurance did emerge for her performance on steps in the training sequence. There was marked improvement for each step at every probe

opportunity. Nearly all endurance probes met aim following training in the specified step. Although shuffle steps did not meet aim, there was a significant increase in the frequency of correct steps and decreases in incorrect steps. Interestingly, the highest probe for shuffle steps followed training in shuffles right and shuffles left. This is further evidence that shuffles right, and shuffles left may be components of shuffle steps.

### *Stability Probes*

Figure 14 shows the results for Daisy's stability probes. As with endurance probes, Daisy's starting rates in the baseline stability probes were low (below 200 for 6 steps and 250 for 2). All were below the aim range. Though some steps were error-free, a handful of them had significant errors—shuffle steps had a rate as high as 12 per minute. All steps reached the aim range during stability probes, including shuffle steps. Except for one probe for toe taps and heel taps respectively, all remained at aim thereafter. As with endurance probes, each step reached aim following training on that step; except for shuffle steps which reached the aim following training in shuffles right and left. Overall, the frequency of incorrect steps decreased during stability probes and all but one (windshield wipers) reached zero errors. Table 8 shows additional details of Daisy's performance in stability probes.

Figure 14. Daisy Stability Probes



The triangles indicate the frequency of correct steps linked to the primary axis. The X's indicate the frequency of incorrect steps linked to the secondary axis. A legend is provided to indicate the color of the data path that corresponds to each data series.

Table 8. Daisy Stability Outcomes

	Celeration		Growth/Decay (-)		Improvement Index
	Accel	Decel	Accel	Decel	Overall
Toe Taps	X 1.25	X 1	25%	0%	X 1.25
Heel Taps	X 1.24	÷ 1.22	24%	-18%	X 1.51
Tip Steps	X 1.8	÷ 1	80%	0%	X 1.8
Dig Steps	X 1.66	X 1.49	66%	49%	X 1.12
Shuffle Steps	X 1.57	÷ 1.31	57%	-24%	X 2.06
Windshield Wipers	X 1.37	X 1.98	37%	98%	÷ 1.44
Shuffles Right	X 1.51	÷ 2.43	51%	-59%	X 3.73
Shuffles Left	X 1.69	÷ 2.43	69%	-59%	X 4.1

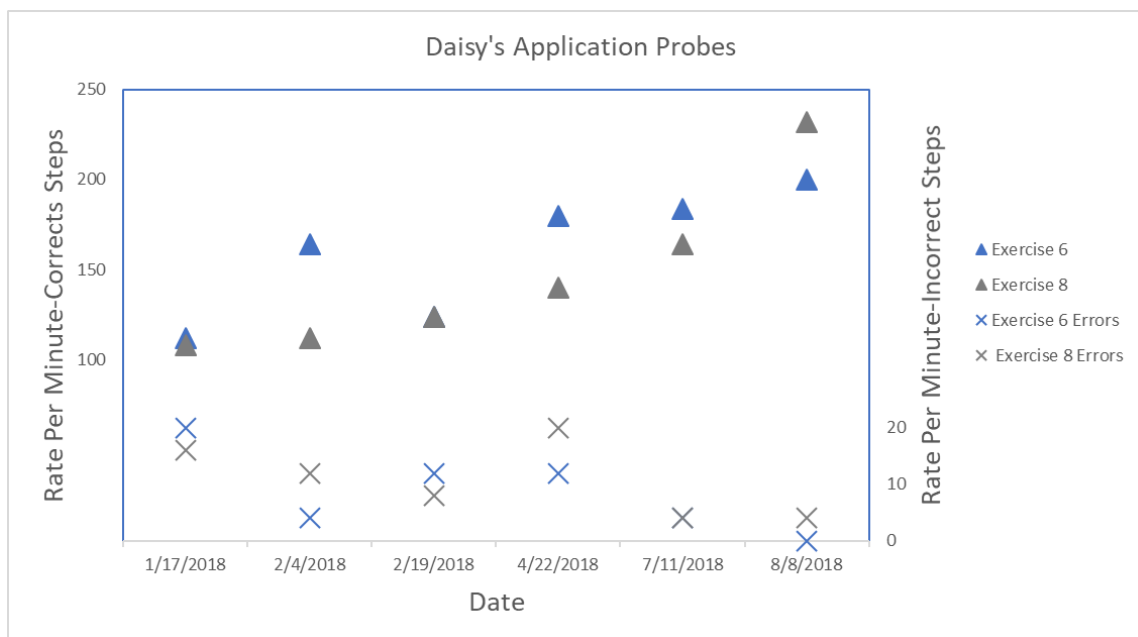
The metrics of celeration, percent growth and decay and the overall improvement index for Daisy's Stability probes are shown above. For celeration and improvement index, an increasing value (acceleration) is indicated by a multiplication symbol (X) and a decreasing value (deceleration) is indicated by a division symbol (÷). For percent growth or decay, growth is shown as a positive number with no symbol and decay is shown as a negative number with a subtraction symbol (-). Dashes (-) indicate one of two things: (1) there was no change in the metric or (2) the metric does not apply to the data set. Measures reflect the change per month.

Daisy's probe data demonstrated the emergence of stability. All probes reached aim following the training of their respective steps. In contrast to endurance probes, shuffle steps did meet aim in stability probes following training in shuffles right and left. Again, we see evidence that training of shuffles right and left should proceed training of shuffle steps. Not only did Daisy gain speed in the stability condition, but she also gained precision; only one of the eight steps had errors in the final probe.

#### *Application Probes*

Figure 15 shows the results of Daisy's application probes. Both application sequences started far below the aim range. Exercise 6 (traveling) started at approximately 35% of the aim and ended at 63% of the aim. The frequency of correct steps increased from 112 per minute in the first probe to 200 per minute in the final probe while errors dropped from 20 per minute to 0 in the final probe. Similarly, Exercise 8 (stationary) started at 39% of the aim and ended at 83% of the aim. The rate of correct steps started at 108 per minute in the first probe and ended at 232 per minute on the final probe. The frequency of incorrect steps decreased from an initial 16 per minute to 4 per minute. Table 9 shows additional details for Daisy's application probes.

Figure 15. Daisy Application Probes



The triangles indicate the frequency of correct steps linked to the primary axis. The X's indicate the frequency of incorrect steps linked to the secondary axis. A legend is provided to indicate the color of the data path that corresponds to each data series.

Table 9. Daisy Application Outcomes

	Celeration		Growth/Decay		Improvement Index
	Accel	Decel	Accel	Decel	Overall
Exercise 6	X 1.5	÷ 4.08	50%	-75%	X 5.63
Exercise 8	X 1.76	÷ 3.04	76%	-67%	X 5.35

The metrics of celeration, percent growth and decay and the overall improvement index for Daisy's application probes are shown above. For celeration and improvement index, an increasing value (acceleration) is indicated by a multiplication symbol (X) and a decreasing value (deceleration) is indicated by a division symbol (÷). For percent growth or decay, growth is shown as a positive number with no symbol and decay is shown as a negative number with a subtraction symbol (-). Dashes (-) indicate one of two things: (1) there was no change in the metric or (2) the metric does not apply to the data set. Measures reflect the change per month.

Daisy's data suggests that application did emerge as a function of mastering basic steps.

Both application probes showed marked improvement across frequency of correct steps and frequency of incorrect steps. Exercise 8 had a particularly drastic change in the final probe. This presumably was a contribution of mastering shuffle steps, which is a step that incorporates several components of balance, weight distribution, and balance shifts from foot to foot. These

are essential components of dancing, and participants mainly contacted them in the final training pair. Like the other outcome probes, Daisy gained substantial accuracy in her footwork in addition to speed as a function of practicing basic tap steps.

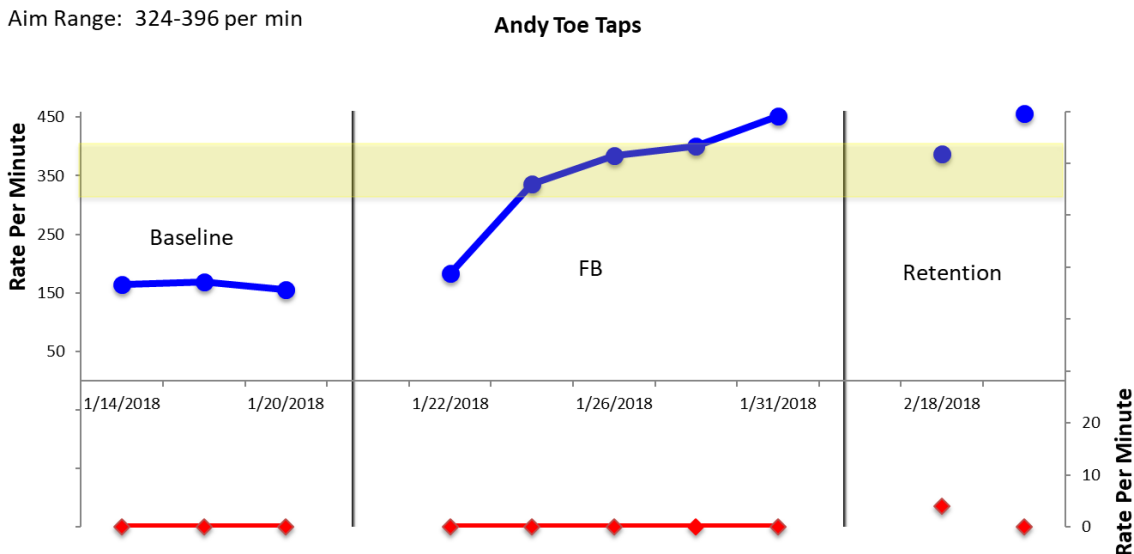
Andy

*Pair 1: Toe Taps & Heel Taps*

Figure 16 shows the data for Andy's toe taps. During Baseline, toe taps had nearly a flat celeration and remained well below the aim range. No incorrect toe taps were recorded in this condition. In the FB condition, toe taps accelerated at a rate of X1.79 per week and reached aim within two sessions. As in Baseline, no errors were recorded during FB. Toe taps remained at aim with low errors during retention probes.

Figure 16. Andy Toe Taps

Aim Range: 324-396 per min

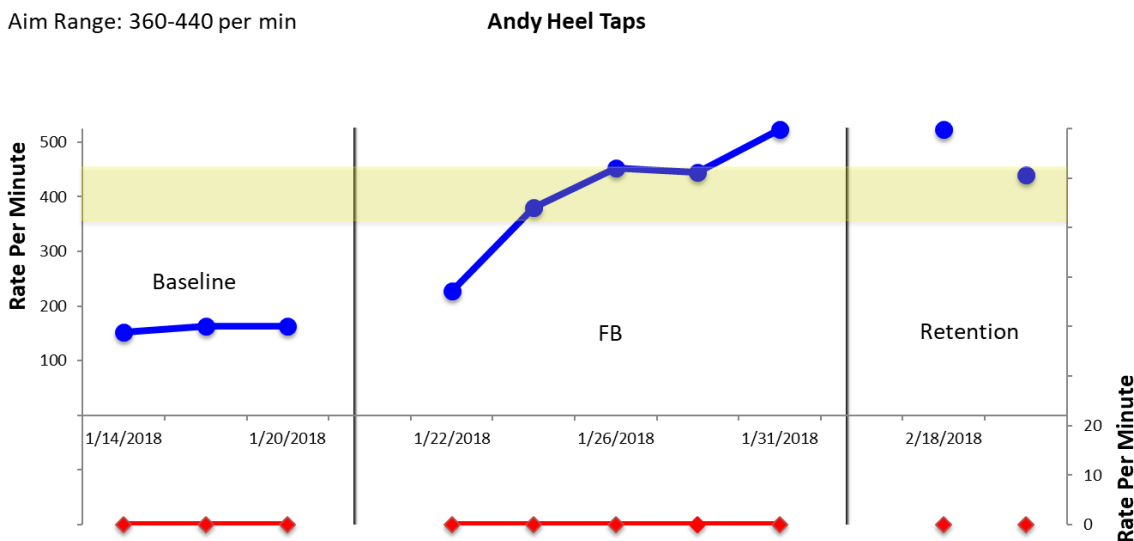


*The blue data series represents the frequency of correct responses (primary axis). The red data series represents the frequency of errors (secondary axis). The yellow band indicates the aim range. FB is a shortened label for frequency building. Both data sets are expressed as a rate per minute (i.e. frequency per minute).*

Figure 17 shows the data for Andy's heel taps. Heel taps also had a flat celeration during baseline and levels significantly below the aim range. No errors were recorded during Baseline,

FB, or Retention. Heel taps accelerated at a rate of X1.71 per week in the FB phase and met mastery criteria within 5 sessions. During Retention probes, toe taps remained at aim.

Figure 17. Andy Heel Taps



*The blue data series represents the frequency of correct responses (primary axis). The red data series represents the frequency of errors (secondary axis). The yellow band indicates the aim range. FB is a shortened label for frequency building. Both data sets are expressed as a rate per minute (i.e. frequency per minute).*

In sum, both toe taps and heel taps accelerated quickly in FB and met the mastery criteria. Though Andy's frequencies for these steps were low in Baseline, he had a high degree of accuracy. Since no corrections to the form of the steps had to be made, goals regarding speed were always provided during FB. This level of initial accuracy may have contributed to the steep accelerations in the frequency of correct steps. For both toe taps and heel taps, retention was clearly demonstrated. Table 10 shows additional data for Andy's toe tap and heel tap performance.

Table 10. Andy Pair 1 Outcomes

	Celeration		Growth/Decay (-)		Level Change		Improvement Index
	Accel	Decel	Accel	Decel	Accel	Decel	Overall
<b>Toe Taps</b>							
Baseline	÷ 1.08	X 1	-7%	0%	-	-	÷ 1.08
Frequency	X 1.79	÷ 1	79%	0%	2.1	1	X 1.79
Retention	-	-	-	-	-	-	X 1.53
<b>Heel Taps</b>							
Baseline	X 1.06	X 1	-6%	0%	-	-	X 1.06
Frequency	X 1.71	÷ 1	71%	0%	2.5	1	X 1.71
Retention	-	-	-	-	-	-	÷1.09

The metrics of celeration, percent growth and decay, level change from previous condition, and the overall improvement index for Andy's Pair 1 per phase are shown above. For celeration and improvement index, an increasing value (acceleration) is indicated by a multiplication symbol (X) and a decreasing value (deceleration) is indicated by a division symbol (÷). For percent growth or decay, growth is shown as a positive number with no symbol and decay is shown as a negative number with a subtraction symbol (-). For level change, a whole number indicates a rise in level. The greater the number, the greater the level change. Decimals smaller than 1 indicate a decrease in level. Dashes (-) indicate one of two things: (1) there was no change in the metric or (2) the metric does not apply to the data set. Measures reflect the change per week for all conditions except for weekly probes, which is expressed as change per month (\*).

### Pair 2: Tip Steps & Dig Steps

Figure 18 shows the data for Andy's tip steps. Tip steps had virtually no changes in celeration during Baseline and remained significantly below the aim range. No errors were observed during any of the phases. In the Weekly Probes, the frequency of corrects steps accelerated at rate of X1.72 per month. There was a substantial jump in frequency from 184 per minute in the last weekly probe to 252 per minute in the first FB session. Then, tip steps continued to accelerate at a rate of X1.18 per week in FB. No errors were recorded in this phase either. Retention probes remained at aim.

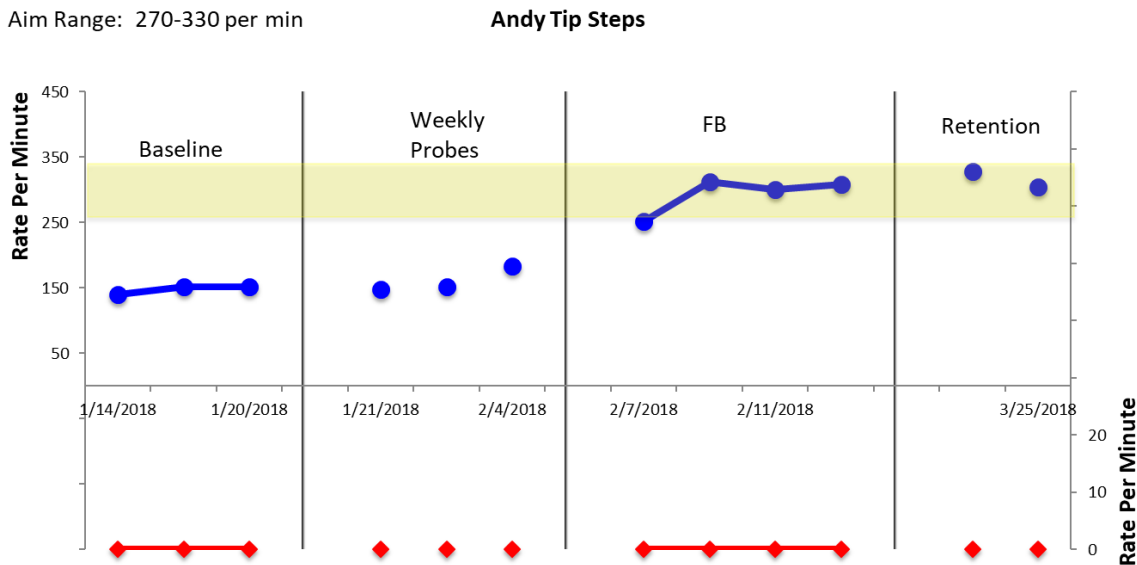
Figure 19 shows Andy's dig step data. Like the previous pairs, dig steps fell below 60% of the aim range in baseline with a flat celeration. No incorrect steps were recorded in any phase. When dig steps entered Weekly Probes, there was little change in frequency for the first two. However, the third probe increased by 52 correct responses per minute producing an overall acceleration of X2.05 per month. The first data point in FB increased by 88 steps per minute and

landed within the aim range immediately. During Retention probes, dig steps remained at aim.

Table 11 shows additional data for Andy's performance on tip steps and dig steps.

Figure 18. Andy Tip Steps

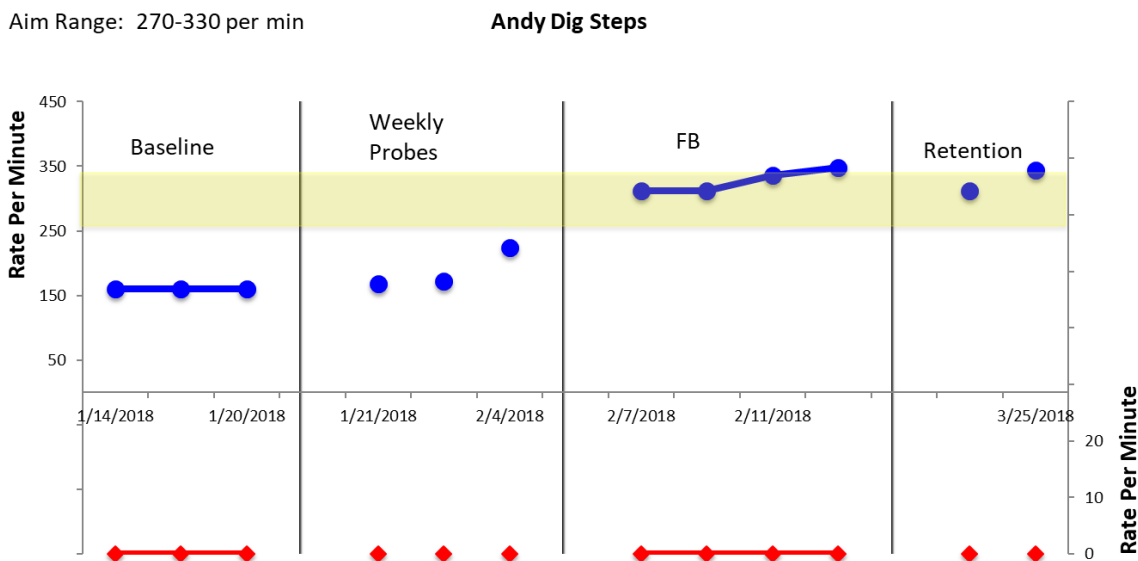
Aim Range: 270-330 per min



The blue data series represents the frequency of correct responses (primary axis). The red data series represents the frequency of errors (secondary axis). The yellow band indicates the aim range. FB is a shortened label for frequency building. Both data sets are expressed as a rate per minute (i.e. frequency per minute).

Figure 19. Andy Dig Steps

Aim Range: 270-330 per min



The blue data series represents the frequency of correct responses (primary axis). The red data series represents the frequency of errors (secondary axis). The yellow band indicates the aim range. FB is a shortened label for frequency building. Both data sets are expressed as a rate per minute (i.e. frequency per minute).

In summary, dig steps and tip steps had substantial celerations during Weekly Probes; though the values were primarily impacted by the last probe in this phase. This would have correlated with the end of the FB phase for the previous training pair. It is possible that generativity in Weekly Probes for Pair 2 occurred to a greater degree at the height of training for Pair 1 (i.e. when it had reached aim). Both steps met mastery within 4 sessions of entering FB. Retention probes show that rates maintained after a period of no practice.

