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Using Video Feedback to Increase Figure Skaters' Performance

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Using Video Feedback to Increase Figure Skaters' Performance

by

Lori Greenberg

A thesis defense submitted in partial fulfillment
of the requirements for the degree of
Master of Science
Applied Behavior Analysis
Department of Child and Family Studies
College of Behavioral and Community Science
University of South Florida

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Dedication

I dedicate this manuscript to my husband, Aaron Greenberg, for his unconditional support and pushing me to continue. To my daughter, Katie Greenberg, who has been my inspiration. Your love of skating motivated me to go back to school and your grace and beauty on the ice led me to do this project. To my mom, Karen Gawronski, for always supporting me and spending late nights editing my work. To my sister's, Kelly and Christine for always pitching in when I needed help. To the great friends that I have made at USF, Rocky, Taylor, and Erin, you have supported me and motivated me when I needed it the most.

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Table of Contents

List of Tables	iii
List of Figures.....	iv
Abstract	v
Introduction	1
Method	8
Setting	8
Participants.....	8
Equipment.....	9
Target Behaviors and Data Collection	10
Combination Spin	10
Layback Spin	10
Double Salchow Jump	11
Flying Camel Spin	11
Double Toe Loop Jump.....	11
Double Loop Jump.....	11
Inter-observer Agreement (IOA).....	12
Supplemental Measures	13
Treatment Integrity	13
Social Validity Direct Participants	14
Expert Ratings of Intervention Outcomes.....	14
Experimental Design and Procedures.....	14
Experimental design.....	14
Baseline	15
Video Feedback Utilizing Dartfish App Intervention.....	16
Results	18
Video Feedback Using the Dartfish App.....	18
Social Validity.....	23
Discussion	30
Implications for Practice.....	32
Limitations.....	32
Future Research.....	33
References	35

Appendices	39
Appendix A: Task Analysis Checklist	40
Appendix B: Task Analysis Checklist	42
Appendix C: Task Analysis Checklist	44
Appendix D: Task Analysis Checklist	46
Appendix E: Task Analysis Checklist	48
Appendix F: Task Analysis Checklist	50
Appendix G: Fidelity Checklist	52
Appendix H: Social Validity Questionnaire for Figure Skater Participants	53
Appendix I: Social Validity Questionnaire for Coach Participants	56
Appendix J: Expert Ratings of Intervention Outcomes	59
Appendix K: Expert Ratings of Intervention Outcomes	61
Appendix L: Expert Ratings of Intervention Outcomes	63
Appendix M: Expert Ratings of Intervention Outcomes	65
Appendix N: Expert Ratings of Intervention Outcomes	67
Appendix O: Expert Ratings of Intervention Outcomes	69
Appendix P: USF IRB Approval.....	71

List of Tables

Table 1: Coach Social Validity Survey Results	25
Table 2: Skater Social Validity Survey Results	26
Table 3: Independent Coach Survey Results for Emily	27
Table 4: Independent Coach Survey Results for Ashley	28
Table 5: Independent Coach Survey Results for Karen.....	29

List of Figures

Figure 1: Percentage of individual components performed correctly across moves for Emily 20

Figure 2: Percentage of individual components performed correctly across moves for Ashley... 21

Figure 3: Percentage of individual components performed correctly across moves for Karen 22

Abstract

Figure skating is a competitive sport that requires intensive training which can be taught in a variety of settings. There are various methods to teaching figure skaters new skills such as positive and corrective feedback, modeling and coaching procedures, and physical guidance. These different approaches may lead to a lack of consistency among coaches. Over the years, these established coaching strategies have not changed substantially as training methods are passed down from coach to student. Also, research in the area of what constitutes effective coaching methods is lacking. Skaters may progress more quickly in skill development if coaches are implementing empirically based successful coaching methods. These teaching approaches may also be enhanced by incorporating the latest technology available. This study evaluated the effectiveness of a video feedback coaching procedure using the Dartfish application. A multiple baseline design was utilized to document the impact of this video feedback coaching procedure on the demonstration of six established figure skating moves, three moves for one skater and three different moves for two other skaters. Results showed utilizing video feedback improved figure skater's performance levels on the targeted moves to an acquisition of 80% accuracy or higher.

Introduction

Ice skating has been around since prehistoric times (Khvostov, 1925). By the 19th century, ice skating started to develop into figure skating in the form of ballet on ice (Khvostov, 1925). In 1921, the U.S. Figure Skating Association (USFSA) was founded as the national governing body for figure skating in the United States (*2017 U. S. Figure Skating Factsheet*, 2017). According to the *2017 U. S. Figure Skating Factsheet* (2017), there were 181,703 USFSA members during the 2015-16 season with 35% of these skaters aged 7 to 12. This number of USFSA members does not include figure skaters that are only members of the Ice Skating Institute (ISI). Similar to other sports, figure skaters require a certain level of training to improve and compete at different levels. There are two different competitive tracks in figure skating, USFSA and ISI, both of which have a testing system to determine the level of the skater (*Joint Statement of Cooperation*, 2004). To prepare a skater for these tests, the skater trains regularly with his/her coach.

During figure skater training sessions, coaches use an array of training methods. The different methods of training figure skaters have not changed much since figure skating first began (Laak, n.d.). Most coaches currently use traditional and established methods of training figure skaters. The general format of coaching figure skaters involves 1) the coach teaching the skater what to do by describing the steps involved and/or 2) modeling the move for the skater and/or 3) the skater attempts the move, then the coach then gives corrective feedback, and 4) the process starts again, however, coaches may provide corrective feedback in many different ways.