Table 11. Andy Pair 2 Outcomes

	Celeration		Growth/Decay (-)		Level Change		Improvement Index
	Accel	Decel	Accel	Decel	Accel	Decel	Overall
<b><i>Tip Steps</i></b>							
Baseline	X 1.07	X 1	7	0	-	-	X 1.07
Weekly Probes*	X 1.72	X 1	72%	0%	1.1	1	X 1.72
Frequency	X 1.18	X 1	18%	0%	1.8	1	X 1.18
Retention	-	-	-	-	-	-	÷ 1.03
<b><i>Dig Steps</i></b>							
Baseline	X 1	X 1	0%	0%	-	-	X 1
Weekly Probes*	X 2.05	X 1	105%	0%	1.2	1	X 2.05
Frequency	X 1.14	÷ 1	14%	0%	1.7	1	X 1.14
Retention	-	-	-	-	-	-	X 1.04

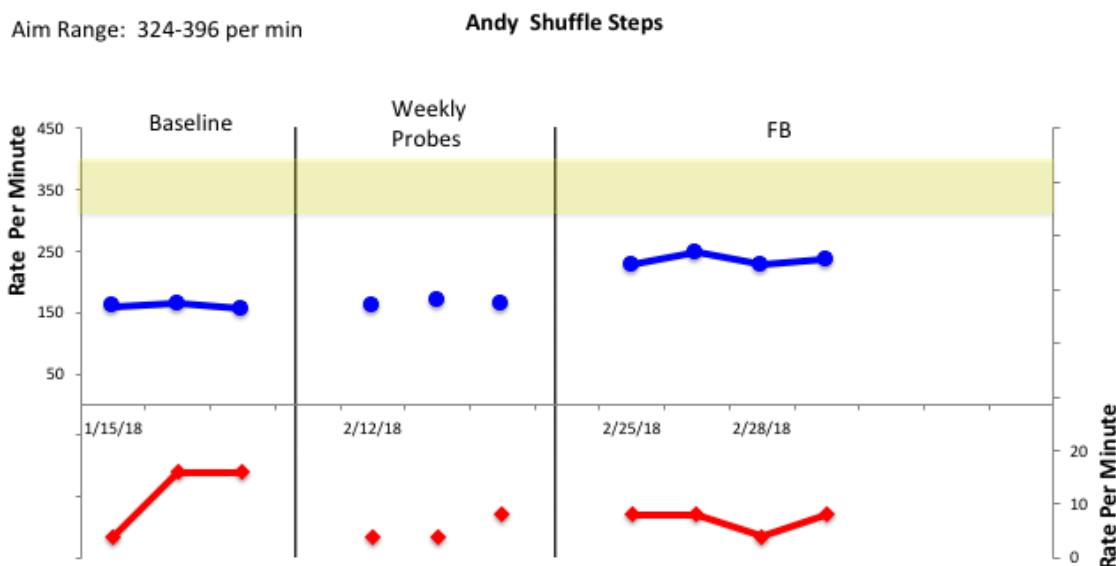
*The metrics of celeration, percent growth and decay, level change from previous condition, and the overall improvement index for Andy's Pair 2 per phase are shown above. For celeration and improvement index, an increasing value (acceleration) is indicated by a multiplication symbol (X) and a decreasing value (deceleration) is indicated by a division symbol (÷). For percent growth or decay, growth is shown as a positive number with no symbol and decay is shown as a negative number with a subtraction symbol (-). For level change, a whole number indicates a rise in level. The greater the number, the greater the level change. Decimals smaller than 1 indicate a decrease in level. Dashes (-) indicate one of two things: (1) there was no change in the metric or (2) the metric does not apply to the data set. Measures reflect the change per week for all conditions except for weekly probes, which is expressed as change per month (\*).*

### ***Pair 3: Shuffle Steps & Windshield Wipers***

Figure 20 shows the data for Andy's shuffle steps. Just as the previous steps, shuffle steps fell below 60% of aim and had a relatively flat celeration in Baseline. Moreover, the rate of errors accelerated at a rate of X2.99 per week in this phase. In the Weekly Probes, the celeration of shuffle steps remained flat, while errors accelerate at a value of X1.48 per month. When

shuffle steps entered FB a significant jump from 164 per minute in the last data point in the previous phase to 228 per minute in the first data point of FB occurred. However, celeration of correct steps remained flat, and incorrect steps remained high. Since this pattern was similar to that of Daisy's, shuffle steps returned to weekly probes, and shuffles right and left entered into training instead. Shuffle steps re-entered FB once shuffles right, and left were mastered.

Figure 20. Andy Shuffle Steps

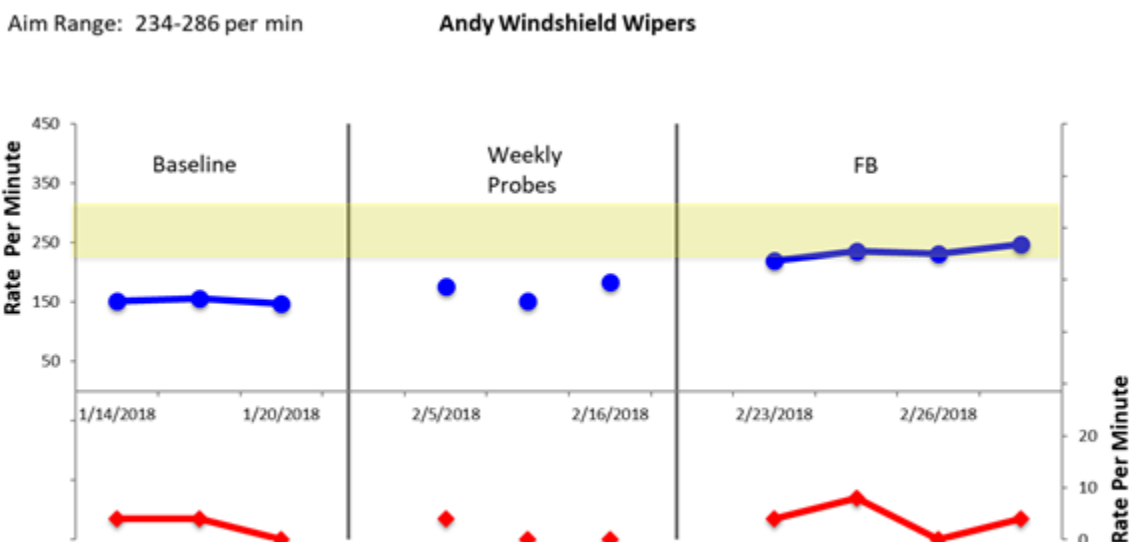


*The blue data series represents the frequency of correct responses (primary axis). The red data series represents the frequency of errors (secondary axis). The yellow band indicates the aim range. FB is a shortened label for frequency building. Both data sets are expressed as a rate per minute (i.e. frequency per minute).*

Figure 21 shows Andy's data for windshield wipers. Windshield wipers hovered at approximately 60% of the aim in Baseline with minimal change in the celeration of correct steps; though incorrect steps decelerated at a rate of  $\div 2.37$  per week. The frequency of correct steps remained relatively flat during Weekly Probes, but incorrect steps decreased from 2 per minute to zero. Windshield wipers immediately fell within the aim range upon entering FB. Initially errors increased in, but quickly dropped below 4 per minute. Windshield wipers met mastery criteria within the first 3 sessions of FB. However, like Daisy's case, windshield wipers re-

entered Weekly Probes with its partner (shuffle steps) and returned to FB following training in Pair 4. Table 12 shows additional data of Andy's performance on shuffle steps and windshield wipers.

Figure 21. Andy Windshield Wipers



*The blue data series represents the frequency of correct responses (primary axis). The red data series represents the frequency of errors (secondary axis). The yellow band indicates the aim range. FB is a shortened label for frequency building. Both data sets are expressed as a rate per minute (i.e. frequency per minute).*

In conclusion, the pattern in Andy's shuffle steps resembled that of Daisy's. Shuffle steps saw little improvements during Weekly Probes. Though there was a substantial level change between probes and frequency building, there was no change in celeration. Andy was not exposed to interventions in shuffle steps, and instead moved to training on Pair 4 as soon as the pattern was detected. Andy's data coupled with Daisy's data further suggested that shuffles right and left are components of shuffle steps. The last two participants in the study experienced an alternative sequence where shuffles right and left constituted Pair 3 and shuffle steps and windshield wipers constituted Pair 4. On the other hand, Andy did meet the mastery criteria for

Windshield wipers rapidly. Table 12 shows additional data for Andy's performance on shuffle steps and windshield wipers.

Table 12. Andy Pair 3 Outcomes

	Celeration		Growth/Decay (-)		Level Change		Improvement Index
	Accel	Decel	Accel	Decel	Accel	Decel	Overall
<b>Shuffle Steps</b>							
Baseline	÷ 1.04	X 2.99	-4%	199%	-	-	÷ 3.12
Weekly Probes*	X 1.02	X 1.48	1%	0%	1	0.5	÷ 1.45
Frequency	X 1.02	÷ 1.21	2%	-17%	1.4	1.3	X 1.23
Weekly Probes 2*	÷ 1.07	X 1.46	-6%	-46%	0.8	1.3	÷ 1.56
Return from hurt ankle	X 1.06	÷ 1.63	6%	-39%	1.1	0.6	X 1.74
Frequency 2	÷ 1.16	X 1.36	-11%	4%	1	1.3	÷ 1.08
Shuffle Stomps	-	-	-	-	-	-	X 1
Balance Bar	÷ 1.12	÷ 1.3	-23%	104%	-	-	÷ 2.65
Shuffle Steps Isolated	÷ 1.85	X 1	-46%	0%	1.2	0.8	÷ 1.85
Remove Prime	X 1.05	X 1.17	5%	17%	1.3	1.5	÷ 1.12
Shuffle Steps 2nd	÷ 1.11	X 4.29	-4%	329%	1.1	1.1	÷ 4.48
Balance Exercise	÷ 1.09	X 2.92	-8%	192%	1	0.8	÷ 3.19
Remove Balance Exercis	÷ 1.23	X 1.41	-19%	41%	1	0.6	÷ 1.75
Retention	-	-	-	-	-	-	X 1.01
<b>Windshield Wipers</b>							
Baseline	÷ 1.01	÷ 2.37	-4%	-58%	-	-	X 2.26
Weekly Probes*	X 1.01	÷ 1.6	1%	37%	1.1	0.8	X 1.61
Frequency	X 1.17	÷ 1.45	17%	-31%	1.4	1.6	X 1.7
Weekly Probes 2*	÷ 1.08	X 1.03	-7%	3%	1	0.9	÷ 1.12
Hurt Ankle	X 1.36	X 1	36%	0%	1	0.6	X 1.36
Frequency 2	X 1.02	X 1.03	2%	3%	1.2	1.2	÷ 1.02
Retention	-	-	-	-	-	-	X 1

The metrics of celeration, percent growth and decay, level change from previous condition, and the overall improvement index for Andy's Pair 3 per phase are shown above. For celeration and improvement index, an increasing value (acceleration) is indicated by a multiplication symbol (X) and a decreasing value (deceleration) is indicated by a division symbol (÷). For percent growth or decay, growth is shown as a positive number with no symbol and decay is shown as a negative number with a subtraction symbol (-). For level change, a whole number indicates a rise in level. The greater the number, the greater the level change. Decimals smaller than 1 indicate a decrease in level. Dashes (-) indicate one of two things: (1) there was no change in the metric or (2) the metric does not apply to the data set. Measures reflect the change per week for all conditions except for weekly probes, which is expressed as change per month (\*).

#### Pair 4: Shuffles Right and Shuffles Left

Figure 22 displays Andy's data for shuffles right. Shuffles right began substantially below aim with minimal celeration (X1.1 per week). No errors were recorded in the Baseline phase. Because of the brevity of the frequency building phase for Pair 3, only two data points were collected during Weekly Probes. There was no change in the frequency of corrects steps for

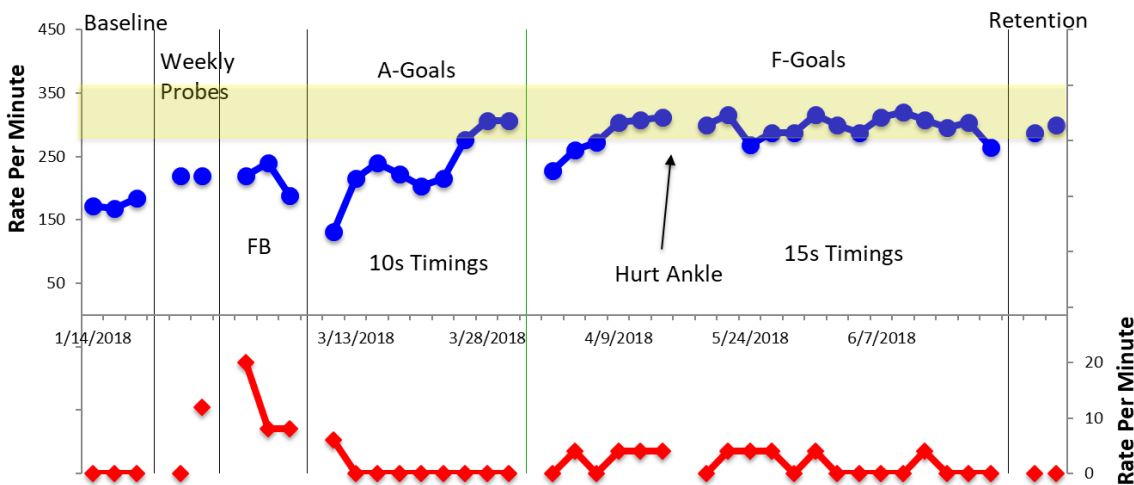
the two probes, but there was an increase in error from 0 per minute to 12 per minute. When shuffles right entered FB, correct steps ( $\div 1.21$  per week) and incorrect steps ( $\div 3.86$  per week) decelerated concurrently. Though incorrect steps decreased in this phase, levels still remained above 4 per minute. This, coupled with the deceleration in correct steps, prompted an intervention of providing accuracy goals and changing the timing length to 10s. The intervention successfully shifted the downward trend of correct steps. Shuffles right reached aim and errors dropped to zero. Once at aim, shuffles right returned to standard implementation of frequency goals and 15s timings. The frequency of shuffles right decreased initially at the increased timing length, but quickly recovered and accelerated at a rate  $\times 1.33$  per week toward aim. Incorrect steps increased but remained within a range of 0-4 per minute. Shuffles right met the mastery criteria within 3 sessions of introducing 15s timings. However, it remained in FB until its partner, shuffles left, met mastery criteria as well.

Andy is an avid basketball player, and during the study, he suffered a minor ankle injury to his right foot during a basketball game. Though he did not require intrusive medical attention such as surgery, he was absent from the study for approximately 5 weeks while he healed. A break in the data denoting this incident is indicated on the graphs. Following Andy's return from his injury, shuffles right remained at aim and errors remained low during the remainder of FB and during the Retention probes.

Figure 22. Andy Shuffles Right

Aim Range: 288-352 per min

## Andy Shuffles Right



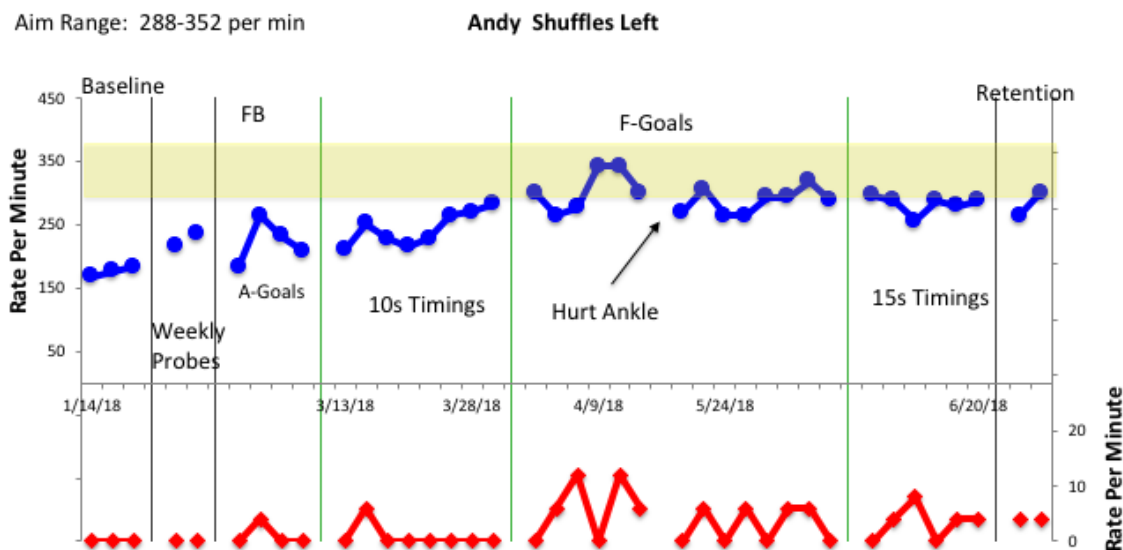
The blue data series represents the frequency of correct responses (primary axis). The red data series represents the frequency of errors (secondary axis). The yellow band indicates the aim range. FB is a shortened label for frequency building. Both data sets are expressed as a rate per minute.

Figure 23 shows Andy's data for shuffles left. Shuffles left fell just as far from aim as its partner (shuffles right) in Baseline. No errors were recorded in either Baseline or Weekly Probes. Though there were only two weekly probes, there was a noteworthy increase in the frequency of correct steps from the first weekly probe (216 per minute) to the second weekly probe (236 per minute). FB started with accuracy goals (A-goals) to ensure precision of the movement. Nonetheless, variability in the frequency of correct steps prompted the intervention of reducing the timing length to 10s. Following the introduction of the intervention, frequency of corrects accelerated ( $\times 1.08$  per week) and errors decelerated ( $\div 1.15$  per week). When shuffles left was near aim, standard implementation frequency goals (F-goals) were implemented. Correct steps immediately fell within the aim range, but incorrect steps accelerated ( $\times 1.42$  per week) reaching a high of 12 per minute. Toward the end of this phase, incorrect steps dropped between 0-6 per minute. At this point, standard implementation of 15s timing lengths was re-introduced. Shuffles left fell within aim and incorrect steps decreased to 0-4 per minute except for one data point and

met the mastery criteria. Shuffles left remained high near or at aim during retention probes.

Table 13 shows additional data for Andy's performance on shuffles right and left.

Figure 23. Andy Shuffles Left



The blue data series represents the frequency of correct responses (primary axis). The red data series represents the frequency of errors (secondary axis). The yellow band indicates the aim range. FB is a shortened label for frequency building. Both data sets are expressed as a rate per minute (i.e. frequency per minute).

Andy's injury provided an additional unplanned opportunity to observe retention outcomes. Before his injury, Andy had already met the mastery criteria for shuffles right and had a period of stability. When he returned to the study, shuffles right did remain at aim and incorrect steps remained low. Shuffles left had not met the mastery criteria before the injury because the incorrect steps were too high. In general, shuffles left exhibited more variability than shuffles right. Though shuffles left met the mastery criteria by falling in the low end of the aim range, it did not reach the same level of stability or the same frequencies as shuffles right. Consequently, a drop-in frequency, though slight, occurred following the injury, as well as in the first retention probe. It may be that a certain amount of stability at a functional aim may impact the level of retention.

Table 13. Andy Pair 4 Outcomes

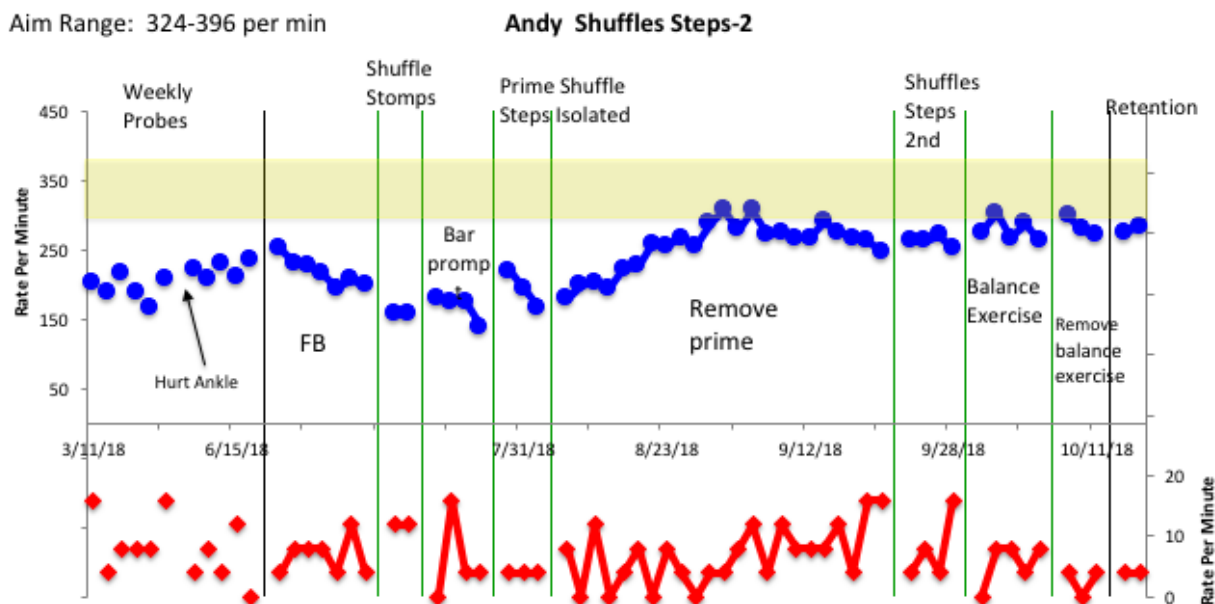
	Celeration		Growth/Decay (-)		Level Change		Improvement Index
	Accel	Decel	Accel	Decel	Accel	Decel	Overall
<b><i>Shuffles Right</i></b>							
Baseline	X 1.1	X 1	10%	0%	-	-	X 1.1
Weekly Probes*	-	-	-	-	-	-	÷ 4.8
Frequency	÷ 1.21	÷ 3.86	-17%	-74%	-	-	X 3.2
A-phase	X 1.24	÷ 1.14	24%	-12%	1.1	0.3	X 1.41
F-Phase	X 1.33	X 1.79	33%	79%	1.2	1	÷ 1.35
Hurt Ankle	÷ 1	÷ 1.11	-1%	-10%	1.1	0.8	X 1.11
Retention	-	-	-	-	-	-	X 1.01
<b><i>Shuffles Left</i></b>							
Baseline	X 1.1	X 1	10%	0%	-	-	X 1.1
Weekly Probes*	-	-	-	-	-	-	X 1.08
Frequency (A-goals)	X 1.46	X 1.16	8%	16%	-	-	÷ 1.07
10s	X 1.08	÷ 1.15	10%	-13%	1.1	1.4	X 1.26
F-Phase	X 1.18	X 1.42	18%	42%	1.2	1.8	÷ 1.21
Hurt Ankle	X 1.04	X 1.06	4%	6%	0.9	0.7	÷ 1.02
15s	÷ 1.01	X 1.32	-1%	32%	1	0.8	÷ 1.33
Retention	-	-	-	-	-	-	X 1.04

The metrics of celeration, percent growth and decay, level change from previous condition, and the overall improvement index for Andy's Pair 4 per phase are shown above. For celeration and improvement index, an increasing value (acceleration) is indicated by a multiplication symbol (X) and a decreasing value (deceleration) is indicated by a division symbol (÷). For percent growth or decay, growth is shown as a positive number with no symbol and decay is shown as a negative number with a subtraction symbol (-). For level change, a whole number indicates a rise in level. The greater the number, the greater the level change. Decimals smaller than 1 indicate a decrease in level. Dashes (-) indicate one of two things: (1) there was no change in the metric or (2) the metric does not apply to the data set. Measures reflect the change per week for all conditions except for weekly probes, which is expressed as change per month (\*).

### *Return to Pair 3: Shuffle Steps and Windshield Wipers*

Figure 24 shows the data for Andy's second round of shuffle steps. Shuffle steps began with high variability and acceleration (X1.46 per month) errors in Weekly Probes and little change in the celeration in correct steps (÷1.07 per month). After the injury, shuffle steps began to improve, and correct steps accelerated (X1.06 per month) while incorrect steps decelerated (÷1.63 per month). During FB incorrect steps were relatively high but less variable, within a range of 4-12 per minute. Moreover, correct steps began to decrease (÷1.16 per week), which prompted an intervention.