A variety of feedback presentation can lead to a lack of consistency between coaches because different methods are used for teaching. According to figure skating coach V. Valle (personal communication, April 10, 2017), some coaching strategies used are: verbal feedback including corrections, non-specific praise, non-specific prompts, and instructions; coach modeling; physical guidance; and physical corrections. Additionally, some coaches have recently started incorporating the use of technology to provide video feedback within the coaching approach. This consists of recording the skater's performance of a move and showing the skater the video. Video feedback can be provided using a video camera or video analysis software such as Dartfish or Pro-Trainer (Laak, 2007).

Research conducted in figure skating has typically examined psychological interventions and behavioral coaching methods. Hall and Rodgers (1989) evaluated the effectiveness of a workshop designed to teach figure skating coaches to incorporate mental training techniques (MTTs) into their lessons. Results showed more than half of the coaches reported the workshop was effective and helped them use the MTTs more effectively. Ming and Martin (1996) evaluated the use of self-talk for on and off ice training practice of prenovice and novice level figure skaters (11-13 years old). Self-talk consisted of key words the skater would recite just before performing a skill to enhance acquisition during practice. For example, reciting faster before the skater performs a jump if the skater needed more speed. They found an increase in performance for all participants and participants still used the intervention at the one year follow up.

Hume, Martin, Gonzalez, Cracklen, and Genthon (1985) evaluated a behavioral coaching treatment package consisting of instructions, self-monitoring checklists, and coach feedback. They found prenovice skaters (14-16 years old) increased their level of performance during

freestyle practice, decreased off task behaviors, increased frequency of jumps and spins preformed, the number of times a routine was practiced increased, and participants exhibited an overall improvement in their skating. Martin and Toogood (1997) then combined the research of Ming and Martin (1996) and Hume et al. (1985) to evaluate the use of a treatment package consisting of self-management strategies (checklists), coach feedback utilizing a checklist, rehearsing key words that would prompt a specific position or movement when rehearsing, and simulations of the competitive environment. Outcomes showed all groups highly agreed how the components of the treatment package were used and on the helpfulness of the components. However, there was a disagreement between what components the skater said he/she used compared to the components the coach and parents said the skater used. Even though the program used was validated by choosing components with supporting evidence from applied sport psychology literature as well as single subject studies that were conducted on some of the components, this study was only able to provide consumer satisfaction evaluations. Therefore, further evaluation of the treatment package is recommended as there is limited empirical evidence supporting the individual components (Martin & Toogood, 1997).

Another package intervention evaluated to address the limitations of prior research, was conducted by Law and Ste-Marie (2005). They evaluated the effectiveness of self-modeling plus physical practice on the psychological and physical performance of figure skating jumps with intermediate figure skaters. To do this, they implemented a within participant design. The skaters received intervention for one jump and another jump was the control condition. Additionally, the skaters were compared to another control group that received no intervention. They used self-modeling in the form of positive self-review (PSR) as a method to improve figure skater's jump performance because skaters executed the skill infrequently. Positive self-review, also called

video self-modeling, consisted of editing video footage of an individual to remove any error and distracting footage to create a videotape depicting the individual's best performance of a target behavior at that time (Dowrick, 1991). Unfortunately, using a paired-sample t-test, Law and Ste-Marie found no significant differences between the two jump conditions for each skater. Both jumps had a slight increase in the desired direction. Self-report questionnaires did note the figure skaters liked the intervention and perceived it as being beneficial; they also claimed the self-modeling video allowed them to identify their errors and analyze their own performance, which is the opposite of what the video showed them (Law & Ste-Marie, 2005). The video showed the skaters their best performance with minimal to no errors allowing the skater to view the positive aspects of their performance. Therefore, it was not anticipated that the skaters would identify their errors while watching the video.

Although there is limited research with regard to behavioral coaching techniques and figure skating, studies in applied behavior analysis and sports psychology have demonstrated behavioral coaching to be an effective method in improving skill performance in areas such as football (Ward & Carnes, 2002), gymnastics (Boyer, Miltenberger, Batsche, & Fogel, 2009), tennis (Mathews, 2008), football (Stokes, Luiselli, Reed, & Fleming, 2010), and classical ballet (Fitterling & Ayllon, 1983). There are a wide range of behavioral coaching methods used to increase the performance of athletes such as: behavioral coaching packages that consisted of verbal instruction and feedback, positive and negative reinforcement, positive practice, and time out (Allison & Ayllon, 1980); public posting and goal-setting (Brobst & Ward, 2002; Mathews, 2008; Ward & Carnes, 2002); descriptive feedback (Stokes et al., 2010); video modeling with video feedback (Boyer et al., 2009); and video feedback (Benitez Santiago & Miltenberger, 2016; Hazen, Johnstone, Martin, & Srikameswaran, 1990; Kelley & Miltenberger, 2016).

Video modeling with video feedback allows individuals to view a video of a model performing the same skill and then the video of themselves in order to receive specific and corrective feedback of their performance in relation to the model (Boyer et al., 2009; Hazen et al., 1990). Research has also demonstrated using video feedback without video modeling can also be effective to increase athletic skills (BenitezSantiago & Miltenberger, 2016; Kelley & Miltenberger, 2016). Video feedback allows a coach to teach complex skills as it provides a visualization of the full movement and the coach can pause the video at specific parts to provide feedback. Therefore, video modeling may not be needed since video feedback alone has been shown to be effective (e.g., Kelley & Miltenberger, 2016). Bateman (2015) provided video feedback to figure skaters as a part of an intervention package, but video feedback alone has yet to be evaluated in figure skating.

To provide video feedback, technology needs to be used to record the individual performance. Some sports studies, such as martial arts and horseback riding, have used video cameras (Benitez Santiago & Miltenberger, 2016; Kelley & Miltenberger, 2016), while others have used apps such as Dartfish, Übersense, or Coaches Eye (DeFroda, Thigpen, & Kriz, 2016; Mihai, 2010; Mulqueen, 2014; Weiler, 2015). Apps are used in many sports including baseball, figure skating, and track and field (e.g., Bateman, 2015; DeFroda et al., 2016; Mihai, 2010). With newer devices such as iPad Pro or iPhone6 having video cameras, 3-D accelerometers, and gyroscopes, it is becoming more cost effective to use apps to show performance analysis (Keogh, Espinosa, & Grigg, 2016). In addition, using apps on devices such as iPhones to implement video feedback allows trainers and coaches to use lightweight, less obtrusive equipment that can be easily downloaded via app stores (McNab, James, & Rowlands, 2011). Additionally, using apps on smartphones allows the athlete to move from a semi-static mode of analysis to a

dynamic, unconstrained, real-world field environment (McNab et al., 2011). One app some figure skating coaches are starting to use is Dartfish (Bateman, 2015). According to V. Valle (personal communication, April 10, 2017), coaches like how the app can be used anywhere with a student and the immediate feedback the app provides. Coaches utilize the app to show a skater how he/she performed and to provide corrective feedback.

The Dartfish app is motion analysis software used to provide a visual analysis of a target behavior (DeFroda et al., 2016). Studies suggest it may be an effective training tool for skill acquisition in areas such as track and field and figure skating (e.g., Bateman, 2015; Dyal, 2016; Mihai, 2010). Mihai (2010) used the Dartfish software to create a visual aid in training the male triple jump event technique. She found Dartfish software could be used to discriminate the steps of the male triple jump event technique (Mihai, 2010). Furthermore, she determined using the Dartfish software could be a useful tool in monitoring the activity of the male triple jump technique by including it in the training process (Mihai, 2010). Bateman (2015) compared a traditional verbal approach of coaching to a hybrid method, which included enhanced video replay using the Dartfish software for teaching a specific skating jump. The results indicated significant differences for 4 of the 5 variables when post-test scores of the groups were compared; however, no skater completely mastered the skating jump by the end of the study (Bateman, 2015). Dyal (2016) used the Dartfish app to facilitate video feedback to enhance the starting block execution of sprinters. Results showed an improvement in all participants that were maintained at follow-up (Dyal, 2016).

Currently though, there is only one study found examining the effects of video feedback using the Dartfish app for the sport of figure skating even though Dartfish is being used in the field by higher level coaches (coaches training Olympic track skaters). The only study found to

date using an app in figure skating evaluated the Dartfish app as part of an intervention package, which incorporated visualizations, kinesthetic cue words, and video replay using the Dartfish app (Bateman, 2015). Bateman (2015) suggested the intervention package needed further evaluation. Since video feedback allows an individual to see correct and incorrect components of a performance, it may show to be more effective independently than being a part of an intervention package for figure skating. If a skater is able to visualize what is correct or incorrect in their performance with the assistance of a coach, the performance may improve quicker than traditional methods. Therefore, the purpose of this study was to evaluate the use of visually enhanced positive and corrective feedback for increasing figure skating skills utilizing the Dartfish app.

Method

Setting

The study was conducted at a Central Florida ice arena during regularly scheduled freestyle sessions. Freestyle sessions at the arena were skating times specifically designated for competitive figure skaters. Baseline and intervention data was collected during each individual figure skaters regularly scheduled 30 min private lesson time at the time the coach determined it appropriate for the lesson. This allowed the intervention to be less intrusive by not changing the format of the skater's typical lesson and allowed the coach to implement the intervention at appropriate times throughout the lesson.

Participants

The participants included one figure skating coach and three figure skaters. The coach was recruited from a Central Florida ice skating arena and had 20 years coaching experience. The coach was a member of the United States Figure Skating Association (USFSA) and Professional Skaters Association (PSA). The first skater participant was Emily (pseudonym). Emily was 15 years old and passed her Freestyle 5 test. The second skater was Ashley (pseudonym) and she was also 15 years old and passed her Freestyle 6 test. The third skater was Karen (pseudonym). Karen was 17 years old and passed her Freestyle 6 test. All three skaters were recruited from a Central Florida ice skating arena and had been figure skating for over six years. Criteria for figure skaters included having no known disabilities that prevented them from participating in standard figure skating activities as confirmed by parent(s) and each skater was

already participating in private lessons with the coach participating in the study at the ice skating arena.

In addition, the skaters were at least a Freestyle 5 level through ISI, which requires the skater to successfully pass the Freestyle 5 ISI test by an ISI certified judge. To pass the Freestyle 5 test a skater must perform a Lutz jump, Axel jump, Camel spin, Camel-Sit-Upright spin, fast Back Scratch spin, and the dance step sequence. Freestyle 5 figure skaters were chosen for this study because the skills that were taught for this study were for the Freestyle 6 and Freestyle 7 test. This was to ensure the skaters had the prior training needed to learn the skills and had not mastered these skills. To determine if the skater met the inclusion criteria of the study, the coach participant evaluated the skater before being accepted into the study to ensure he/she could not complete more than 70% of the move to be taught. The evaluation was the coach reviewing the task analysis of the move (see Appendix A, B, C, D, E, and F) when the skater was asked to perform the move with no additional coaching,

Informed consent forms were given to the coach and parents of the skaters participating in the study by the primary investigator. The coach and parents were able to ask any questions prior to deciding if he/she would like to participate in the study. Assent was obtained from all skaters participating in the study by the primary investigator with the skater's parents present. The skater participating was able to ask any questions she had before deciding to participate.