Figure 24. Andy Shuffles Steps-2

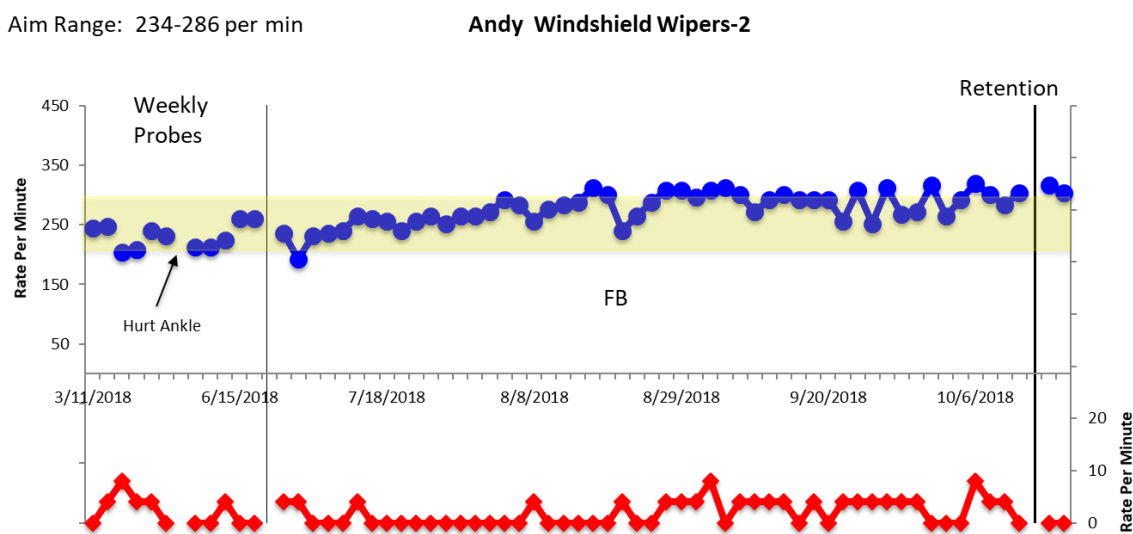


The blue data series represents the frequency of correct responses (primary axis). The red data series represents the frequency of errors (secondary axis). The yellow band indicates the aim range. FB is a shortened label for frequency building. Both data sets are expressed as a rate per minute (i.e. frequency per minute).

First, the intervention of practicing shuffle stomps whereby Andy practiced engaging in shuffles, but instead of engaging in a step (which requires balancing on the ball of the foot) he could put his heel down (creating a stomp). The purpose of this was to eliminate the balance component and allow for improvements in accuracy of the shuffle. The intervention was unsuccessful and immediately removed. The next intervention of providing a bar for Andy to hold onto while balancing was also unsuccessful at reducing errors without suppressing the rate of correct steps. Nonetheless, practicing shuffle steps on each foot in isolation before beginning regular shuffles steps was successful in decreasing errors to a rate of 4 per minute. Though correct steps decelerated during this intervention, the level of correct steps was higher than in previous interventions. Once the intervention was removed correct steps accelerated at a rate of X1.05 per week and reached aim. However, errors remained high reaching 16 per minute. To

provide Andy with opportunities to contact reinforcement before shuffle steps, Andy performed windshield wipers first and shuffle steps second, the reverse of the usual order of session. This intervention did not produce significant changes. Finally, a balance exercise was employed in which Andy practiced setting, shifting, and adjusting his weight at the end of the dance platform, which served to provide feedback on how high his heel should be above the ground. This exercise did produce a reduction in errors (0-8 per minute), and correct steps stabilized near the aim. The balance exercise was removed, and incorrect steps remained low, and the step was mastered. Shuffle steps remained near aim and maintained accuracy during retention probes.

Figure 25. Andy Windshield Wipers-2



*The blue data series represents the frequency of correct responses (primary axis). The red data series represents the frequency of errors (secondary axis). The yellow band indicates the aim range. FB is a shortened label for frequency building. Both data sets are expressed as a rate per minute (i.e. frequency per minute).*

Figure 25 shows Andy's windshield wiper data. Andy met the mastery criteria for windshield wipers in the first round of training. Therefore, the second round served as an opportunity to observe the long-term maintenance of the step. Windshield wipers remained at aim during Weekly Probes, FB, and Retention. The frequency of incorrect steps remained low,

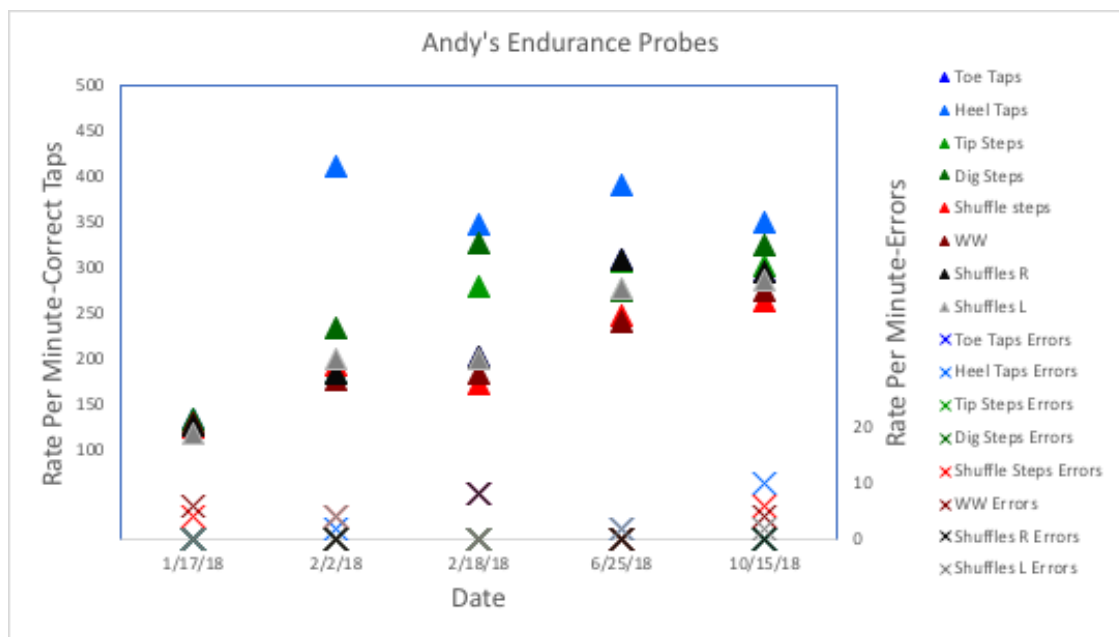
usually between 0-4 per minute with a few occasions at 8 per minute. Table 12 shows additional data of Andy's shuffle steps and windshield wipers.

In contrast to Daisy's data, Andy did not master shuffle steps rapidly following training in shuffles right and left and required many interventions. However, the nature of Andy's errors was largely related to balance skills and not the production of shuffles within the shuffle steps. It is possible that more generativity would have been observed for Andy if component balance skills would have been part of the training sequence before shuffles right and shuffles left.

#### *Endurance Probes*

Figure 26 shows Andy's endurance probe data. Endurance probes started well below aim, all steps with frequencies lower than 140 per minute. For all steps, frequencies more than doubled by the final probe, ranging from 264 to 324. Only shuffle steps and windshield wipers started with errors, though at a relatively low rates (4 per minute, 6 per minute respectively). All steps showed increases in correct steps, however several did have increases in incorrect steps as well.

Figure 26. Andy Endurance Probes



The triangles indicate the frequency of correct steps linked to the primary axis. The X's indicate the frequency of incorrect steps linked to the secondary axis. A legend is provided to indicate the color of the data path that corresponds to each data series.

Like Daisy, Andy met aim for endurance probes for all but one step, shuffle steps.

Reaching aim frequently corresponded with training in that step and remained at aim thereafter.

The exceptions were toe taps, which met aim following training in shuffles right, and shuffle steps, which hovered right below the aim. Andy did not gain the same level of precision as Daisy did during endurance probes. Nonetheless, the increases in the frequency of correct steps suggests endurance did emerge. Table 14 shows additional data for Andy's performance on endurance probes.

Table 14. Andy Endurance Outcomes

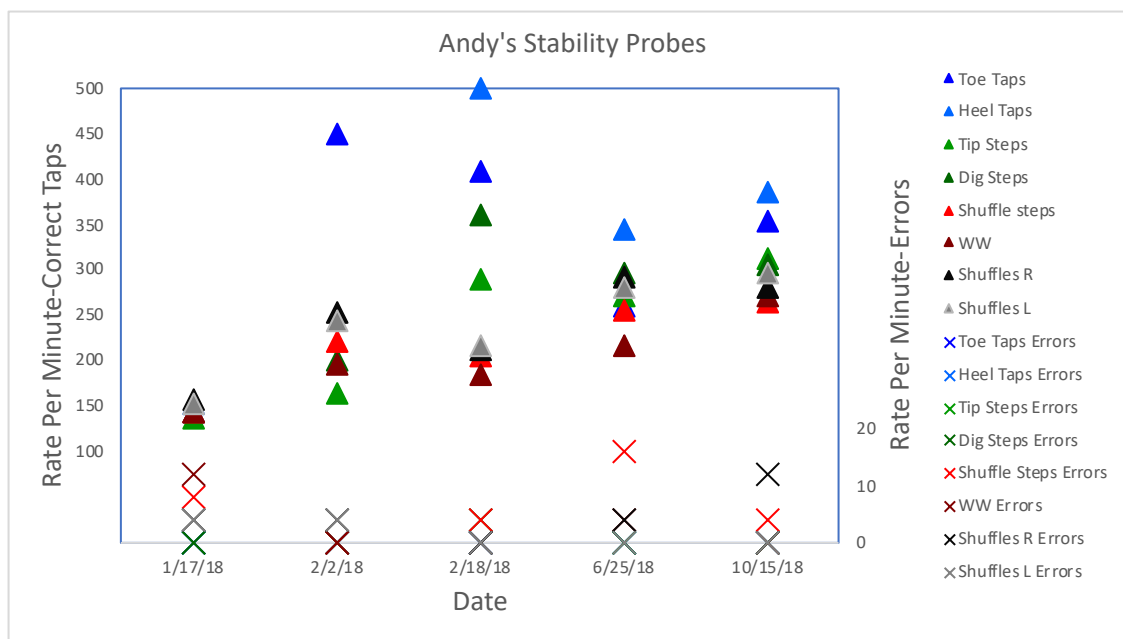
	Celeration		Growth/Decay (-)		Improvement Index
	Accel	Decel	Accel	Decel	Overall
Toe Taps	X 1.63	÷ 1.61	63%	-38%	X 2.63
Heel Taps	X 1.37	X 3.97	37%	297%	÷ 2.9
Tip Steps	X 1.53	X 1	53%	0%	X 1.53
Dig Steps	X 1.41	X 1	41%	0%	X 1.41
Shuffle Steps	X 1.51	÷ 1.19	51%	-16%	X 1.8
Windshield Wipers	X 1.53	X 1.27	53%	27%	X 1.2
Shuffles Right	X 1.63	÷ 1.61	63%	-38%	X 2.63
Shuffles Left	X 1.6	X 1.26	60%	-26%	X 1.26

The metrics of celeration, percent growth and decay and the overall improvement index for Andy's endurance probes are shown above. For celeration and improvement index, an increasing value (acceleration) is indicated by a multiplication symbol (X) and a decreasing value (deceleration) is indicated by a division symbol (÷). For percent growth or decay, growth is shown as a positive number with no symbol and decay is shown as a negative number with a subtraction symbol (-). Dashes (-) indicate one of two things: (1) there was no change in the metric or (2) the metric does not apply to the data set. Measures reflect the change per month.

### Stability Probes

Figure 27 shows Andy's data for stability probes. Performance on stability probes resembled that of endurance probes. Baseline frequencies started between 140-150 per minute and many steps had high frequencies of incorrect steps, as high as 12 per minute. Final frequencies of correct steps ended between 264-384. Generally, errors did decrease throughout the probes. Shuffles right was the only step that saw an increase in errors. Again, shuffle steps were the only step that did not meet aim in this condition; though it increased substantially and ended very close to aim.

Figure 27. Andy Stability Probes



The triangles indicate the frequency of correct steps linked to the primary axis. The X's indicate the frequency of incorrect steps linked to the secondary axis. A legend is provided to indicate the color of the data path that corresponds to each data series.

Andy's stability probes showed more variability than his endurance probes. For example, toe taps, and heel taps had much higher rates than necessary for aim in the probe following training in this pair; then dropped in later probes. Nevertheless, stability probes mostly stayed within the aim range after reaching it. Like in endurance probes, shuffle steps did not reach the aim range in stability probes, and this is likely since this step did not reach aim in training. It was relatively close to aim and at a similar frequency to that of the training condition. This may be an indication that frequencies 20% below the aim is a functional aim for shuffle steps for Andy specifically. The overall pattern of Andy's probes indicate that stability did emerge for his performance. Table 15 shows additional data on Andy's performance in stability probes.

Table 15. Andy Stability Outcomes

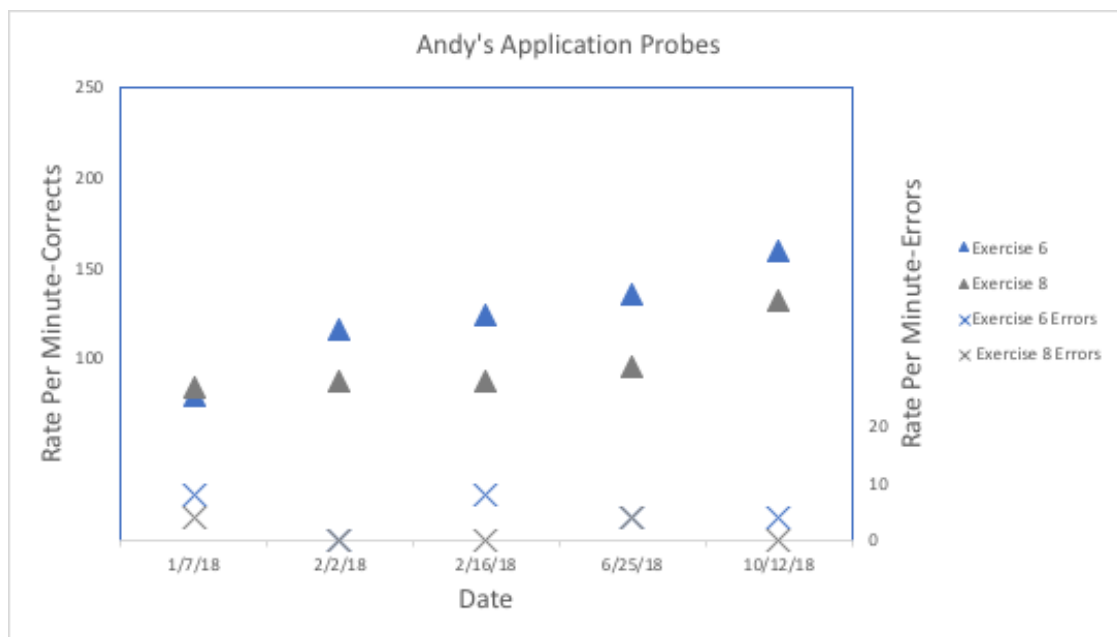
	Celeration		Growth/Decay (-)		Improvement Index
	Accel	Decel	Accel	Decel	Overall
Toe Taps	X 1.17	X 1	17%	0%	X 1.17
Heel Taps	X 1.18	X 1	18%	0%	X 1.18
Tip Steps	X 1.52	X 1	52%	0%	X 1.52
Dig Steps	X 1.36	÷ 1.17	36%	-15%	X 1.59
Shuffle Steps	X 1.35	X 1.2	35%	20%	X 1.12
Windshield Wipers	X 1.4	÷ 1.61	40%	-38%	X 2.26
Shuffles Right	X 1.34	X 2.3	34%	130%	÷ 1.71
Shuffles Left	X 1.39	÷ 1.48	39%	33%	X 2.07

The metrics of celeration, percent growth and decay and the overall improvement index for Andy's stability probes are shown above. For celeration and improvement index, an increasing value (acceleration) is indicated by a multiplication symbol (X) and a decreasing value (deceleration) is indicated by a division symbol (÷). For percent growth or decay, growth is shown as a positive number with no symbol and decay is shown as a negative number with a subtraction symbol (-). Dashes (-) indicate one of two things: (1) there was no change in the metric or (2) the metric does not apply to the data set. Measures reflect the change per month.

#### Application Probes

Figure 28 shows the results of Andy's application probes. Exercise 6 (traveling) started at approximately 25% of the aim and ended at 50% of the aim. Correct steps increased from 80 steps per minute in the first probe to 160 steps per minute in the final probe. There was a high of 8 incorrect steps per minute in the first three probes but dropped to 4 per minute in the last two. Exercise 8 (stationary) started at approximately 33% of the aim and ended at 47% of the aim. The frequency of correct responses started at 84 per minute in the first probe and ended at 132 per minute in the final probe. Incorrect steps remained low, below 4 per minute.

Figure 28. Andy Application Probes



The triangles indicate the frequency of correct steps linked to the primary axis. The X's indicate the frequency of incorrect steps linked to the secondary axis. A legend is provided to indicate the color of the data path that corresponds to each data series.

Andy's application probes also experienced notable growth. He doubled his frequency for Exercise 6, and nearly did the same for Exercise 8. For both probes, Andy had a more substantial jump up in frequency in the last probe, once he had passed through training on all component steps. Incorrect steps remained low throughout application probes. Andy did comment during his debrief that his main concern in application probes was accuracy and that speed was never his goal. This may or may not have impacted his frequencies. Table 16 shows additional data for Andy's performance in application probes.

Table 16. Andy Application Outcomes

	Celeration		Growth/Decay		Improvement Index
	Accel	Decel	Accel	Decel	Overall
Exercise 6	X 1.4	÷ 1.26	40%	-21%	X 1.77
Exercise 8	X 1.32	÷ 1.11	32%	-10%	X 1.47

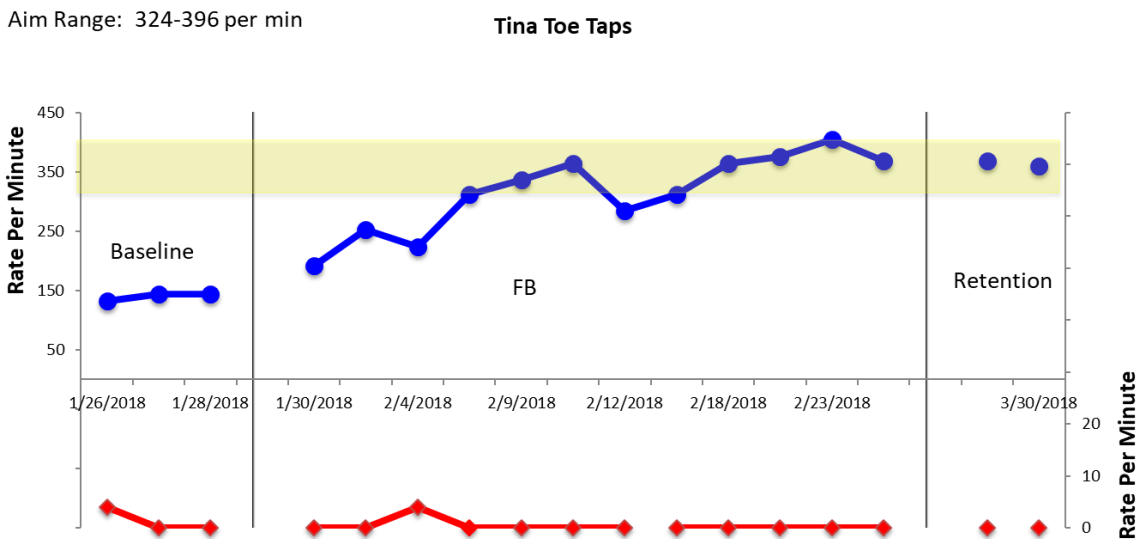
The metrics of celeration, percent growth and decay and the overall improvement index for Andy's application probes are shown above. For celeration and improvement index, an increasing value (acceleration) is indicated by a multiplication symbol(X) and a decreasing value (deceleration) is indicated by a division symbol (÷). For percent growth or decay, growth is shown as a positive number with no symbol and decay is shown as a negative number with a subtraction symbol (-). Dashes (-) indicate one of two things: (1) there was no change in the metric or (2) the metric does not apply to the data set. Measures reflect the change per month.

Tina

#### *Pair 1: Toe Taps and Heel Taps*

Figure 29 shows Tina's data for toe taps. At baseline, toe taps were well below 60% of aim with virtually no celeration. Baseline started with 4 incorrect steps per minute and decreased to zero, producing a steep deceleration (÷11.3). Toe taps made a significant jump from Baseline to FB, with an increase of 144 correct steps per minute for the last data point in the previous condition to 192 per minute for the first data point in the next condition. In FB, correct steps accelerated at a rate of X1.5 per week and incorrect steps remained low throughout. Only one session had a rate of 4 errors per minute. Toe taps met the mastery criteria within 6 sessions but remained in FB until its partner (heel taps) also met the mastery criteria. Toe taps remained at aim during Retention with no errors.

Figure 29. Tina Toe Taps



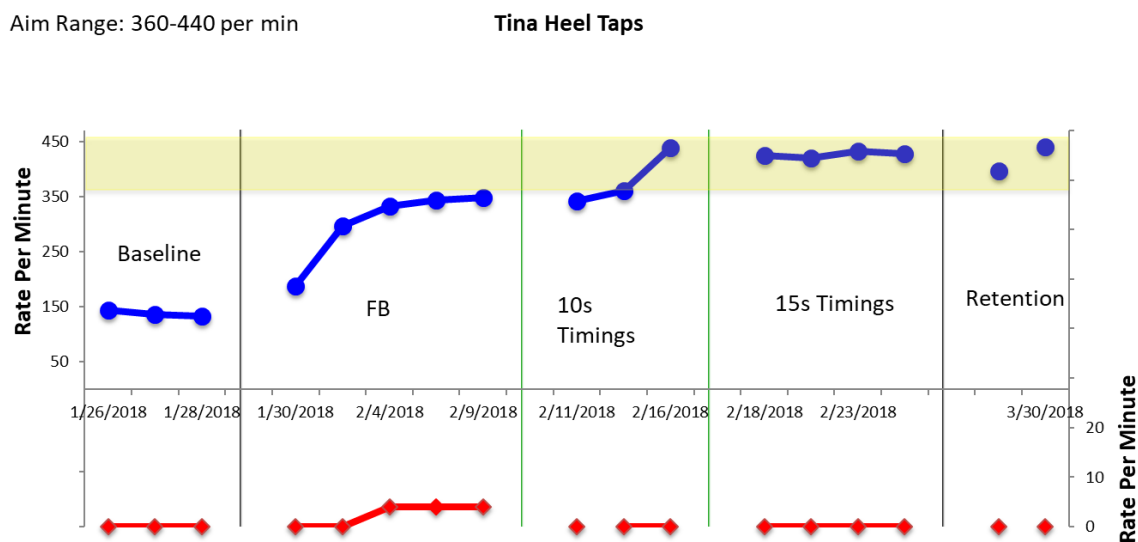
*The blue data series represents the frequency of correct responses (primary axis). The red data series represents the frequency of errors (secondary axis). The yellow band indicates the aim range. FB is a shortened label for frequency building. Both data sets are expressed as a rate per minute (i.e. frequency per minute).*

Figure 30 shows the data for Tina's heel tap performance. Heel taps started far below 60% of aim and with a slight deceleration ( $\div 1.36$  per week). No incorrect steps occurred during Baseline. Just like toe taps, heel taps had a jump up in correct steps, which grew from 132 per minute in the last Baseline session to 188 per minute for first data FB session. Then correct steps accelerated at a rate of X1.5 but plateaued slightly below aim, while incorrect steps increased from zero to 4 per minute. The timing length was reduced to 10s, and this intervention successfully brought heel taps to aim and reduced incorrect steps. Heel taps remained at aim at the re-introduction of 15s timings and in Retention probes. No incorrect steps were recorded for either phase.