Equipment

The coach used the Dartfish app on an iPhone provided by the primary investigator. The primary investigator ensured the correct app was uploaded and working properly. The coach was trained on how and when to use the app prior to the intervention beginning.

During intervention, the coach showed the skater the video on the iPhone using the app immediately following the target behavior and provided specific feedback related to the task analysis of the target behavior. In addition to the device the coach used (iPhone), the primary investigator used an iPhone to record sessions for treatment fidelity and a MacBook to upload the coaches Dartfish app videos and the observer session videos. This allowed for easier scoring of videos.

Target Behaviors and Data Collection

The dependent variables in this study were the percentage of individual components performed correctly for a Combination spin, Layback spin, and Double Salchow for one participant and a flying camel, double toe, and double loop for the other participants. The combination spin had 27 components (see Appendix A). The Layback spin had 22 components (see Appendix B). The Double Salchow had 22 components (see Appendix C). The Flying Camel had 23 components (see Appendix D). The Double Toe Loop had 21 components (see Appendix E). The Double Loop had 19 components (see Appendix F). The specific definitions for each spin or jump were as follows:

Combination spin. A Combination spin is defined as a spin with any three spin positions from the following list of spins: Sit spin, Back Sit spin, Camel spin, Back Camel spin, or Layback spin. All spins have to meet the minimum passing test standard and held for a minimum of three rotations each. Additionally, there must be one change of foot between two of the spins (Ice Skating Institute, 2016). The Combination spin used in this study was a Camel/Sit/Back Sit spin.

Layback spin. A Layback spin is defined as making an approach from a forward outside entry edge. This spin is completed on one foot and must be performed with the free leg extended

back and the skater's back arched. The skater's shoulders do not have to parallel to the ice, but the head needs to be below the shoulders. Arm position is optional and the position must be held for a minimum of six revolutions (Ice Skating Institute, 2016).

Double Salchow jump. The Double Salchow jump is defined as taking off from a backward inside edge of one foot. The skater needs to complete two rotations in the air in the direction of the curve of the takeoff edge. The jump is then landed on the backward outside edge of the other foot (Ice Skating Institute, 2016).

Flying Camel spin. A Flying Camel spin is defined as a jump in the air in which the skater's body position is near horizontal to the ice, with both legs extended above the hips one at a time. The skater must land on the opposite foot of the takeoff foot and immediately complete six revolutions in camel position. The skater's free leg must be extended higher than hip position throughout the revolutions. If the skater holds the free leg foot or blade during the spin, it is considered an uncaptured maneuver (Ice Skating Institute, 2016).

Double Toe Loop jump. A Double Toe Loop jump is defined as simultaneously taking off from a backward outside edge and the toe of the other foot without rotating on the other toe. The skater needs to complete two rotations in the air in the direction of the picking toe. The jump is then landed on the backward outside edge of the takeoff foot (Ice Skating Institute, 2016).

Double Loop jump. A Double Loop jump is defined as taking off from a backward outside edge of one foot. The skater needs to complete two rotations in the air in the direction of the curve of the takeoff foot. The jump is then landed on the backward outside edge of the takeoff foot (Ice Skating Institute, 2016).

Each attempt of a spin or jump was scored as a percentage correct by using the task analysis checklist (see Appendix A, B, C, D, E, and F), which the primary investigator used to

mark each component correct or incorrect. Each task analysis was created by the primary investigator and was reviewed by an expert coach to ensure the steps were correct for each move. Any changes the expert coach determined needed to be made to the task analysis were adjusted prior to the start of the study. The expert coach had been coaching for 20 years, was certified to coach in ISI and USFSA, and was an ISI Gold Judge. The percentage of individual components performed correctly was calculated by dividing the number of components performed correctly by the total number of steps in the task analysis and then multiplying by 100.

Inter-observer Agreement

To assess inter-observer agreement (IOA) for the skater's performance, a second observer independently observed and collected data for 36% of the trials across all phases. The independent observer was trained by the primary investigator. This was done by conducting probe sessions using videos of skaters. The observers scored 100% correct before collecting data for the study. When assessing IOA, the second observer watched the recorded videos independently of the primary investigator. The second observer marked off her own checklist (see Appendix A, B, C, D, E, & F) that was the same as the primary investigator's checklist. Agreements were defined as both observers marking a step as properly performed or not properly performed. To calculate IOA the number of agreements were divided by the number of agreements plus disagreements and then multiplied by 100. IOA for Emily's Combination spin was collected for 33.3% of trials which equaled 98.9% on average. IOA for Emily's Layback spin was collected for 38.9% of trials which equaled 99.4% on average. IOA for Emily's Double Salchow jump was collected for 33.3% of trials which equaled 98.5% on average. IOA for Ashley's Flying Camel spin was collected for 33.3% of trials which equaled 99.2% on average. IOA for Ashley's Double Toe Loop jump was collected for 38.9% of trials which equaled 98%

on average. IOA for Ashley's Double Loop jump was collected for 33.3% of trials which equaled 98.3% on average. IOA for Karen's Flying Camel spin was collected for 38.9% of trials which equaled 98.2% on average. IOA for Karen's Double Toe Loop jump was collected for 33.3% of trials which equaled 100% on average. IOA for Karen's Double Loop jump was collected for 33.3% of trials which equaled 99.1% on average.