Because Tina's baseline frequencies started much lower than the previous two participants', it required more session to reach aim on Pair 1. While Andy and Daisy both met mastery criteria in 4 sessions, she took 6 for toe taps and 9 for heel taps, with an intervention.

Nonetheless, once at aim retention did emerge as evidenced by her stable frequencies in the aim range during Retention probes. Table 17 shows additional data on Tina's performance for toe taps and heel taps.

Figure 30. Tina Heel Taps



The blue data series represents the frequency of correct responses (primary axis). The red data series represents the frequency of errors (secondary axis). The yellow band indicates the aim range. FB is a shortened label for frequency building. Both data sets are expressed as a rate per minute (i.e. frequency per minute).

Table 17. Tina Pair 1 Outcomes

	Celeration		Growth/Decay (-)		Level Change		Improvement Index
	Accel	Decel	Accel	Decel	Accel	Decel	Overall
<b>Toe Taps</b>							
Baseline	X 1.36	÷ 11.3	36%	-91%	-	-	X 15.3
Frequency	X 1.18	÷ 1.05	18%	-5%	2.3	0.8	X 1.24
Retention	-	-	-	-	-	-	X 1.32
<b>Heel Taps</b>							
Baseline	÷ 1.36	X 1	-26%	0%	-	-	÷ 1.36
Frequency	X 1.5	X 1.8	50%	80%	2.1	1.5	X 1.14
10s	X 1.41	X 1	41%	0%	1.3	1	X 1.41
15s	X 1.02	X 1	2%	0%	1.1	0.7	X 1.02
Retention	-	-	-	-	-	-	X 1.03

The metrics of celeration, percent growth and decay, level change from previous condition, and the overall improvement index for Tina's Pair 1 per phase are shown above. For celeration and improvement index, an increasing value (acceleration) is indicated by a multiplication symbol (X) and a decreasing value (deceleration) is indicated by a division symbol (÷). For percent growth or decay, growth is shown as a positive number with no symbol and decay is shown as a negative number with a subtraction symbol (-). For level change, a whole number

*indicates a rise in level. The greater the number, the greater the level change. Decimals smaller than 1 indicate a decrease in level. Dashes (-) indicate one of two things: (1) there was no change in the metric or (2) the metric does not apply to the data set. Measures reflect the change per week for all conditions except for weekly probes, which is expressed as change per month (\*).*

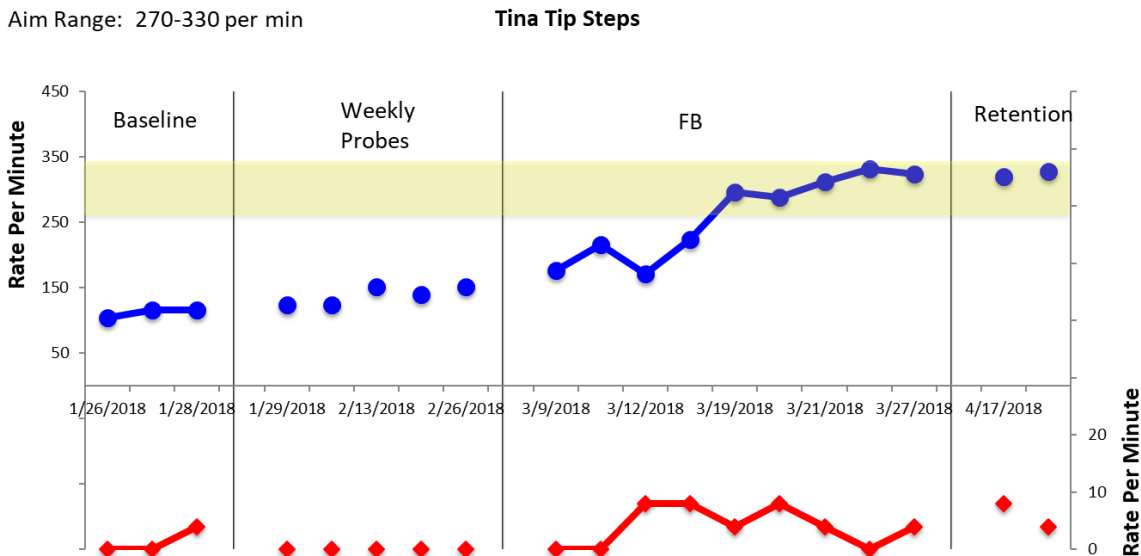
### *Pair 2: Tip Steps and Dig Steps*

Figure 31 shows the data for Tina's performance on tip steps. Tip steps started considerably below 60% of the aim though with an acceleration of X1.47 per week. Nonetheless, incorrect steps also accelerated at a rate of X11.3 per week. Though, errors only occurred in the last session at a rate of 4 per minute. During Weekly Probes, correct steps grew from 124 per minute to 152 per minute (X1.3 per month). No errors were recorded in this phase. In FB, tip steps accelerated at a rate of X1.3 per week and reached the aim range within 5 sessions. Errors also increased initially, reaching a high of 8 per minute; then decreased to a range of 0-4 per minute in the last 3 sessions of the phase. Tip steps met mastery criteria within 9 sessions of FB and remained at aim during Retention Probes. The first Retention Probe did have a high rate of errors (8 per minute) but dropped in the second probe (4 per minute).

Figure 32 shows the data for Tina's performance on dig steps. Dig steps fell even further below 60% of aim than tip steps during Baseline and had a deceleration ( $\div 1.31$  per week). Incorrect steps occurred at a range of 0-4 per minute in this phase. During Weekly Probes, dig steps grew from 104 per minute in the first probe, reached a high of 168 per minute, and ended on 148 per minute in the last probe. Errors only occurred on the first probe at a frequency of 12 per minute during. Dig steps made a considerable jump from Weekly Probes to FB with an increase from 148 correct steps per minute in the last data point of the previous condition to 220 per minute in the first data point of the next condition. This brought the frequency close to the aim range, and after 6 sessions, dig steps stabilized at aim. Incorrect steps occurred during two sessions at the beginning of FB at a rate of 12 per minute, but quickly decelerated ( $\div 1.67$  per

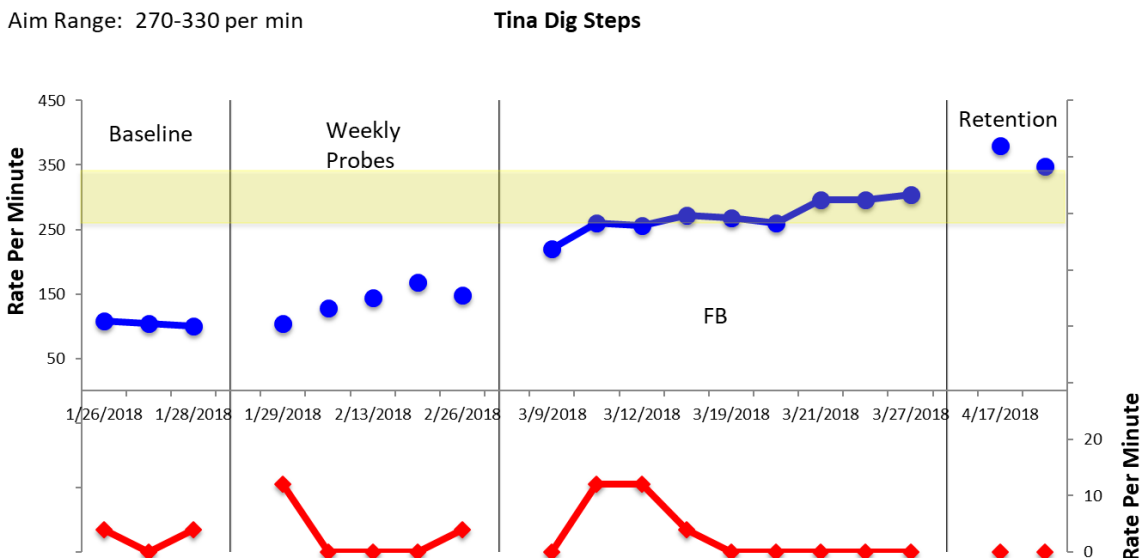
week) and reached zero. Dig steps met the mastery criteria within 9 sessions of entering the FB phase. Both Retention probes remained above aim with no incorrect steps.

Figure 31. Tina Tip Steps



The blue data series represents the frequency of correct responses (primary axis). The red data series represents the frequency of errors (secondary axis). The yellow band indicates the aim range. FB is a shortened label for frequency building. Both data sets are expressed as a rate per minute (i.e. frequency per minute).

Figure 32. Tina Dig Steps



The blue data series represents the frequency of correct responses (primary axis). The red data series represents the frequency of errors (secondary axis). The yellow band indicates the aim range. FB is a shortened label for frequency building. Both data sets are expressed as a rate per minute (i.e. frequency per minute).

Like toe taps and heel taps, Tina’s baseline levels started much further from aim than other participants’ and hence the time frame for mastery was longer, yet shorter than the amount she took to master the previous pair. Tip steps had a moderate improvement in the weekly probes, while dig steps had a robust improvement. This suggests that training in Pair 1 did have relative generative effects on Pair 2. Retention emerged for both steps in the pair, given that both remained at or above aim in Retention Probes. Table 18 shows additional data for Tina’s performance on tip steps and dig steps.

Table 18. Tina Pair 2 Outcomes

	Celeration		Growth/Decay (-)		Level Change		Improvement Index
	Accel	Decel	Accel	Decel	Accel	Decel	Overall
<b>Tip Steps</b>							
Baseline	X 1.47	X 11.3	47%	1031%	-	-	÷ 7.72
Weekly Probes*	X 1.3	X 1	30%	0%	1.2	0.8	X 1.3
Frequency	X 1.3	X 1.03	30%	3%	1.8	2	X 1.26
Retention	-	-	-	-	-	-	X 1.34
<b>Dig Steps</b>							
Baseline	÷ 1.31	X 1	-24%	0%	-	-	÷ 1.31
Weekly Probes*	X 1.63	÷ 3	63%	-67%	1.3	1	X 4.89
Frequency	X 1.1	÷ 1.67	10%	-40%	2	1	X 1.38
Retention	-	-	-	-	-	-	÷ 1.04

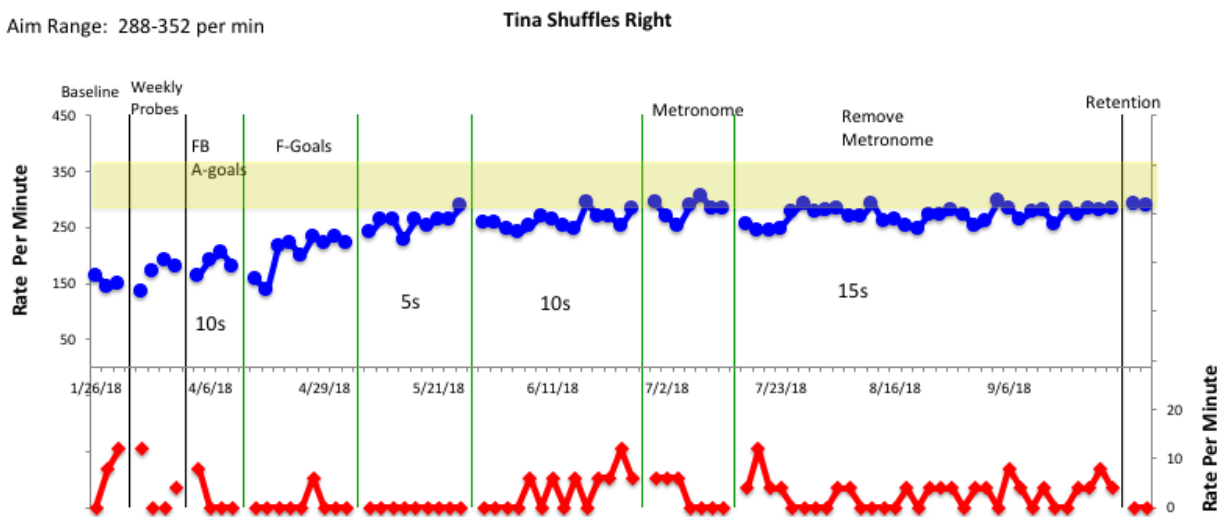
The metrics of celeration, percent growth and decay, level change from previous condition, and the overall improvement index for Tina’s Pair 2 per phase are shown above. For celeration and improvement index, an increasing value (acceleration) is indicated by a multiplication symbol (X) and a decreasing value (deceleration) is indicated by a division symbol (÷). For percent growth or decay, growth is shown as a positive number with no symbol and decay is shown as a negative number with a subtraction symbol (-). For level change, a whole number indicates a rise in level. The greater the number, the greater the level change. Decimals smaller than 1 indicate a decrease in level. Dashes (-) indicate one of two things: (1) there was no change in the metric or (2) the metric does not apply to the data set. Measures reflect the change per week for all conditions except for weekly probes, which is expressed as change per month (\*).

### Pair 3: Shuffles Right & Shuffles Left

Figure 33 shows Tina’s performance on shuffles right. All three of Tina’s Baseline sessions fell below 60% and decelerated at a rate of ÷1.43 per week. Incorrect steps increased from none to 12 per minute by the third session. These data trends reversed directions in the

Weekly Probes. Correct steps accelerated (X1.61 per month) and incorrect steps decelerated ( $\div 5.21$  per month). Shuffles right started with an intervention of A-goals only in the FB and a shortened timing length of 10s given its considerable distance from aim. Errors rapidly decreased to zero and standard implementation of F-goals was introduced. There was an initial drop in correct steps when F-goals were implemented, but frequencies quickly recovered and accelerated at a rate of X1.2 per week. Then, the frequency of corrects stabilized around 220-235 per minute, approximately at 60%-70% of aim. The timing length was shortened to 5s, which successfully increased frequencies and shuffles right reached aim. The timing length was then dropped to 10s. Shuffles right remained stable at or near aim, but errors increased (X1.27 per week). A metronome intervention was introduced to combat the increase in errors without suppressing the frequency of correct steps. The metronome served as a model of perfect pace. Tina practiced with the metronome before timings. This intervention successfully pushed correct steps higher into the aim range, while simultaneously decreasing errors ( $\div 1.52$  per week). The metronome was removed, and standard implementation of 15s timings was introduced. Again, there was an initial drop in correct steps and an increase in errors when the timing length increased to 15s, but quickly recovered and reached aim. Shuffles right met mastery criteria within 7 sessions of returning to standard implementation but remained in FB until its partner (shuffles left) mastered the phase as well. Shuffles right remained within aim with no errors during Retention probes.

Figure 33. Tina Shuffles Right

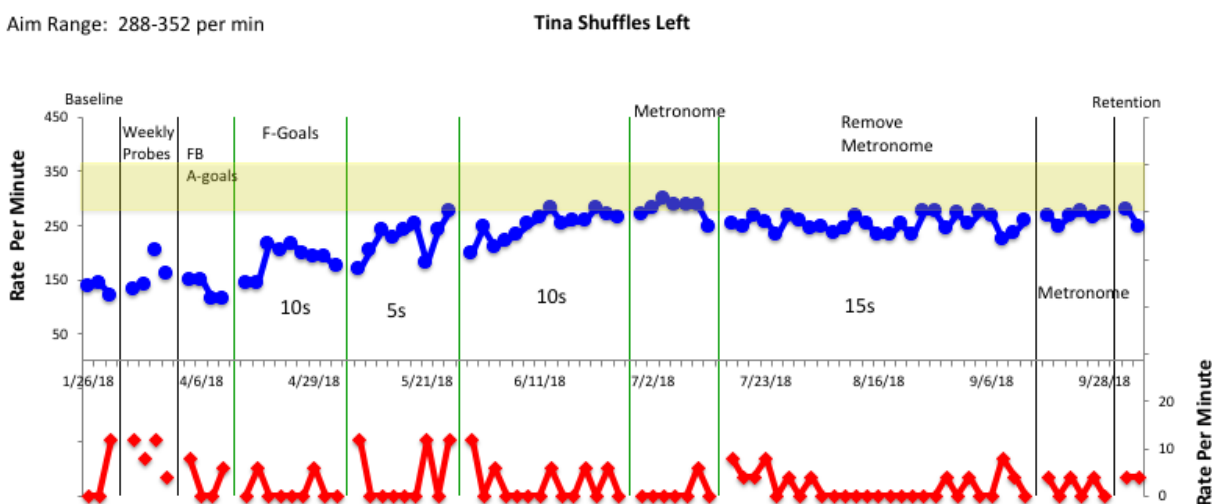


The blue data series represents the frequency of correct responses (primary axis). The red data series represents the frequency of errors (secondary axis). The yellow band indicates the aim range. FB is a shortened label for frequency building. Both data sets are expressed as a rate per minute (i.e. frequency per minute).

Figure 34 shows the data for Tina's performance on shuffles left. Shuffles left followed a similar data pattern to that of shuffles right. Shuffles left started below 60% of aim with a deceleration in correct steps ( $\div 1.55$  per week) and an acceleration in incorrect steps ( $\times 5.29$  per week) in Baseline. This pattern was reversed in the weekly probes condition and correct steps accelerated at a rate of  $\times 1.61$  per month, while errors decelerated at a rate of  $\div 4.26$  per month. Like shuffles right, shuffles left started with A-goals in FB. Here, frequency of correct steps decelerated ( $\div 1.36$  per week) concurrently with a deceleration in errors ( $\div 1.45$  per week). This is not unusual given that accuracy goals were provided. Since errors decreased, F-goals were introduced, and the timing length was shortened to 10s, since shuffles left was more than 50% below aim. Though there was a noteworthy level change (1.4), there was virtually no acceleration ( $\div 1.04$  per week). The timing length was shortened to 5s and shuffles left then accelerate at a rate of  $\times 1.11$  per week; though errors also increased ( $\times 1.24$  per week), reaching a high of 12 per minute. Despite the spike in incorrect steps, once shuffles left met aim at 5s the timing length

was increased to 10s. Here, the shuffles left initially dropped, but quickly recovered and increased from 198 per minute to 264 per minute then stabilized at approximately 20% away from the aim. The metronome intervention was introduced, and shuffles stabilized at aim with minimal errors (only one session at 4 per minute). When the metronome was removed, shuffles left became variable falling in and out of aim, making it difficult to meet the mastery criteria. The metronome was re-introduced, and variability decreased, and shuffles left met mastery criteria. In both Retention Probes, correct steps remained high and incorrect steps low. Table 19 shows additional data of Tina's performance on shuffles right and shuffles left.

Figure 34. Tina Shuffles Left



The blue data series represents the frequency of correct responses (primary axis). The red data series represents the frequency of errors (secondary axis). The yellow band indicates the aim range. FB is a shortened label for frequency building. Both data sets are expressed as a rate per minute (i.e. frequency per minute).

Tina was the first participant to experience the new sequence of training steps based on the findings from Daisy and Andy's data. That is, shuffles right and shuffles left were trained before shuffle steps and windshield wipers. Despite this change, Pair 3 took much longer to master than the previous two pairs, breaking Tina's pattern of agility. Moreover, a great many interventions were required. There are several reasons why this may have been the case. First,

shuffles right and shuffles left started much lower below the aim than the other two pairs and the trends for correct steps and incorrect steps were in undesirable directions in Baseline. Though Weekly Probes demonstrated generativity in various way (an upturn and acceleration of correct steps and downturn and deceleration of incorrect steps), frequencies still had a long span to cross to meet aim. Another plausible scenario may be that there are component skills that need to be mastered between Pair 2 and Pair 3 that may have produced more generativity across the entirety of the sequence. Yet, another possibility is that breaking down shuffles themselves into finer components (brushes and spans) and building the rates of these prior to shuffles right and shuffles left, may have produced more efficient learning for Tina and all the participants. Even though training was more extensive in this step, once at aim retention did emerge for shuffles right and left. Table 19 shows additional data for Tina's performance on shuffles right and shuffles left.