Supplemental Measures

Treatment integrity. A total of 100% of sessions were recorded by the primary investigator, using an iPhone, during baseline and 72% of sessions were recorded during intervention to assess treatment integrity. Using an iPhone allowed the primary investigator to move along the edge of the ice and remain within 3 m of the coach and skater. The primary investigator and coach conducted a practice session to ensure that 3 m was close enough to hear what the coach was saying and doing. The iPhone was turned on and off by the primary investigator at the beginning and end of the coaching session. Following each session recorded, the primary investigator watched the recorded sessions and marked off the fidelity checklist (see Appendix G) that listed each step of the video feedback intervention for the coach. Each step completed (not attempted or completed inaccurately) was checked off with a check mark. Any listed step not completed was marked with a minus. Treatment integrity was calculated for each session by adding the total number of correct steps divided by the total number of steps and then multiplied by 100. If treatment integrity fell below 90%, the coach was retrained on the step(s) missed. Treatment integrity for the coach was 96% across all video feedback sessions. Out of 25 sessions, Treatment integrity fell below 90% five times due to the coach missing one step on the fidelity checklist. The coach was retrained each time immediately following the skater's lesson on the step missed, using the task analysis to provide positive and corrective feedback, by the

primary investigator. This included the primary investigator reviewing the print out of the task analysis and providing the coach examples of how to provide positive and corrective feedback.

Social validity direct participants. At the end of the study, the coach and skaters were asked to complete individualized social validation questionnaires in order to document the rater's perception of the study. Questions reflecting procedures, outcomes, and treatment acceptability were included. The questions were rated using a Likert scale from 1-5; 1 being least liked or feasible and 5 being most liked or feasible (see Appendix H and I). Some of the questions were: Did you feel watching your video and receiving feedback helped improve your skating position, Did you feel the skill improved quicker than during regular coaching lessons, Was it hard to watch the video while on the ice, and Did you feel embarrassed being video recorded in front of other skaters.

Expert ratings of intervention outcomes. One figure skating coach from central Florida who was not involved in the study was shown 18 videos, three videos from baseline and three videos from intervention, of the skaters performing their skating move in random order. The expert coach had been coaching for 19 years. She has coached USFSA and ISI skaters, was PSA rated, and was an ISI Gold Judge. The coach rated the spin videos for: control throughout the move, speed or acceleration of spin, number of revolutions, centering of spin, and body position (see Appendix J, M, & N). The coach rated the jump videos for: control throughout move, speed or acceleration of jump, number of revolutions, body position, and landing (see Appendix K, L, & O). All moves were rated on a Likert scale from 1-5.

Experimental Design and Procedures

Experimental design. A multiple baseline design across figure skating moves for each participant was used to assess the effectiveness of video feedback using the Dartfish app for

increasing and maintaining a figure skater's level of performance. The multiple baseline design demonstrates the effects of an intervention by intervening on several baselines at different points in time (Kazdin, 2011).

Baseline. Baseline data was collected by the primary investigator. The coach instructed the skater to perform the target behavior three times at the beginning of the skater's regular private 30 min lesson once the skater was warmed up. The coach provided no instructions or feedback for the skater's performance. The primary investigator recorded the skater using the Dartfish app each time the coach asked the skater to perform the target behavior. Videos were watched and scored using the task analysis checklist (see Appendix A, B, C, D, E, & F) for the skaters. Each attempt was one data point of baseline. All videos were scored before the next data collection session.

The coach did not have access to the Dartfish app during baseline. The skater was told the coach was working with them utilizing the Dartfish app during their lesson to increase improvement in these skills and to prepare them for their next Freestyle test. Skaters were not coached on the intervention target behaviors outside of using the Dartfish app. Baseline for each skater for the target behavior lasted until scores for the skill were stable. The criteria of each skater was that she scored below 70% in baseline. If she scored higher than 70% for a skill during baseline, she would have been dismissed from the study. The first behavior remained in baseline until baseline data was acceptable. Acceptable baseline was defined as the behavior showing a decreasing trend or a level of performance below 70% for three consecutive data points. The second and third behavior remained in baseline until the target behaviors were at an acceptable baseline level as well or until the previous behavior was at an acceptable intervention performance for the target behavior. An acceptable intervention performance was defined as the

behavior showing an increasing trend with little or no data points overlapping from baseline or achieving 80% or more of the task analysis for at least three consecutive data points.

Video feedback utilizing Dartfish App intervention. Intervention consisted of the coach giving the skater the instruction to perform the target behavior. The coach then recorded the skater performing the target behavior using the Dartfish app. After the skater was done, the coach immediately showed the skater the video on the app. While the skater watched the video, the coach provided positive (identifying the steps in the TA done correctly and informing the skater e.g., your arms were at the right height) and corrective feedback (identifying the steps in the TA done incorrectly and informing the skater what could be done differently e.g., your supporting leg needs to be at a 90-degree angle) of the skater's performance based on the task analysis, which the coach had in front of her to use while providing feedback. The coach drew on the app to show the skater the exact angle of their leg, back, shoulders, or other body parts to provide specific positive or corrective feedback. Intervention was done three times consecutively after the skater was warmed up for her lesson.

The coach was trained how to implement the intervention during baseline by the primary investigator. This was done using another figure skater student of the coach who was not participating in the study. Consent and assent was also obtained for the figure skater that assisted in the training of the coach. The coach was trained until she reached 100% treatment fidelity.

Intervention for each behavior lasted until scores for the skill were stable. The coach recorded the target behavior using the Dartfish app. The coach first asked the skater to perform the move and then recorded the skater using the Dartfish app. Then, the coach provided positive and corrective feedback using the app. After feedback was provided, the coach asked the skater to perform the move again and then recorded the skater's performance using the app. This was

repeated two more times consecutively during the private lesson. Following the intervention session, the primary investigator asked the skater to perform the target behavior three times and then recorded the skater's performance. These three videos were scored for the intervention data points. The primary investigator was present and standing along the outside of the ice for each session.

During data collection, if the view of the skater became obstructed (e.g., another skater was in the way for part of the task analysis) the data point was not used. This did not occur during the study. If the skater fell during the performance, every component that would have occurred after the fall was scored a no. When the skater's performance was stable, the intervention was terminated.

Results

Video Feedback Using the Dartfish App

Figures 1, 2, and 3 display the percentage of individual components completed correctly across three figure skating moves for each of the three participants. All participants completed the individual components for the figure skating moves at a low level with high variability, except for the first move for participant 1 who completed the Layback spin consistently at a low level with little variability during baseline. After intervention, there was an immediate increase in individual components completed for all moves for all participants. All figure skating moves increased in performance level and had decreased variability in the components completed incorrectly.

During baseline, Emily completed 27% correct of the individual components of the Layback spin during all baseline trials. During intervention, Emily's average steps completed for the Layback spin increased to 78% (range, 63.64 to 86.36%). For the Combination spin, Emily completed the individual components an average of 48% (range, 18.52% to 66.67%) in baseline, which increased during intervention to an average of 84% (range, 77.78% to 92.59%). For the Double Salchow jump, Emily completed the individual components an average of 46% (range, 18.18% to 59.09%) in baseline, which increased to an average of 88% (range, 86.36% to 95.45%) in the intervention phase.

During baseline, Ashley completed the individual components of the Flying Camel spin on average 42% (range, 39.13% to 47.83%). During intervention, Ashley completed the

individual components of the Flying Camel spin 83% (range, 65.22 to 91.3%). During baseline, Ashley completed the individual components of the Double Loop jump 44% (range, 21.05% to 68.42%). The one time she scored a 68.42% was when she landed the jump. During intervention, Ashley completed the individual components of the Double Loop 80% (range, 63.16% to 89.47%). The two times she scored a 63.16% was when she fell during the land. During baseline, Ashley completed the individual components of the Double Toe Loop jump 45% (range, 19.05% to 66.67%). During intervention, Ashley completed the individual components of the Double Toe Loop jump 79% (range, 66.67% to 85.71%)

During baseline, Karen completed the individual components of the Double Toe Loop jump 60% (range, 52.38% to 66.67%). During intervention, Karen completed the individual components of the Double Toe Loop jump 87% (range, 76.19% to 90.48%). During baseline, Karen completed the individual components of the Double Loop jump 56% (range, 47.37% to 68.42%). During intervention, Karen completed the individual components of the Double Loop 81% (range, 63.16% to 89.47%). The two times during intervention she scored a 63.16% was when she fell during the land. During baseline, Karen completed the individual components of the Flying Camel spin on average 46% (range, 39.13% to 52.17%). During intervention, Karen completed the individual components of the Flying Camel spin 86% (range, 82.60 to 86.96%).