Table 19. Tina Pair 3 Outcomes

	Celeration		Growth/Decay (-)		Level Change		Improvement Index
	Accel	Decel	Accel	Decel	Accel	Decel	Overall
<b>Shuffles Right</b>							
Baseline	÷ 1.43	X 529	-30%	52809%	-	-	÷ 758
Weekly Probes*	X 1.61	÷ 5.21	61%	-81%	1.1	0.6	X 8.39
FB-A Goals/10s	X 1.13	÷ 2.62	13%	-24%	1.1	1.1	X 2.95
F-Goals	X 1.2	X 1.08	20%	8%	1.1	0.9	X 1.12
5s	X 1.05	X 1.11	5%	11%	1.3	1.7	÷ 1.17
10s	X 1.02	X 1.27	2%	27%	1	0.8	÷ 1.25
Metronome	X 1.01	÷ 1.52	1%	-34%	1.1	1	X 1.54
15s-Remove Metronome	X 1.01	÷ 1	1%	0%	1.1	0.7	X 1.01
Retention	-	-	-	-	-	-	÷ 1.01
<b>Shuffles Left</b>							
Baseline	÷ 1.55	X 5.29	-47%	52809%	-	-	÷ 820
Weekly Probes*	X 1.61	÷ 4.26	61%	-77%	1.2	2.3	X 6.86
FB-A Goals/10s	÷ 1.36	÷ 1.45	-27%	-31%	0.8	0.6	X 1.07
F-Goals	X 1.07	÷ 1.04	7%	-2%	1.4	0.8	X 1.11
5s	X 1.11	X 1.24	11%	24%	1.2	1.9	÷ 1.12
10s	X 1.07	÷ 1.05	7%	-5%	1.1	0.6	X 1.12
Metronome	÷ 1	X 1.13	0%	13%	1.1	0.8	÷ 1.13
15s-Remove Metronome	X 1	÷ 1.04	0%	-4%	0.9	0.9	X 1.04
Metronome	X 1.03	÷ 1.23	3%	-18%	1.1	0.9	X 1.26
Retention	-	-	-	-	-	-	÷ 1.05

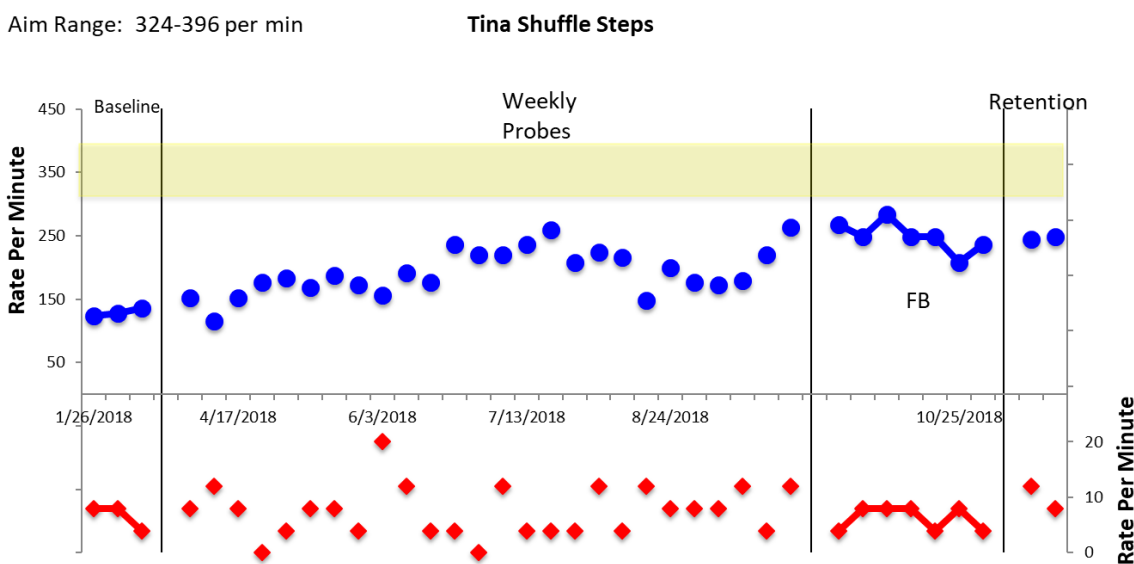
The metrics of celeration, percent growth and decay, level change from previous condition, and the overall improvement index for Tina's Pair 3 per phase are shown above. For celeration and improvement index, an increasing value (acceleration) is indicated by a multiplication symbol (X) and a decreasing value (deceleration) is indicated by a division symbol (÷). For percent growth or decay, growth is shown as a positive number with no symbol and decay is shown as a negative number with a subtraction symbol (-). For level change, a whole number indicates a rise in level. The greater the number, the greater the level change. Decimals smaller than 1 indicate a decrease in level. Dashes (-) indicate one of two things: (1) there was no change in the metric or (2) the metric does not apply to the data set. Measures reflect the change per week for all conditions except for weekly probes, which is expressed as change per month (\*).

#### Pair 4: Shuffle Steps and Windshield Wipers

Figure 35 shows Tina's data for shuffle steps. At Baseline, shuffle steps were significantly below 60% of aim and had moderate acceleration (X1.38 per week). Incorrect steps decreased from a rate of 8 per minute in the first two sessions to an error rate of 4 per minute in the last session of Baseline (÷11.3 per week). Since Pair 3 was in training for a long period of time, shuffle steps were in Weekly Probes for the equivalent time frame. Throughout Weekly Probes, shuffle steps increased from 152 per minute to 264 per minute. The frequency of

incorrect steps was highly variable during this phase, ranging from 0-12 per minute with one exceptionally high point at 20 per minute. Initially in the FB, shuffle steps started high (within 20% below the aim range); however, on the third session they began to downtrend. Nonetheless errors decreased to a range of 0-4 per minute. Due to time and financial constraints of the project, Tina's training on Pair 4 was terminated before reaching mastery criteria. Fortunately, outcome probes were still measured, providing a unique opportunity to observe the outcomes in absence of mastery of Pair 4. Retention probes had comparable performance to that of her last few FB sessions.

Figure 35. Tina Shuffle Steps

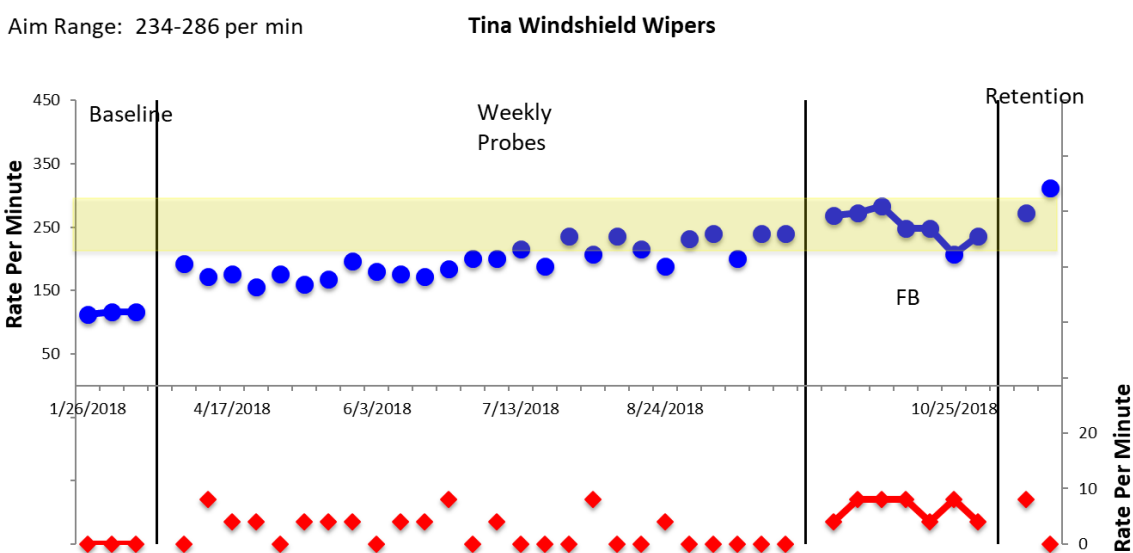


*The blue data series represents the frequency of correct responses (primary axis). The red data series represents the frequency of errors (secondary axis). The yellow band indicates the aim range. FB is a shortened label for frequency building. Both data sets are expressed as a rate per minute (i.e. frequency per minute).*

Figure 36 shows the data for Tina's performance on windshield wipers. Tina's performance for windshield wipers fell below 60% of aim with minimal acceleration (X1.13 per week). No errors were recorded in Baseline. As with shuffle steps, windshield wipers also remained in Weekly Probes until training in Pair 3 concluded. At the phase change from Baseline

to Weekly Probes, windshield wipers increased from 116 per minute for the last data point in the previous phase to 192 per minute for the first data point in the next phase. This jump placed windshield wipers very close to the aim range, and therefore had a moderate celeration (X1.07 per month) during this phase. Windshield wipers stabilized within the aim range, and incorrect steps decreased from a high of 8 per minute to zero, essentially meeting mastery criteria before training. When windshield wipers entered FB, correct steps remained within the aim range and incorrect steps remained in a range of 4-8 per minute. Tina's performance remained far in the aim range during Retention Probes.

Figure 36. Tina Windshield Wipers



*The blue data series represents the frequency of correct responses (primary axis). The red data series represents the frequency of errors (secondary axis). The yellow band indicates the aim range. FB is a shortened label for frequency building. Both data sets are expressed as a rate per minute (i.e. frequency per minute).*

Though Weekly Probes for shuffle steps had high variability, a distinct upward trend is still evident and the growth from the first to the last probe was significant. It appears that there were generative effects on shuffle steps as a result of training Pair 3. In fact, there may have been a missed opportunity to pass Tina on shuffles right and left earlier based on her performance on

shuffle steps probes. At Weekly Probe 16, Tina had reached a high of 260 and hovered close to aim. If these steps are truly components, substantial increases in shuffle steps would indicate functional mastery of shuffles right and left. Tina did not contact this alternative and interestingly, her performance in shuffle steps probes then experienced a downtrend. These two events may or may not be related. Though shuffle steps did not meet the mastery criteria before termination, retention of the rates where the step ended were maintained. This suggests that levels of retention are related to the level at which training ends. Windshield wipers met mastery criteria before experiencing training and persisted through FB and Retention Probes, evidence of generativity and retention. Table 20 shows additional data for Tina's performance on shuffle steps and windshield wipers.

Table 20. Tina Pair 4 Outcomes

	Celeration		Growth/Decay (-)		Level Change		Improvement Index
	Accel	Decel	Accel	Decel	Accel	Decel	Overall
<b><i>Shuffle Steps</i></b>							
Baseline	X 1.38	÷ 11.3	38%	-91%	-	-	X 15.6
Weekly Probes*	X 1.07	X 1.06	7%	6%	1.5	1	X 1.01
Frequency	÷ 1.15	÷ 1.06	-13%	-5%	1.3	0.9	÷ 1.08
<b><i>Windshield Wipers</i></b>							
Baseline	X 1.13	X 1	13%	0%	-	-	X 1.13
Weekly Probes*	X 1.07	÷ 1.14	7%	-12%	1.7	1.5	X 1.22
Frequency	÷ 1.18	÷ 1.06	-15%	-6%	1.3	2	÷ 1.11

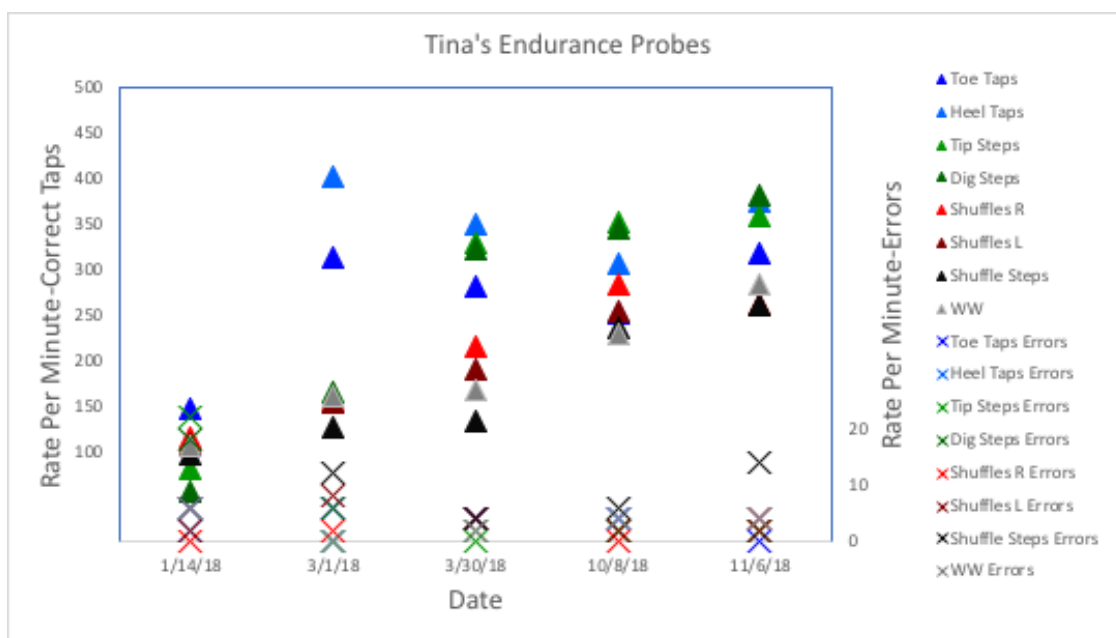
*The metrics of celeration, percent growth and decay, level change from previous condition, and the overall improvement index for Tina's Pair 4 per phase are shown above. For celeration and improvement index, an increasing value (acceleration) is indicated by a multiplication symbol (X) and a decreasing value (deceleration) is indicated by a division symbol (÷). For percent growth or decay, growth is shown as a positive number with no symbol and decay is shown as a negative number with a subtraction symbol (-). For level change, a whole number indicates a rise in level. The greater the number, the greater the level change. Decimals smaller than 1 indicate a decrease in level. Dashes (-) indicate one of two things: (1) there was no change in the metric or (2) the metric does not apply to the data set. Measures reflect the change per week for all conditions except for weekly probes, which is expressed as change per month (\*).*

### ***Endurance Probes***

Figure 37 shows the data for Tina's performance on endurance probes. Tina's endurance probes all started very low (150 per minute or less) and substantially below their respective aims.

Moreover, except for shuffles right, all other steps started with varying levels of incorrect steps. Tip steps and dig steps started with exceptionally high errors (22 per minute and 18 per minute respectively). Tina's endurance probes gained both precision and speed throughout the study. Aside from shuffles left and shuffle steps, all other probes met aim. For all steps, the highest frequencies occurred in the probe following training in that step. For those that did not meet aim, they were within 10% of aim, an inconsequential difference on the standard celeration chart and in terms of functional use of the skill. For steps that had high rates of errors in the baseline probe, pronounced decreases occurred. For steps that started with moderate rates of errors, decreases to a range of 0-4 per minute occurred. Shuffle steps was the only one in the series that had an increase in errors as she gained speed.

Figure 37. Tina Endurance Probes



The triangles indicate the frequency of correct steps linked to the primary axis. The X's indicate the frequency of incorrect steps linked to the secondary axis. A legend is provided to indicate the color of the data path that corresponds to each data series.

The results of Tina's endurance probes suggest that endurance did emerge. Endurance probes showed overall improvement in both speed and accuracy at an increased timing length.

There was little separation between frequencies of correct steps and incorrect steps in the baseline probe and the data sets diverged more and more with every opportunity. More distinct separation is especially noticeable in the final two probes. Table 21 shows additional data for Tina's performance on endurance probes.

Table 21. Tina Endurance Outcomes

	Celeration		Growth/Decay (-)		Improvement Index
	Accel	Decel	Accel	Decel	Overall
Toe Taps	X 1.93	÷ 1.68	93%	-41%	X 3.24
Heel Taps	X 1.39	X 1.62	39%	62%	÷ 1.17
Tip Steps	X 1.93	÷ 1.68	93%	-41%	X 3.24
Dig Steps	X 2.19	÷ 2.51	219%	-60%	X 5.5
Shuffles Right	X 1.53	X 1.16	53%	16%	X 1.33
Shuffles Left	X 1.55	÷ 1.48	55%	-32%	X 2.28
Shuffle Steps	X 1.74	X 1.31	74%	31%	X 1.33
Windshield Wipers	X 1.58	X 1.29	58%	29%	X 1.22

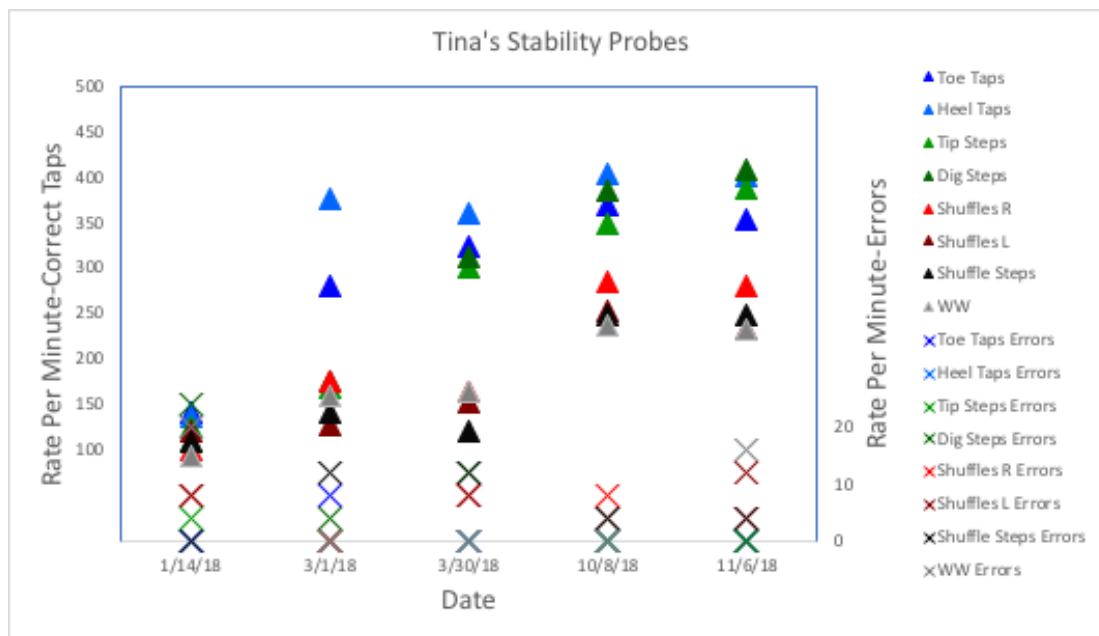
*The metrics of celeration, percent growth and decay and the overall improvement index for Tina's endurance probes are shown above. For celeration and improvement index, an increasing value (acceleration) is indicated by a multiplication symbol (X) and a decreasing value (deceleration) is indicated by a division symbol (÷). For percent growth or decay, growth is shown as a positive number with no symbol and decay is shown as a negative number with a subtraction symbol (-). Dashes (-) indicate one of two things: (1) there was no change in the metric or (2) the metric does not apply to the data set. Measures reflect the change per month.*

### Stability Probes

Figure 38 shows the data for Tina's performance on stability probes. Much like her endurance probes, Tina's stability probes began low and significantly below the aim ranges and with a high degree of inaccuracy, especially dig steps (24 per minute) and windshield wipers (20 per minute). All steps had increases in correct steps across stability probes and the majority met their respective aims (Shuffles left, and shuffle steps did not). Antithetically to the usual pattern, many of them met aim in the final two probes, rather than after training in that step. Generally, there was greater variability in frequencies of incorrect steps across stability probes than endurance probes. Four steps (toe taps, tip steps, dig steps, and shuffle steps) had prominent

decelerations in errors. Windshield wipers experienced little change in celeration though errors were high. Shuffle steps had a sizeable acceleration (X 1.22 per month).

Figure 38. Tina Stability Probes



*The triangles indicate the frequency of correct steps linked to the primary axis. The X's indicate the frequency of incorrect steps linked to the secondary axis. A legend is provided to indicate the color of the data path that corresponds to each data series.*

Notwithstanding the variability in frequencies of incorrect steps, a clear pattern of divergence between correct steps and incorrect steps is evident. Moreover, all steps made substantial increases toward aim. Ergo, stability did emerge as an outcome of Tina's performance in training. Table 22 shows additional data for Tina's performance on stability probes.

Table 22. Tina Stability Outcomes

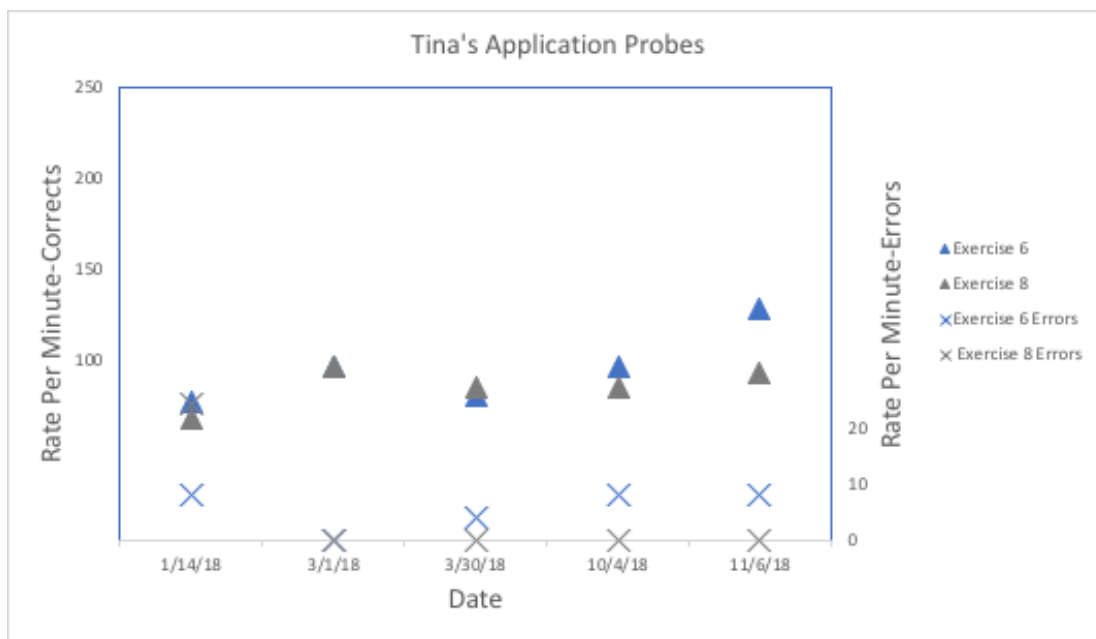
	Celeration		Growth/Decay (-)		Improvement Index
	Accel	Decel	Accel	Decel	Overall
Toe Taps	X 1.23	÷ 2.1	23%	-42%	X 2.59
Heel Taps	X 1.47	X 1	47%	0%	X 1.47
Tip Steps	X 1.72	÷ 1.75	72%	-43%	X 3.01
Dig Steps	X 1.86	÷ 2.56	86%	-61%	X 4.76
Shuffles Right	X 1.69	÷ 1.01	69%	-1%	X 1.71
Shuffles Left	X 1.54	X 1.22	54%	22%	X 1.26
Shuffle Steps	X 1.67	÷ 1.2	67%	-17%	X 2.01
Windshield Wipers	X 1.55	X 1.06	55%	6%	X 1.47

The metrics of celeration, percent growth and decay and the overall improvement index for Tina's stability probes are shown above. For celeration and improvement index, an increasing value (acceleration) is indicated by a multiplication symbol (X) and a decreasing value (deceleration) is indicated by a division symbol (÷). For percent growth or decay, growth is shown as a positive number with no symbol and decay is shown as a negative number with a subtraction symbol (-). Dashes (-) indicate one of two things: (1) there was no change in the metric or (2) the metric does not apply to the data set. Measures reflect the change per month.

### Application Probes

Figure 39 shows the data for Tina's performance on application probes. Both application probes began at 24% of the aim. Exercise 6 (traveling) ended at 40% of the aim. Exercise 6 increased from 76 per minute to 128 per minute (X 1.25 per month). Incorrect steps mostly ranged between 4-8 per minute, with only one probe where none were recorded, producing an acceleration of X 1.48 per month. Exercise 8 (stationary) ended at 33% of the aim. Exercise 8 started at 68 per minute, reached a high of 96 per minute, and ended at 92 per minute (X 1.08 per month). Errors started with a high of 24 per minute in the first probe and decreased to zero by the final probe (÷ 2.25 per month).

Figure 39. Tina Application Probes



*The triangles indicate the frequency of correct steps linked to the primary axis. The X's indicate the frequency of incorrect steps linked to the secondary axis. A legend is provided to indicate the color of the data path that corresponds to each data series.*

In sum, Tina's application probes did not demonstrate as powerful evidence of application as the previous participants given her moderate accelerations for frequencies of correct steps and acceleration for incorrect steps for Exercise 6. Nevertheless, there is evidence to suggest that some degree of application did emerge. She did have an extraordinary deceleration in errors for Exercise 8, which yielded a compelling improvement index (X 2.43 per month). In dance, precision is just as important as speed. Therefore, any improvements in accuracy contributes greatly to your repertoire as a dancer. In that environment, even improvements in accuracy only are quite meaningful. Furthermore, for Exercise 6, Tina increased her performance by 16-20 steps in the first three probes after the baseline probe. In the last probe, Tina increased her performance by 32 steps, nearly doubling the amount of change. Though overall acceleration was low, this jump indicates that Tina experienced greater generativity once she had experienced training in all the component steps. Also, keep in mind

that Tina's training for Pair 4 ended prematurely, which may have impacted her application outcomes. Table 23 shows additional data for Tina's performance on application probes.

Table 23. Tina Application Outcomes

	Celeration		Growth/Decay		Improvement Index
	Accel	Decel	Accel	Decel	Overall
Exercise 6	X 1.25	X 1.48	25%	48%	÷ 1.18
Exercise 8	X 1.08	÷ 2.25	8%	-55%	X 2.43

*The metrics of celeration, percent growth and decay and the overall improvement index for Tina's application probes are shown above. For celeration and improvement index, an increasing value (acceleration) is indicated by a multiplication symbol (X) and a decreasing value (deceleration) is indicated by a division symbol (÷). For percent growth or decay, growth is shown as a positive number with no symbol and decay is shown as a negative number with a subtraction symbol (-). Dashes (-) indicate one of two things: (1) there was no change in the metric or (2) the metric does not apply to the data set. Measures reflect the change per month.*

Berry

#### *Pair 1: Toe Taps & Heel Taps*

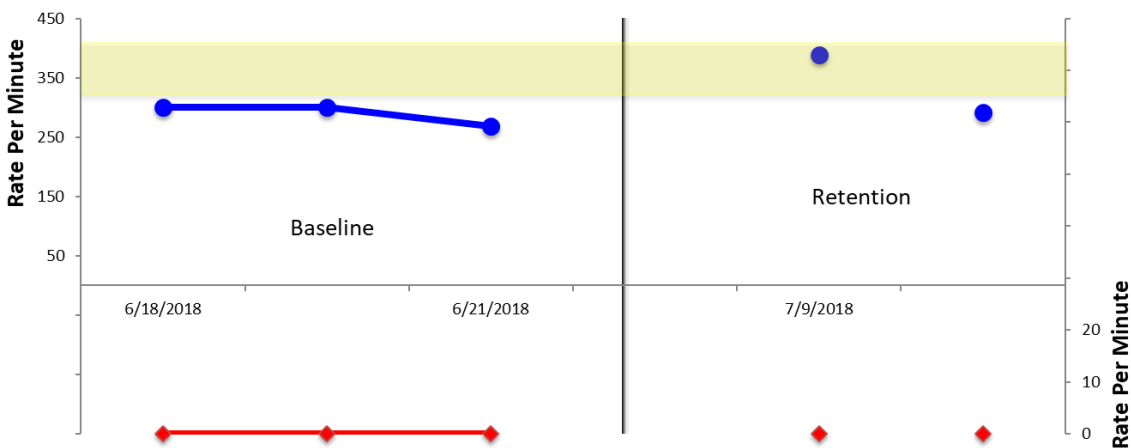
Figure 40 shows the data for Berry's performance on toe taps. Berry's toe taps far exceeded 60% of aim. His frequency was about 80% of the aim. No errors occurred during Baseline. Given Berry's Baseline levels, toe taps were excluded from training. Nonetheless, toe taps participated in probes. Retention probes yielded frequencies in or near the aim with perfect accuracy.

Figure 41 shows the data for Berry's heel taps. Congruent with toe taps, heel taps also far exceeded 60% of aim with no errors. Since frequencies fell so close to aim, this step was also excluded from training. Frequencies in Retention probes remained at a similar level as baseline levels with no incorrect steps. Table 24 shows additional data for Berry's toe taps and heel taps performance.

Figure 40. Berry Toe Taps

Aim Range: 324-396 per min

**Berry Toe Taps**

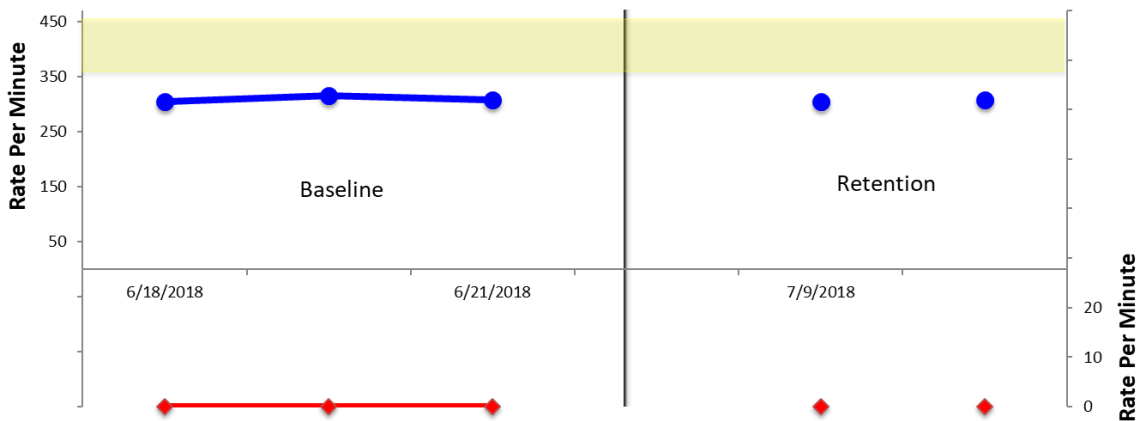


The blue data series represents the frequency of correct responses (primary axis). The red data series represents the frequency of errors (secondary axis). The yellow band indicates the aim range. FB is a shortened label for frequency building. Both data sets are expressed as a rate per minute (i.e. frequency per minute).

Figure 41. Berry Heel Taps

Aim Range: 360-440 per min

**Berry Heel Taps**



The blue data series represents the frequency of correct responses (primary axis). The red data series represents the frequency of errors (secondary axis). The yellow band indicates the aim range. FB is a shortened label for frequency building. Both data sets are expressed as a rate per minute (i.e. frequency per minute).

Table 24. Berry Pair 1 Outcomes

	Celeration		Growth/Decay (-)		Level Change		Improvement Index
	Accel	Decel	Accel	Decel	Accel	Decel	Overall
<b><i>Toe Taps</i></b>							
Baseline	X 1.09	X 4	9%	300%	-	-	÷ 3.68
Retention	-	-	-	-	-	-	÷ 1.13
<b><i>Heel Taps</i></b>							
Baseline	X 1.05	X 1	5%	0%	-	-	X 1.05
Retention	-	-	-	-	-	-	X 1

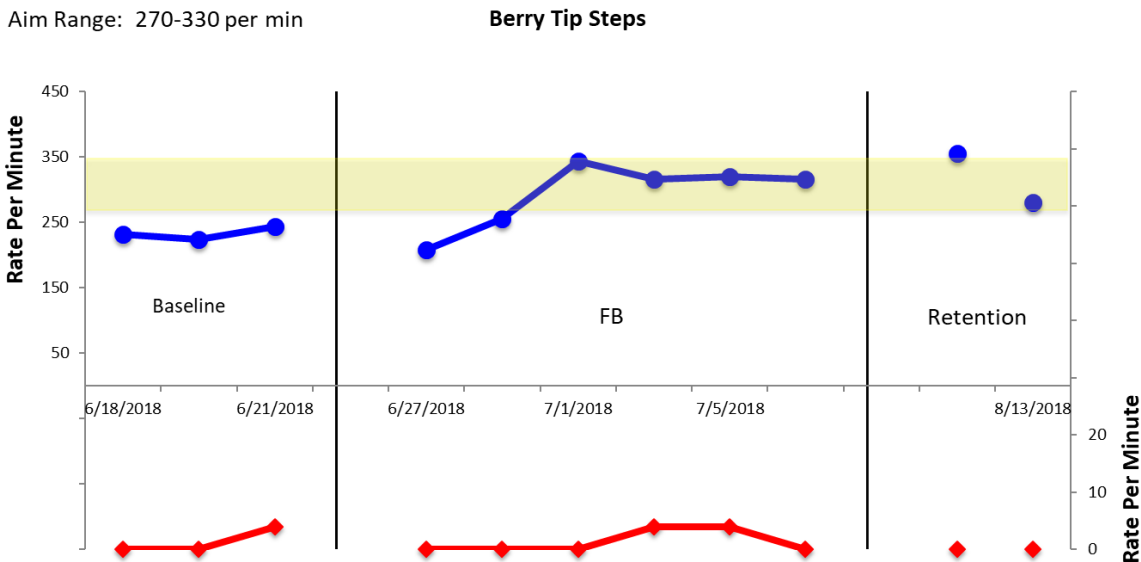
The metrics of celeration, percent growth and decay, level change from previous condition, and the overall improvement index for Berry's Pair 1 per phase are shown above. For celeration and improvement index, an increasing value (acceleration) is indicated by a multiplication symbol (X) and a decreasing value (deceleration) is indicated by a division symbol (÷). For percent growth or decay, growth is shown as a positive number with no symbol and decay is shown as a negative number with a subtraction symbol (-). For level change, a whole number indicates a rise in level. The greater the number, the greater the level change. Decimals smaller than 1 indicate a decrease in level. Dashes (-) indicate one of two things: (1) there was no change in the metric or (2) the metric does not apply to the data set. Measures reflect the change per week for all conditions except for weekly probes, which is expressed as change per month (\*).

#### *Pair 2: Tip Steps and Dig Steps*

Figure 42 shows the data for Berry's tip step performance. Berry's tip steps were above 60% of aim and had low rates (0-4 per minute) of incorrect steps during baseline. Nonetheless, tip steps were included in training given that its partner (dig steps) met inclusion criteria. Tip steps reached the aim range within the first 3 sessions of FB and subsequently met mastery criteria. Incorrect steps remained between 0-4 per minute. Retention probes remained high and in the aim range and no errors were recorded.

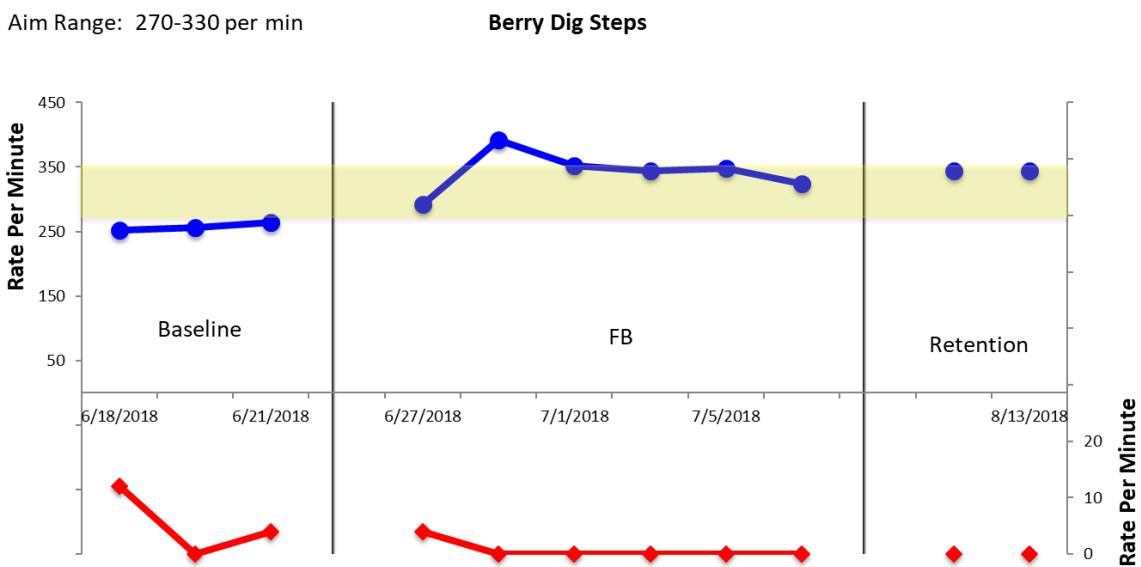
Figure 43 shows the data for Berry's dig steps. Dig steps were less than 10% below aim in Baseline. However, incorrect steps were high and variable (0-12) per minute. Dig steps were included in training to ensure that errors would remain low, and not interfere with learning subsequent steps. Dig steps immediately fell within the aim range in FB and incorrect steps dropped to zero (÷1.54 per week). Dig steps met the mastery criteria within 6 sessions. Retention probes remained at aim with zero errors.

Figure 42. Berry Tip Steps



The blue data series represents the frequency of correct responses (primary axis). The red data series represents the frequency of errors (secondary axis). The yellow band indicates the aim range. FB is a shortened label for frequency building. Both data sets are expressed as a rate per minute (i.e. frequency per minute).

Figure 43. Berry Dig Steps



The blue data series represents the frequency of correct responses (primary axis). The red data series represents the frequency of errors (secondary axis). The yellow band indicates the aim range. FB is a shortened label for frequency building. Both data sets are expressed as a rate per minute (i.e. frequency per minute).

Though Berry's tip steps and dig steps were already close to aim, FB still proved helpful in producing increases into the aim range. For dig steps, instructor feedback during FB was essential to increase the accuracy of the step. Again, this was imperative to preventing stagnation in Berry's learning further in the sequence. Retention for tip steps and dig steps emerged following training. Table 25 shows additional data for Berry's performance on tip steps and dig steps.

Table 25. Berry Pair 2 Outcomes

	Celeration		Growth/Decay (-)		Level Change		Improvement Index
	Accel	Decel	Accel	Decel	Accel	Decel	Overall
<b>Tip Steps</b>							
Baseline	X 1.09	X 4	9%	300%	-	-	÷ 3.91
Frequency	X 1.36	X 1.41	36%	41%	1.3	1	÷ 1.04
Retention	-	-	-	-	-	-	÷ 1.13
<b>Dig Steps</b>							
Baseline	X 1.11	÷ 22	11%	-95%	-	-	X 24.4
Frequency	X 1.04	÷ 1.54	4%	-35%	1.3	0.5	X 1.61
Retention	-	-	-	-	-	-	X 1

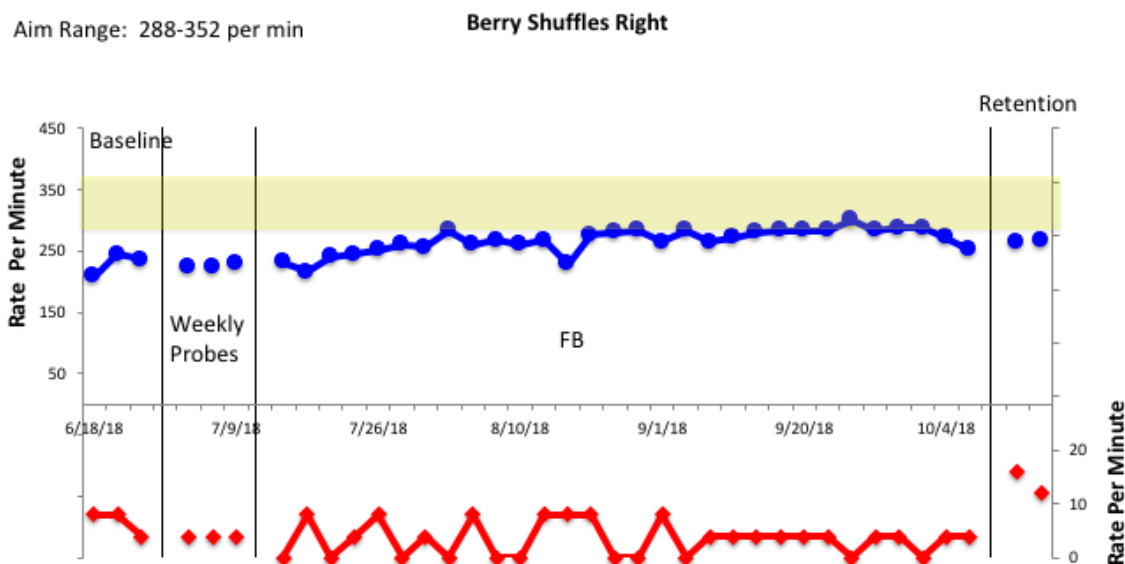
*The metrics of celeration, percent growth and decay, level change from previous condition, and the overall improvement index for Berry's Pair 3 per phase are shown above. For celeration and improvement index, an increasing value (acceleration) is indicated by a multiplication symbol (X) and a decreasing value (deceleration) is indicated by a division symbol (÷). For percent growth or decay, growth is shown as a positive number with no symbol and decay is shown as a negative number with a subtraction symbol (-). For level change, a whole number indicates a rise in level. The greater the number, the greater the level change. Decimals smaller than 1 indicate a decrease in level. Dashes (-) indicate one of two things: (1) there was no change in the metric or (2) the metric does not apply to the data set. Measures reflect the change per week for all conditions except for weekly probes, which is expressed as change per month (\*).*

### Pair 3: Shuffles Right & Shuffles Left

Figure 44 shows the data for Berry's shuffles right performance. Shuffles right also started above 60% of aim, near the aim range, and with a moderate celeration (X1.39). Incorrect steps started high (8 per minute) but decelerated substantially (÷4 per week) during baseline. Nonetheless, shuffles right was included in training because its partner (shuffles left) met inclusion criteria. Shuffles right experienced little change in Weekly Probes with relatively flat celerations for both correct steps (X 1.05 per month) and incorrect steps (X1). During FB, the

corrects steps increased slightly and fell within the aim range, but incorrect steps increased and became more variable (0-8). With feedback related to precision of the step and practice, Berry brought down his incorrect steps to a range of 0-4 per minute without intervention. Shuffles right hovered below aim during Retention, but errors increased, yielding frequencies higher than in any other phase.

Figure 44. Berry Shuffles Right

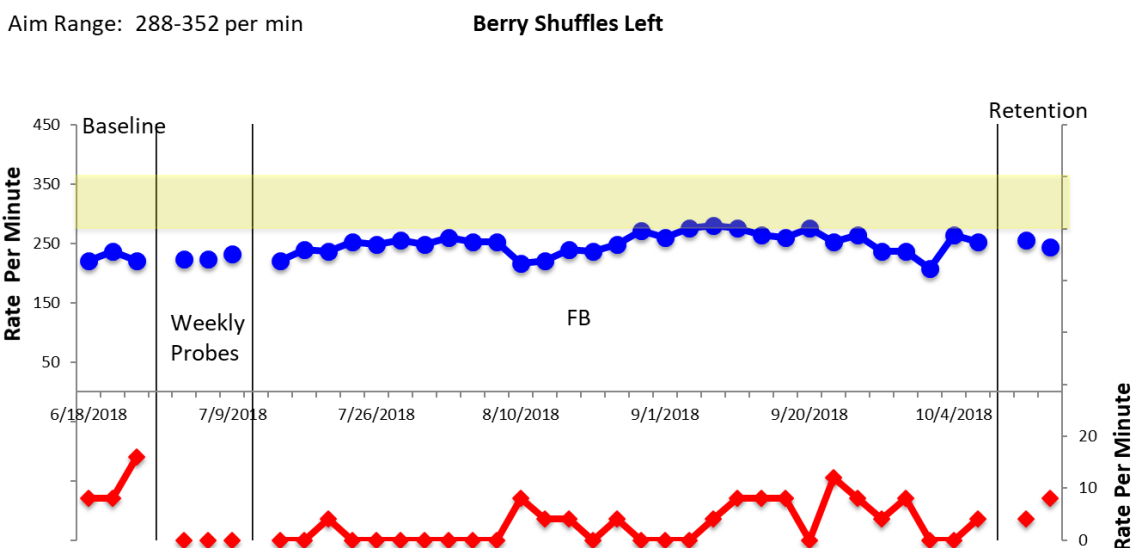


*The blue data series represents the frequency of correct responses (primary axis). The red data series represents the frequency of errors (secondary axis). The yellow band indicates the aim range. FB is a shortened label for frequency building. Both data sets are expressed as a rate per minute (i.e. frequency per minute).*

Figure 45 shows the data for Berry's performance on shuffles left. Shuffles left was also above 60% of aim but incorrect steps were high, ranging from 8-16 per minute and accelerating (X4 per week). Given the high levels of incorrect steps and the acceleration, shuffles left was included in training. Weekly Probes for shuffles left looked almost identical to those of shuffles right with flat celerations for both correct steps (X1.09 per month) and incorrect steps (X1 per month). Albeit, incorrect steps did drop to zero in this phase. In FB, initially, correct steps remained within a range of 220-280 per minute, just below the aim range, while errors remained

low. As correct steps increased in frequency, so did incorrect steps. Because Berry's errors would increase with increases in correct steps, his mastery criteria were modified to 80 % of the aim with no more than 4 errors per minute. This decision was also informed by Berry's Weekly Probes of the next training pair in the sequence, which indicated that shuffles right and left had met functional mastery.

Figure 45. Berry Shuffles Left



*The blue data series represents the frequency of correct responses (primary axis). The red data series represents the frequency of errors (secondary axis). The yellow band indicates the aim range. FB is a shortened label for frequency building. Both data sets are expressed as a rate per minute (i.e. frequency per minute).*

The frequencies of corrects steps for shuffles right and left did not change significantly during training. However, there was little room for growth considering Baseline frequencies. Though Berry's error rates may not have prompted training in another sport, tap dancing is a high precision performance art, and decreasing the rate from 8 per minute to 4 per minute makes a considerable difference for the dancer. It should be noted that during training of Pair 3, Berry frequently cancelled training sessions. Additionally, during training in this pair, due to Berry's work and school schedule, practice opportunities typically happened 3 consecutive days with 3-4

days of no practice in between. This may have impacted Berry's ability to further accelerate in shuffles right and left and also in the increase of variability in errors. Retention did emerge for both shuffles right and left, though to a lesser extent with shuffles right, considering the increase in incorrect steps during Retention probes. Table 26 shows additional data for Berry's performance on shuffles right and shuffles left.