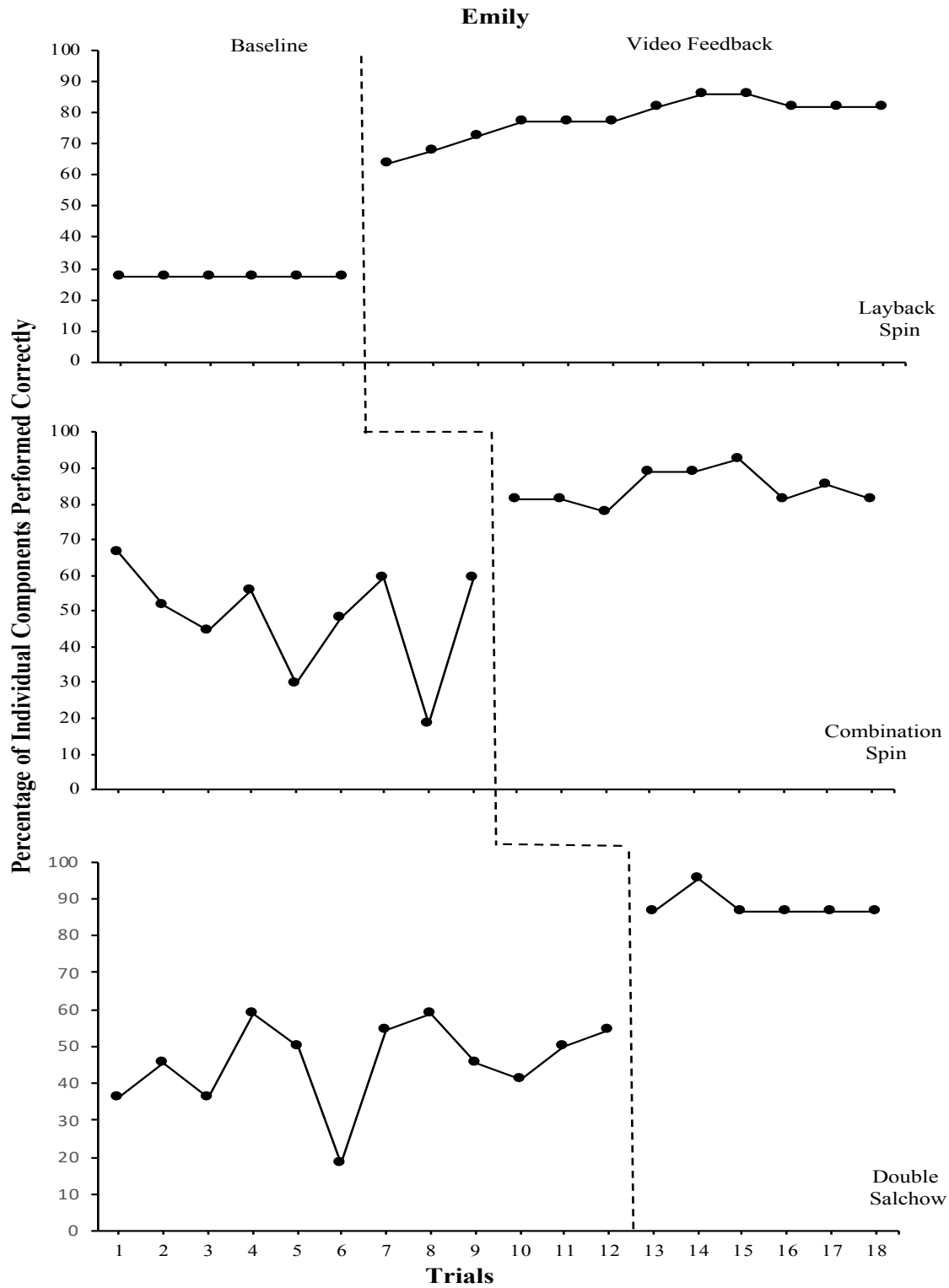


Figure 1. Results for Emily show an immediate increase in performance with a decrease in variability in the intervention phase.

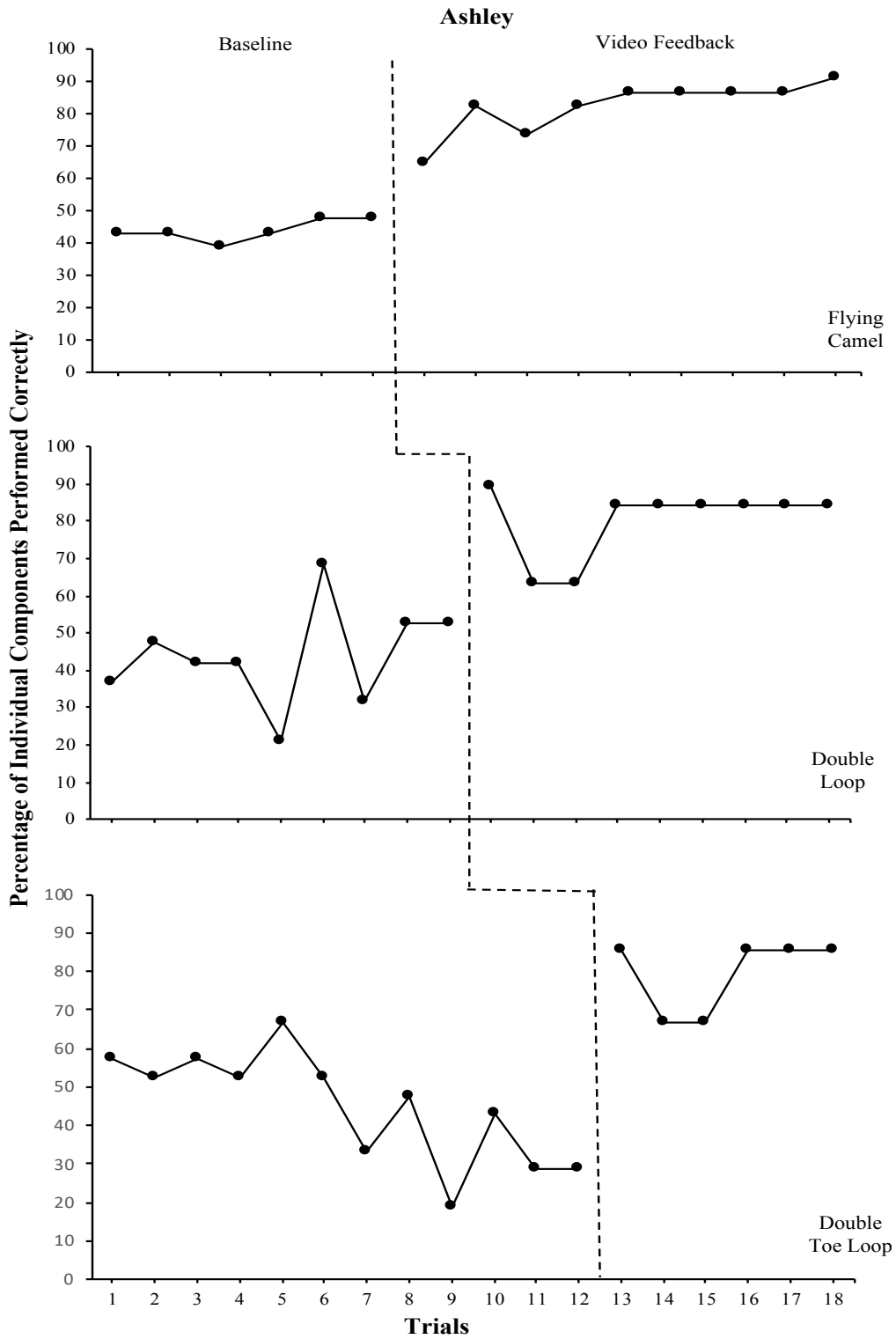


Figure 2. Results for Ashley show an immediate increase in performance with a decrease in variability in the intervention phase.