Table 26. Berry Pair 3 Outcomes

	Celeration		Growth/Decay (-)		Level Change		Improvement Index
	Accel	Decel	Accel	Decel	Accel	Decel	Overall
<b><i>Shuffles Right</i></b>							
Baseline	X 1.39	÷ 4	39%	-75%	-	-	X 5.58
Weekly Probes	X 1.05	X 1	5%	0%	1	0.6	X 1.05
Frequency	X 1.01	÷ 1	1%	0%	1.2	0.9	X 1.02
Retention	-	-	-	-	-	-	X 1.1
<b><i>Shuffles Left</i></b>							
Baseline	X 1.04	X 4	4%	300%	-	-	÷ 3.86
Probes	X 1.09	X 1	9%	0%	1	0.2	X 1.09
Frequency	X 1	X 1.07	0%	7%	1.1	1.6	÷ 1.07
Retention	-	-	-	-	-	-	÷ 1.27

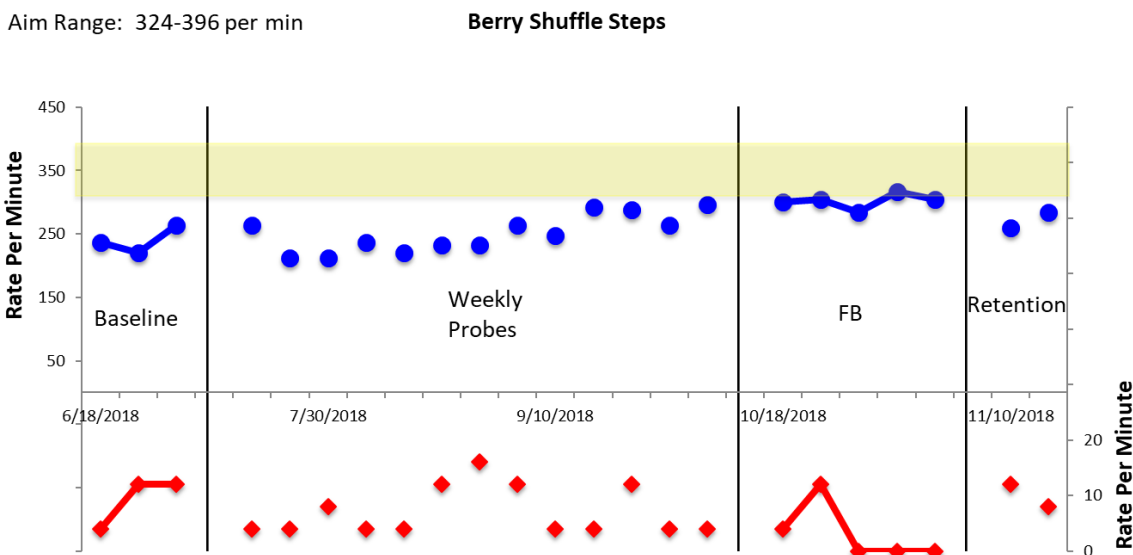
*The metrics of celeration, percent growth and decay, level change from previous condition, and the overall improvement index for Berry's Pair 3 per phase are shown above. For celeration and improvement index, an increasing value (acceleration) is indicated by a multiplication symbol (X) and a decreasing value (deceleration) is indicated by a division symbol (÷). For percent growth or decay, growth is shown as a positive number with no symbol and decay is shown as a negative number with a subtraction symbol (-). For level change, a whole number indicates a rise in level. The greater the number, the greater the level change. Decimals smaller than 1 indicate a decrease in level. Dashes (-) indicate one of two things: (1) there was no change in the metric or (2) the metric does not apply to the data set. Measures reflect the change per week for all conditions except for weekly probes, which is expressed as change per month (\*).*

#### *Pair 4: Shuffle Steps & Windshield Wipers*

Figure 46 shows the data for Berry's performance on shuffle steps. As with most of Berry's steps, shuffle steps were near aim in Baseline. Like shuffles left, Berry met inclusion criteria for this step based on the presence of high and accelerating errors (X15.6 per week). Weekly Probes had variability in correct steps and incorrect steps. In this phase, it was common for correct steps and errors to concurrently increase and decrease. At the end of the Weekly Probes phase, they began to diverge. Shuffle steps immediately fell in the aim range and

incorrect steps quickly dropped to zero once in FB. Shuffle steps met mastery criteria within 5 sessions. The first probe in Retention dropped slightly below aim and saw an increase in errors (12 per minute), but the second probe landed in the lower end of the aim range with less errors (4 per minute).

Figure 46. Berry Shuffle Steps



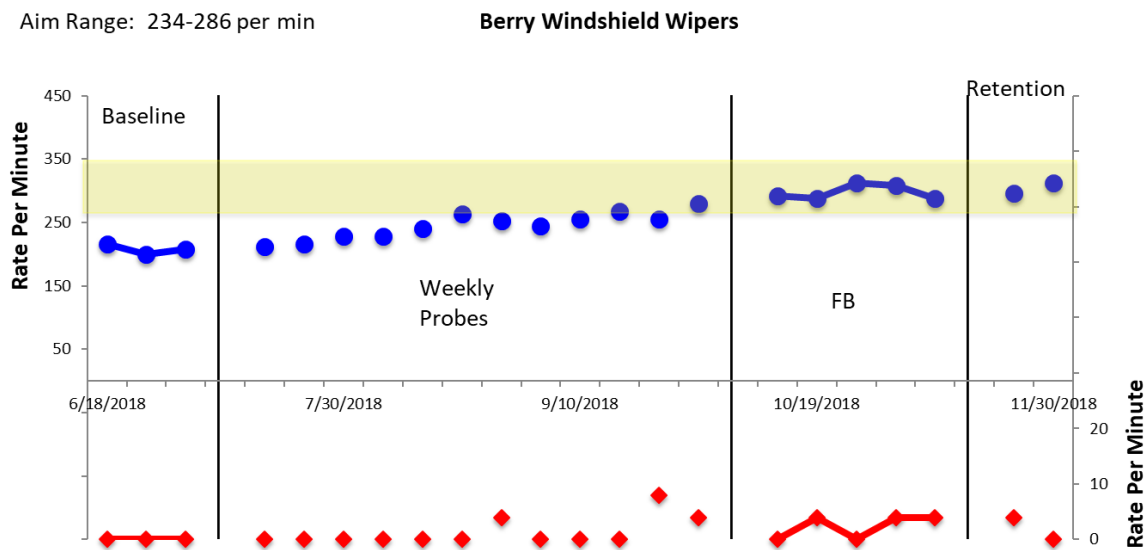
The blue data series represents the frequency of correct responses (primary axis). The red data series represents the frequency of errors (secondary axis). The yellow band indicates the aim range. FB is a shortened label for frequency building. Both data sets are expressed as a rate per minute (i.e. frequency per minute).

Figure 47 shows the data for Berry's windshield wipers. Windshield wipers fell within the low end of the aim range during baseline, with no errors. Nonetheless, windshield wipers accompanied its partner (shuffle steps) through the phases of the study. Windshield wipers remained at aim and relatively accurate in all phases including Retention.

As with shuffles left, the main objective in training shuffle steps was improving accuracy. This objective was accomplished in FB. Though both the frequency of corrects steps and incorrect steps returned to Baseline levels in the first Retention probe, Berry performed more similarly to his FB performance on the second probe, suggesting that retention did emerge for

shuffle steps. Table 27 shows additional data on Berry’s performance for shuffle steps and windshield wipers.

Figure 47. Berry Windshield Wipers



The blue data series represents the frequency of correct responses (primary axis). The red data series represents the frequency of errors (secondary axis). The yellow band indicates the aim range. FB is a shortened label for frequency building. Both data sets are expressed as a rate per minute (i.e. frequency per minute).

Table 27. Berry Pair 4 Outcomes

	Celeration		Growth/Decay (-)		Level Change		Improvement Index	
	Accel	Decel	Accel	Decel	Accel	Decel	Overall	
<b>Shuffle Steps</b>								
Baseline	X 1.21	X 15.6	21%	1459%	-	-	÷ 12.9	
Weekly Probes	X 1.09	X 1	9%	0%	1	0.7	X 1.09	
Frequency	X 1.02	÷ 4.88	2%	-80%	1.2	0.5	X 4.99	
Retention	-	-	-	-	-	-	X 1	
<b>Windshield Wipers</b>								
Baseline	÷ 1.12	X 1	-11%	0%	-	-	÷ 1.12	
Weekly Probes	X 1.12	X 1.44	12%	44%	1.2	1.3	÷ 1.29	
Frequency	X 1.02	X 1.74	2%	74%	1.2	1.2	÷ 1.71	
Retention	-	-	-	-	-	-	X 1	

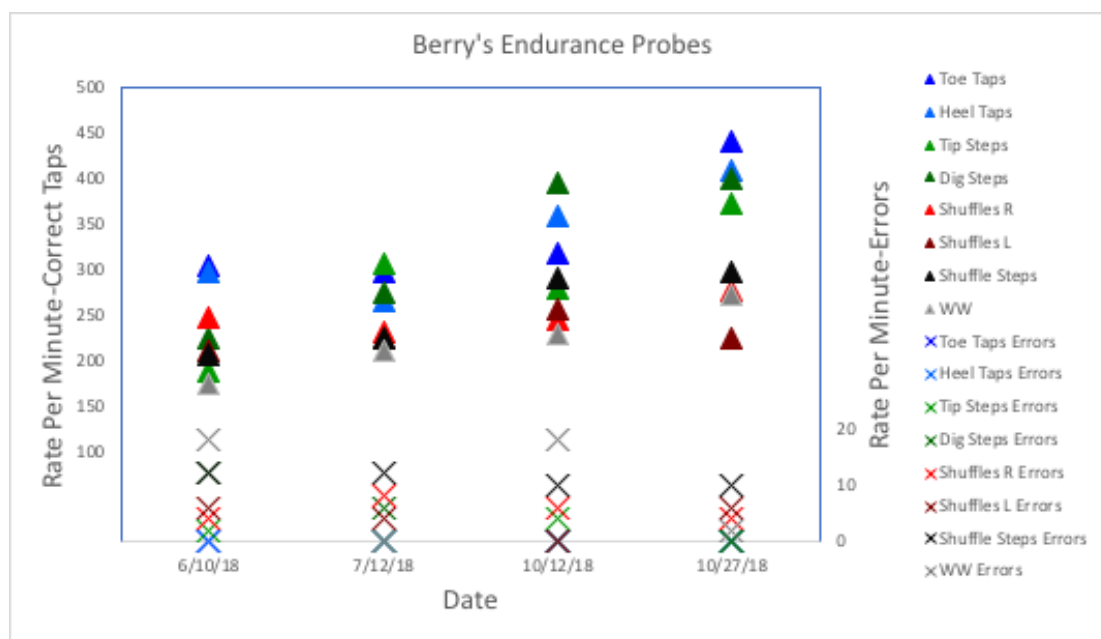
The metrics of celeration, percent growth and decay, level change from previous condition, and the overall improvement index for Berry’s Pair 4 per phase are shown above. For celeration and improvement index, an increasing value (acceleration) is indicated by a multiplication symbol(X) and a decreasing value (deceleration) is indicated by a division symbol (÷). For percent growth or decay, growth is shown as a positive number with no symbol and decay is shown as a negative number with a subtraction symbol (-). For level change, a whole number indicates a rise in level. The greater the number, the greater the level change. Decimals smaller than 1 indicate a decrease in level. Dashes (-) indicate one of two things: (1) there was no change in the metric or (2) the metric does

not apply to the data set. Measures reflect the change per week for all conditions except for weekly probes, which is expressed as change per month (\*).

### Endurance Probes

Figure 48 shows the data for Berry's performance on endurance probes. Though Berry demonstrated high frequencies for all steps during Baseline, his frequencies in endurance probes were not quite as close to aim. In addition, besides toe taps and heel taps, all other probes exhibited high rates of errors. All steps made improvements, even the untrained pair (toe taps and heel taps) in either frequency of correct steps, frequency of incorrect steps, or both. Apart from shuffles right and left, all other steps had accelerations in correct steps above X1.5 per month. Dig steps and shuffles had noteworthy decreases in errors ( $\div 39.6$  per month and  $\div 3.44$  per month respectively). Shuffles right and shuffle steps were the only two steps that did not meet aim. Overall, there was greater divergence between correct steps and incorrect steps in the final probe.

Figure 48. Berry Endurance Probes



The triangles indicate the frequency of correct steps linked to the primary axis. The X's indicate the frequency of incorrect steps linked to the secondary axis. A legend is provided to indicate the color of the data path that corresponds to each data series.

In conclusion, endurance did emerge for Berry's performance. Notably, Berry's toe taps and heel taps, though not trained, improved in endurance probes and met the aim range following training in other steps. It may be that practicing components not only impacts endurance for the steps in training, but also the endurance of related components. Table 28 shows additional data for Berry's performance in endurance probes.

Table 28. Berry Endurance Outcomes

	Celeration		Growth/Decay (-)		Improvement Index
	Accel	Decel	Accel	Decel	Overall
Toe Taps*	X 1.43	X 1	43%	0%	X 1.43
Heel Taps*	X 1.63	X 1	63%	0%	X 1.63
Tip Steps	X 1.82	X 1.51	48%	68%	X 1.21
Dig Steps	X 2.29	÷ 39.6	129%	97%	X 90.6
Shuffles Right	X 1.13	÷ 1.08	13%	-7%	X 1.22
Shuffles Left	X 1.19	÷ 3.44	19%	-71%	X 4.11
Shuffle Steps	X 1.71	÷ 1.35	71%	-26%	X 2.31
Windshield Wipers	X 1.61	÷ 1.1	61%	-9%	X 1.78

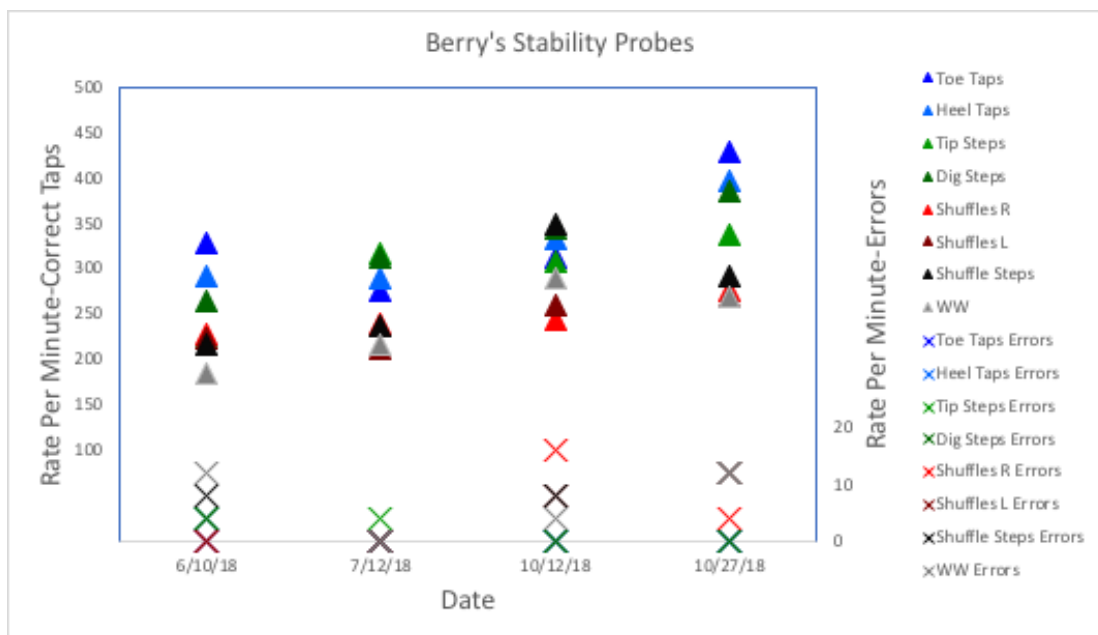
The metrics of celeration, percent growth and decay and the overall improvement index for Berry's endurance probes are shown above. For celeration and improvement index, an increasing value (acceleration) is indicated by a multiplication symbol (X) and a decreasing value (deceleration) is indicated by a division symbol (÷). For percent growth or decay, growth is shown as a positive number with no symbol and decay is shown as a negative number with a subtraction symbol (-). Dashes (-) indicate one of two things: (1) there was no change in the metric or (2) the metric does not apply to the data set. Measures reflect the change per month.

### Stability Probes

Figure 49 shows the data for Berry's stability probes. The frequencies of Berry's stability probes resembled the respective frequencies in Baseline. Many of them were near aim, though some with high rates of incorrect steps. Despite high initial frequencies, stability probes for all steps still increased and all met their respective aims. All stability probes had accelerations of correct steps above a X1.2 per month. Heel taps, tip steps, and digs steps made substantial decreases in errors, but several had increases in errors (shufflers right and left, shuffle steps, and

windshield wipers). Nevertheless, when considering Berry's overall performance on stability probes, correct steps and incorrect steps diverged, especially in the final probe. Table 29 shows additional data of Berry's performance on stability probes.

Figure 49. Berry Stability Probes



The triangles indicate the frequency of correct steps linked to the primary axis. The X's indicate the frequency of incorrect steps linked to the secondary axis. A legend is provided to indicate the color of the data path that corresponds to each data series.

Table 29. Berry Stability Outcomes

	Celeration		Growth/Decay (-)		Improvement Index
	Accel	Decel	Accel	Decel	Overall
Toe Taps*	X 1.32	X 1	32%	0%	X 1.32
Heel Taps*	X 1.44	÷ 2.08	44%	-52%	X 2.99
Tip Steps	X 1.48	÷ 3.13	48%	-68%	X 4.63
Dig Steps	X 1.53	÷ 2.08	53%	-52%	X 3.18
Shuffles Right	X 1.2	X 9.79	20%	879%	÷ 8.16
Shuffles Left	X 1.35	X 13.7	35%	1267%	÷ 10.1
Shuffle Steps	X 1.8	X 3.17	80%	217%	÷ 1.76
Windshield Wipers	X 1.79	X 1.17	79%	17%	X 1.53

The metrics of celeration, percent growth and decay and the overall improvement index for Berry's stability probes are shown above. For celeration and improvement index, an increasing value (acceleration) is indicated by a multiplication symbol(X) and a decreasing value (deceleration) is indicated by a division symbol (÷). For percent growth or decay, growth is shown as a positive number with no symbol and decay is shown as a negative number

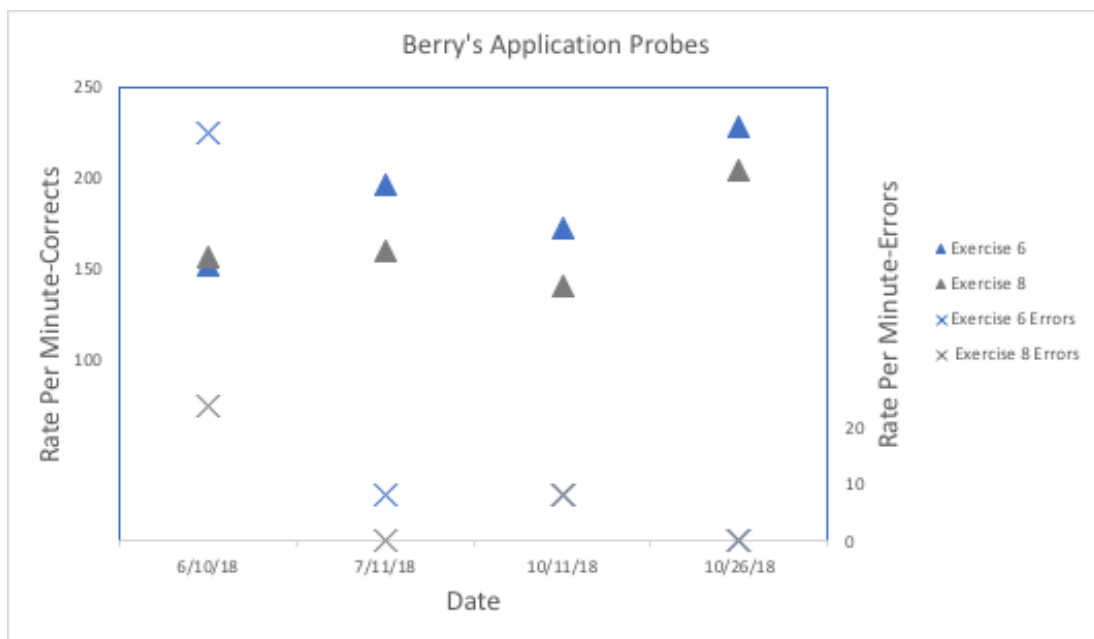
with a subtraction symbol (-). Dashes (-) indicate one of two things: (1) there was no change in the metric or (2) the metric does not apply to the data set. Measures reflect the change per month.

Berry's performance demonstrates the emergence of stability. Like in endurance probes, toe taps, and heel taps increased and reached aim in stability probes despite skipping training. Again, for Berry, it seems practicing other basic steps produced improvement in the fluency outcomes of even untrained responses.

### Application Probes

Figure 50 shows the data for Berry's performance on application probes. Exercise 6 started at 48% of the aim and ended at 71% of the aim. Exercise 6 grew from 152 per minute in the first probe to 228 per minute in the last probe (X 1.33 per month) with a concurrent decreased in errors from 72 per minute to zero ( $\div$  31.7 per month). Exercise 8 started at about 55% of the aim and ended at 73% of the aim. Correct steps grew from 156 per minute to 204 per minute (X 1.12 per month) and incorrect steps decreased from 24 per minute to zero ( $\div$  4.38 per month).

Figure 50. Berry Application Probes



The triangles indicate the frequency of correct steps linked to the primary axis. The X's indicate the frequency of incorrect steps linked to the secondary axis. A legend is provided to indicate the color of the data path that corresponds to each data series.

Although Berry started with higher frequencies than other participants on application probes, he still made substantial improvements, especially in the reduction of errors. Practicing component tap steps yielded higher precision in Berry's performance of the application exercises. Both exercises reached 100% accuracy. As mentioned previously, achieving precision is important in dance. Table 30 shows additional data for Berry's performance on application probes.

Table 30. Berry Application Outcomes

	Celeration		Growth/Decay		Improvement Index
	Accel	Decel	Accel	Decel	Overall
Exercise 6	X 1.33	÷ 31.7	33%	-97%	X 42.1
Exercise 8	X 1.12	÷ 4.38	12%	-77%	X 4.92

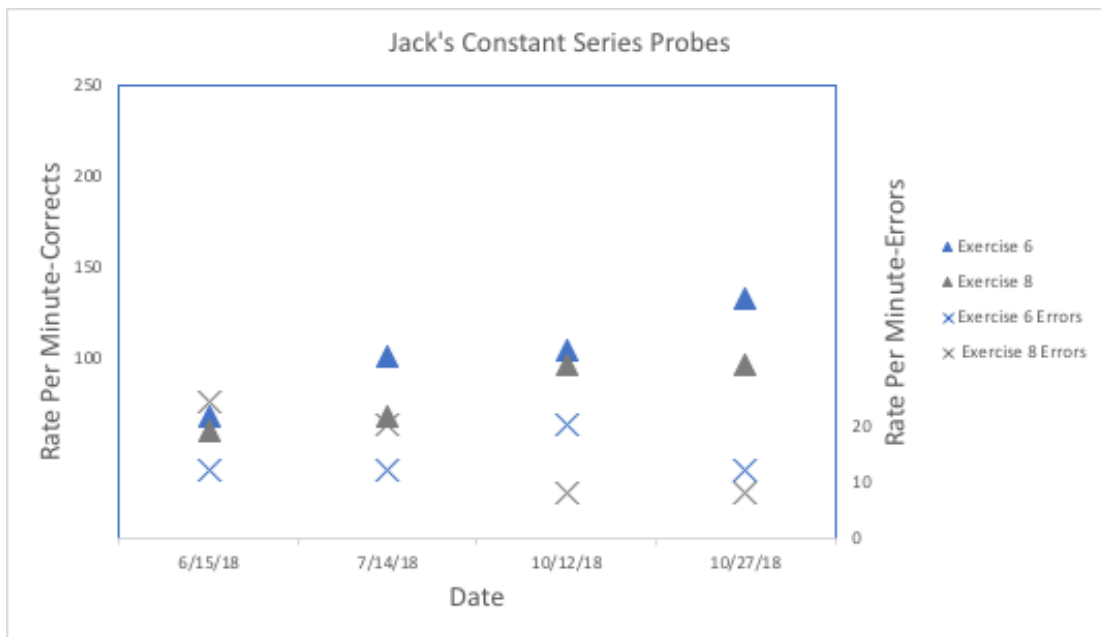
The metrics of celeration, percent growth and decay and the overall improvement index for Berry's application probes are shown above. For celeration and improvement index, an increasing value (acceleration) is indicated by a multiplication symbol(X) and a decreasing value (deceleration) is indicated by a division symbol (÷). For percent growth or decay, growth is shown as a positive number with no symbol and decay is shown as a negative number with a subtraction symbol (-). Dashes (-) indicate one of two things: (1) there was no change in the metric or (2) the metric does not apply to the data set. Measures reflect the change per month.

Jack

### Constant Series Probes

Figure 51 shows Jack's data for constant series probes of Exercise 6 and Exercise 8. For Exercise 6, Jack started at approximately 21% of the aim and ended at 41% of the aim. Correct steps grew from 68 per minute to 132 per minute (X 1.95 per month), while errors remained high (12-20 errors per minute). For Exercise 8, Jack started at approximately 21% of the aim and ended at 34% of the aim. Correct steps grew from 60 per minute to 96 per minute (X 2.0 per month) and errors decreased from 24 per minute to 8 per minute (÷ 5.48).

Figure 51. Jack Constant Series Probes



The triangles indicate the frequency of correct steps linked to the primary axis. The X's indicate the frequency of incorrect steps linked to the secondary axis. A legend is provided to indicate the color of the data path that corresponds to each data series.

Table 31. Jack Constant Series Outcomes

	Celeration		Growth/Decay		Improvement Index
	Accel	Decel	Accel	Decel	Overall
Exercise 6	X 1.95	X 1.52	95%	52%	X 1.28
Exercise 8	X 2.01	÷ 5.48	101%	-82%	X 11

The metrics of celeration, percent growth and decay and the overall improvement index for Jack's Constant Series probes are shown above. For celeration and improvement index, an increasing value (acceleration) is indicated by a multiplication symbol(X) and a decreasing value (deceleration) is indicated by a division symbol (÷). For percent growth or decay, growth is shown as a positive number with no symbol and decay is shown as a negative number with a subtraction symbol (-). Dashes (-) indicate one of two things: (1) there was no change in the metric or (2) the metric does not apply to the data set. Measures reflect the change per month.

Jack made considerable improvements in both constant series probes. Exercise 6 demonstrated great accelerations in frequency of correct steps. Exercise 8 on the other hand, had a robust improvement in both the frequency of corrects and the frequency of errors. Nonetheless, though Jack did make improvements without practicing component steps, he did not reach the level of precision that Berry did. Both participants started very inaccurate, but only the one who

experienced training in components (Berry) reached 100% accuracy. This is an important distinction because for dancers on a stage, speed is irrelevant without accuracy. On this premise, Berry would be considered the better dancer over Jack.

Nonetheless, there are limitations to this comparison since Jack and Berry started at very different baseline frequencies. Because of the standard acceleration chart's logarithmic nature, rates that start in different cycles or logs (as Berry's and Jack's did), will have different acceleration values despite having similar changes in absolute values change. Since Berry started much higher on the standard acceleration chart and closer to aim, he was at a disadvantage in the comparison because he had less room to grow and accelerations were systematically lower in that log. A fair comparison would require that participants start at very similar baseline frequencies and maintain the same schedule of probes.

Tina is the only other participant that had similar baseline frequencies as Jack, though they did not share the same schedule of probes, which limits the comparison. Nonetheless, it is worth discussion. Jack definitively outperformed Tina in terms of acceleration of correct steps and in absolute value change for both exercises. However, Tina outperformed Jack on both exercises in terms of accuracy. Both had accelerations for incorrect steps in Exercise 6, but Tina not only had a lower acceleration value than Jack ( $\times 1.48$  per month versus  $\times 1.52$  per month), she also maintained errors in a lower range than him. Tina's errors did not exceed 8 per minute, while Jack's were as high as 20 per minute. Both started with 24 errors per minute and had decelerations for Exercise 8. While Jack's deceleration ( $\div 5.48$  per month) was steeper than Tina's ( $\div 2.25$  per month), Tina reached 100% accuracy within two probes and maintained it through the rest of the probes. Jack's errors ended as high as 8 per minute and never reached zero. This is evidence that though improvements can be made without component training,

precision in the application probes is more readily achieved when component steps are practiced to mastery. To reiterate, this suggests that a component-composite approach to training dance may lead to more ideal results. Tables 32 and 33 provide additional data to make comparisons between Jack, the constant series participant, and all the other participants. Note that in terms of growth from first to last probe, all participants other than Tina outperformed Jack for both exercises. Furthermore, though Jack's improvement index is much higher than anyone else for Exercise 8, all participants, other than Tina, outperformed him based on Improvement Index on Exercise 6.

Table 32. Constant Series Comparison: Exercise 6

Participant	% of Aim-Start	% of Aim-End	Starting Frequency	Ending Frequency	Growth Start-End	Improvement Index
Jack	21%	41%	68	132	64	X 1.28
Berry	48%	71%	152	228	76	X 42.1
Daisy	35%	63%	112	200	88	X 5.63
Andy	25%	50%	80	160	80	X 1.77
Tina	24%	40%	76	128	52	÷ 1.18

*The table shows where each participant's initial performance started in comparison to the aim in terms of percent of aim, the frequency on the first probe, the frequency on the final probe, the growth in absolute value, and the improvement index.*

Table 33. Constant Series Comparison: Exercise 8

Participant	% of Aim-Start	% of Aim-End	Starting Frequency	Ending Frequency	Growth Start-End	Improvement Index
Jack	21%	34%	60	96	36	X 11
Berry	56%	73%	156	204	48	X 4.92
Daisy	39%	83%	108	232	124	X 5.35
Andy	30%	47%	84	132	48	X 1.47
Tina	24%	33%	68	92	24	X 2.43

*The table shows where each participant's initial performance started in comparison to the aim in terms of percent of aim, the frequency on the first probe, the frequency on the final probe, the growth in absolute value, and the improvement index.*

## General Discussion

The purpose of the current study was to train component tap dance steps to specified aims and to observe the effects of this training on the outcomes of fluency, namely, retention, endurance stability, and application. The results showed that following training, if component steps reached and stabilized within the aim range, retention did emerge. For participants who fell just below the aim range in training, retention checks corresponded to the level(s) at which training frequencies stabilized. For participants who met the aim range, retention probes were either within the aim or, in some cases, above the aim. A prime example of this is Andy, whose data on shuffles right and left were differentially affected after his time-off from a right leg injury. There was no drop-in level for shuffles right, which had not only reached the aim range but had relatively good stability and low errors at the terminal timing length. On the other hand, shuffles left, which showed more variability in the frequency of correct and incorrect steps and was not at the terminal timing length before the injury, dropped in level.

Endurance emerged for those participants for whom training resulted in meeting the frequency aim. Apart from a few non-examples, the overall pattern of emergence for stability and endurance occurred after training a step. There were several examples of stability and endurance emerging for shuffle steps as a function of training shuffles right and shuffles left. Again, this points to the component-composite relationship that appears to exist between these two steps.

Improvement occurred during stability and endurance probes following training in every step for all participants. It is possible that training in component steps leads to stability and endurance across various related steps more generally, and further, that these outcomes do not necessarily relate to a step that is presently in training. It appears that building high rates of

basic tap steps produces “generativity” across all or at least some elements of the tap dance repertoire. This type of generativity, whereby improvements across untrained skills are seen, is what Luiselli, Woods, and Reed (2011) identified as a missing outcome of sports intervention packages along with maintenance of performance.

The results for the application probes are more complicated and difficult to interpret. In the case of Daisy and Berry it seems that application emerged as a function of practicing basic steps. Daisy more than doubled her frequency of correct steps for Exercise 8 and was close to doubling her frequency for Exercise 6. Berry, who started much closer to aim than Daisy and the other participants, also made substantial gains in frequency of correct steps on both application sequences. Moreover, Berry and Daisy both showed dramatic reductions in the frequency of incorrect steps across the probes. A case for application can be made for Andy as well, though he demonstrated application to a lesser degree. Andy’s probe data show accelerations in the frequency of correct steps and decelerations in errors. Likewise, a case can be made for Tina, where application emerged for Exercise 8 in terms of the dramatic decrease in incorrect steps, and for Exercise 6 on the basis of much larger increases in the last probe compared to the first four. Anecdotally, Tina and all the participants showed unmeasured improvements in the aesthetic features of the application sequences, which is an important variable in the performance arts. Throughout the document, the importance of precision has been repeatedly emphasized as well.

Still, the application data must be seen in the light of Jack’s constant series control data. His frequency of correct steps accelerated with minimal practice opportunities and, in most cases, they were higher than the frequencies recorded for the experimental participants. It is possible that factors in Jack’s learning history, such as playing sports, may have influenced his

growth in this study above what is typically considered practice effects. Nonetheless, apart from Tina, experimental participants produced greater improvement in the frequency of incorrect steps of Exercise 6 relative to Jack, who experienced a substantial acceleration in errors for this particular sequence. Moreover, the improvement indices for experimental participants for Exercise 6 were all higher than Jack's index. And, while Jack gained substantial speed with exposure and practice on the composite skill, he did not gain as much precision as did the experimental participants. Exercise 8 was an exception to this, however, as Jack's accelerations and improvement index exceeded the experimental participants. Nevertheless, many of the experimental participants reached higher levels of precision than Jack did for this exercise as well. The main issue here is the mismatch between Jack's baseline frequencies and his schedule of exposure to the composite sequences relative to the other experimental participants. To draw further conclusions on the comparison between improvements on composite skills given training of the component skills versus mere exposure, the variables of baseline frequencies and schedule of exposure would need to be better controlled.

Another issue in the present study was the duration of training with regard to Pair 1 and Pair 2 with Pair 3 and Pair 4. It took a long time and a lot of practice for each participant to master Pair 3 (shuffles right and shuffles left), and for the two participants who started with the original training sequence, Pair 4 also required a considerable amount of time and practice. In considering this matter, it appeared the training sequence was missing some additional critical components. For example, shuffles could have been broken down into smaller more basic movements and exercises that targeted balance and weight shifts could have been included. For all participants, acquiring the two movements that constitute a shuffle slowed the rate of learning. Additionally, many of the participants had difficulties with balance when engaging in

steps that required standing on one foot, standing on the ball of the feet, or shifting their weight from one foot to the other while balancing on the ball of the feet. Adjustments in the training sequence may have led to faster acquisition. This highlights the importance of identifying the components skills that are necessary to produce generativity in the composite skills of interest. In the current study, the subsequent pair in the training sequence was probed weekly. These probes were useful in identifying components that were in the wrong order within the sequence or when there could be missing components.

These limitations aside, the present study contributes to the literature on precision teaching and fluency instruction in several ways. First, it adds to the small yet growing body of evidence regarding behavioral coaching in general and dance instruction in particular. Secondly, it adds to the precision teaching literature on motor behavior, which is not only limited in size but also in the types of behaviors examined until now. The added value of this study is that it attempts to identify and sequence motor behaviors that are related to the feet; the first of its kind. It is also among a handful of studies that have examined a repertory of behavior that resides at the standard celeration chart's 6<sup>th</sup> cycle. Most of the research done in precision teaching has been with behaviors that reside within cycles 4 and 5, which equate to roughly 1- to- 100 responses per minute. There is comparatively less research on responses such as tap dancing that can occur above 100 per minute or below 1 minute. Finally, the use of a software program to count dance steps is the first of its kind. With refinement, this tool may be useful as an electronic application for tap dancers and instructors alike by adding objective, rate-based feedback.

Future research should focus on exploring the basic behaviors that make up our complex gross and fine motor movements and the sequences that yield the most efficient learning and maintenance. This includes identifying sensitive and precise measurements that predict

functional mastery. To this end, dance and sports training in general would benefit. Luiselli, Woods, and Reed (2011), in a review of the sports literature expressed a need for research improving the maintenance of previously taught behaviors with athletes as well as producing generativity to untargeted skills. This is a prime opportunity to investigate whether precision teaching and fluency-based instruction can fill this void in sports performance as it has in the area of education. There are also implications for research in rates of movement to the areas of rehabilitation. Though a path has been forged in rehabilitation of traumatic brain injury (Chapman, Ewing, & Mozzoni, 2005) there is much work to be done before we understand what fluency means when it comes to motor behavior and how we can capitalize on this knowledge.

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## APPENDIX A

## BASELINE SCRIPT

“Today we are going to practice Exercise # \_\_\_\_\_.”

“Exercise # \_\_\_\_\_ is a \_\_\_\_\_ exercise. It is made up of \_\_\_\_\_ . The count is \_\_\_\_\_.”  
 (Provide any other relevant information about the step)

“This is how you do exercise # \_\_\_\_\_.”

“Now you show me how to do it. Do (an 8 count forward & back/an 8 count in place). \_\_\_\_\_.”  
 (Praise for correct execution/Model again if not correct)

“Ok, now you are going to practice this exercise in 8-counts. You will practice in 15-second timings. You will do 3 timings. The apparatus will give you a count down 3-2-1-Go! Start as soon as you hear the fourth tone and see GO. When the apparatus beeps, finish the step you are on and then stop.”

“Do you have any questions?” (Answer questions if necessary)

“Let’s begin.” (Repeat this 3 times)

**DO NOT PROVIDE ANY FEEDBACK AFTER TIMING. SIMPLY FILL OUT DATA SHEET AND CONTINUE WITH TIMINGS.**

## APPENDIX B

## TRAINING SCRIPT

“Today we are going to practice Exercise # \_\_\_\_\_.”

“Exercise # \_\_\_\_\_ is a (stationary/moving) exercise. It is made up of

\_\_\_\_\_. The timing of it is \_\_\_\_\_.” (Provide any other relevant information about the step)

“This is how you do exercise # \_\_\_\_\_.”

“Now you show me Exercise \_\_\_\_\_. Do (an 8 count forward & back/an 8 count in place). (Praise for correct execution/Model again if not correct)

“Ok, now you are going to practice this exercise in 8-counts.

You will practice in 15-second timings. You will do 3 timings. The apparatus will give you a count down 3-2-1-Go! Start as soon as you hear the fourth tone and see GO. When the apparatus beeps, finish the step you are on and then stop.”

“Do as many as you can without making errors. You will have a goal for these timings. Your goal is to meet or beat \_\_\_\_\_ with no more than \_\_\_\_\_ errors.”

“Do you have any questions?” (Answer questions if necessary)

“Let’s Begin.”

**If participant meets goal: (Praise+Performance Feedback)**

*Praise:*

“You did it!”

“Amazing job!”

“Terrific dancing!”

*Performance Feedback:* “You met your goal. You did \_\_\_\_\_ steps correctly and made \_\_\_\_\_ errors!”

**If participant does not meet goal (Performance Feedback + Corrective Feedback)**

*Performance Feedback:* “You did not meet your goal. You did \_\_\_\_\_ steps correctly and made \_\_\_\_\_ errors.”

*Corrective Feedback:* **Tell** participant where mistake was made +**Show** the Exercise+Have Participant **Do** Step (8 forward and eight back/2 eight counts if stationary) times correctly.

REPEAT 3 TIMES

## APPENDIX C

## PROBE SCRIPT

“Today we are going to practice Exercise # \_\_\_\_\_.”

“Exercise # \_\_\_\_\_ is a \_\_\_\_\_ exercise. It is made up of

\_\_\_\_\_. The count is \_\_\_\_\_.”

(Provide any other relevant information about the step)

“This is how you do exercise # \_\_\_\_\_.”

“Now you show me Exercise \_\_\_\_\_. Do (an 8 count forward & back/an 8 count in place).”

(Praise for correct execution/Model again if not correct)

“Ok, now you are going to practice this exercise in 8-counts.

You will practice in 15-second timings. You will do 2 timings. The apparatus will give you a count down 3-2-1-Go! Start as soon as you hear the fourth tone and see GO. When the apparatus beeps, finish the step you are on and then stop.”

“Do you have any questions?” (Answer questions if necessary)

“Let’s begin.” (Repeat 2 times)

**DO NOT PROVIDE ANY FEEDBACK AFTER TIMING. SIMPLY FILL OUT DATA SHEET AND CONTINUE WITH TIMINGS.**

## APPENDIX E

## Feedback Procedures

**Performance Feedback**

The instructor will tell the participant

- Total number of correct responses
- Total number of incorrect responses
- Provide a brief description of inter-timing performance while looking at the visual display from the apparatus

**Praise**

- The instructor will provide a praise statement of their choice
- Praise statements will be delivered quickly and immediately upon completion of timings in which goal was met.
- The praise statement should be short and concise and should not exceed 5 words
- The instructor will deliver praise statements with an enthusiastic voice
- Examples:
  - “You did it!”
  - “Hooray-you met your goal!”
  - “That was awesome!”
  - “I’m so proud of you!”
  - “What an amazing job!”
  - “That was great dancing!”

**Corrective Feedback**

- The instructor will provide corrective feedback when the dancer has not met their goal
- Corrective Feedback will follow a tell, show, do procedure in which the instructor
  - *Tells* the participant the nature of the error
  - *Shows* them how to eliminate the error or otherwise execute the dance move correctly
  - Instructs the participant to *Do* the dance move for an 8-count correctly
- Duration of Corrective Feedback should be less than or equal to 2 minutes

Table 1. Nature of feedback based on timing outcomes

	Errors	
	<u>Low</u>	<u>High</u>
Corrects	<u>High</u>	Praise CF: Slow down to decrease errors
	<u>Low</u>	CF: Increase speed by making movements smaller CF: Insert a prompt or return to previous skill

## APPENDIX F

## Fidelity Checklist-Baseline

<b>FIDELITY CHECKLIST-BASELINE PHASE</b>		
Date: Instructor: Session: Observer:		Circle Y for Yes, N for No or NA for not applicable
Did instructor name the step?		Y N NA
Did instructor describe important features of the step?		Y N NA
Did instructor model the step?		Y N NA
Did instructor tell the dancer to engage in the step for one 8-count?		Y N NA
If the dancer completed step correctly, did instructor provide <b>praise</b> ?		Y N NA
If the dancer completed the step incorrectly, did the instructor model the step again?		Y N NA
<b>Did the instructor tell participant the following things before timings:</b>		
1.You will practice exercise in 15-second timings		Y N NA
2. You will do 3 timings		Y N NA
3.You will start after the fourth tone and when the computer says GO!		Y N NA
4.When the apparatus beeps, finish the step you are on and stop		Y N NA
Did the instructor provide an opportunity for the participant to ask questions?		Y N NA
<b>Timing 1:</b>		
1.Did instructor refrain from providing feedback?		Y N NA
<b>Timing 2:</b>		
1.Did instructor refrain from providing feedback?		Y N NA
<b>Timing 3:</b>		
1.Did instructor refrain from providing feedback?		Y N NA

## APPENDIX G

## Fidelity Checklist-Training Phase

<b>FIDELITY CHECKLIST-TRAINING PHASE</b>		
Date: Instructor: Session: Observer:		Circle Y for Yes, N for No or NA for not applicable
Did instructor name the step?		Y N NA
Did instructor describe important features of the step?		Y N NA
Did instructor model the step?		Y N NA
Did instructor tell the dancer to engage in the step for one 8-count?		Y N NA
If the dancer completed step correctly, did instructor provide <b>praise</b> ?		Y N NA
If the dancer completed the step incorrectly, did the instructor model the step again?		Y N NA
Did instructor tell the participant his or her goal?		Y N NA
<b>Did the instructor tell participant the following things before timings:</b>		
1.You will practice exercise in 15-second timings		Y N NA
2. You will do 3 timings		Y N NA
3.You will start after the fourth tone and when the computer says GO!		Y N NA
4.When the apparatus beeps, finish the step you are on and stop		Y N NA
Did the instructor provide an opportunity for the participant to ask questions?		Y N NA
<b>Timing 1:</b>		
1.Did the instructor provide performance feedback + praise/corrective feedback at the end of the timing?		Y N NA
2.If corrective feedback was given, was the duration equal to or less than 2 minutes?		Y N NA
<b>Timing 2:</b>		
1.Did the instructor provide performance feedback + praise/corrective feedback at the end of the timing?		Y N NA
2.If corrective feedback was given, was the duration equal to or less than 2 minutes?		Y N NA
<b>Timing 3:</b>		
1.Did the instructor provide performance feedback + praise/corrective feedback at the end of the timing?		Y N NA
2.If corrective feedback was given, was the duration equal to or less than 2 minutes?		Y N NA

## APPENDIX H

## Fidelity Checklist-Probes

<b>FIDELITY CHECKLIST-PROBES</b>		Circle Y for Yes, N for No or NA for not applicable
Date: Instructor: Session: Observer:		
Did instructor name the step?		Y N NA
Did instructor describe important features of the step?		Y N NA
Did instructor model the step?		Y N NA
Did instructor tell the dancer to engage in the step for one 8-count?		Y N NA
If the dancer completed step correctly, did instructor provide <b>praise</b> ?		Y N NA
If the dancer completed the step incorrectly, did the instructor model the step again?		Y N NA
<b>Did the instructor tell participant the following things before timings:</b>		
1.You will practice exercise in 15-second timings		Y N NA
2. You will do 3 timings		Y N NA
3.You will start after the fourth tone and when the computer says GO!		Y N NA
4.When the apparatus beeps, finish the step you are on and stop		Y N NA
Did the instructor provide an opportunity for the participant to ask questions?		Y N NA
<b>Timing 1:</b>		
1.Did instructor refrain from providing feedback?		Y N NA
<b>Timing 2:</b>		
1.Did instructor refrain from providing feedback?		Y N NA