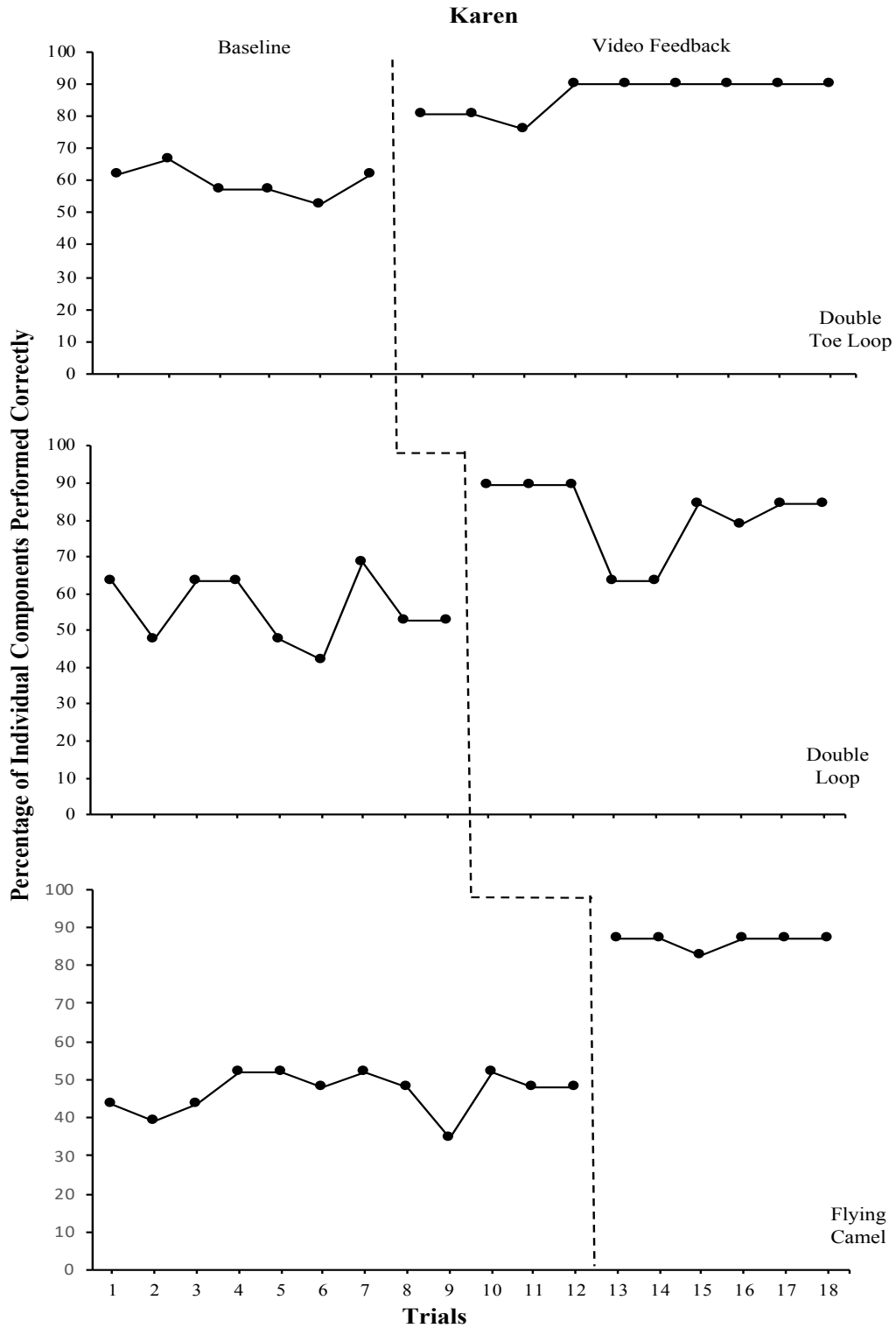


Figure 3. Results for Karen show an immediate increase in performance with a decrease in variability in the intervention phase.

Social Validity

Following the conclusion of the study, the primary investigator provided the coach and figure skater participants with social validity surveys and asked them to answer the questions to evaluate how they rate the intervention. The coach rated the intervention favorable in that she was happy with the skaters' improvements in form and technique as well as the overall results the skaters achieved. Overall the coach rated use of the Dartfish app for providing video feedback a 4.63 out of 5 possible points, on average. The coach reported the app was easy to use and provided cool details to show errors and positives in moves. However, the coach did not like when footage got lost. This occurred approximately two times when the coach was using the app and had the skater redo the move to provide feedback using the video. No recommendations were made for future studies. Table 1 displays the results of the social validity survey completed by the coach.

Skaters rated the video feedback using the Dartfish app intervention favorable in that they liked that it was a different technique and the overall results they achieved. Overall, skaters rated their experience with the Dartfish app as 4.13 out of 5 possible points, on average. Skaters reported that they liked how the video gave them a new and different view of themselves; seeing how they were jumping and spinning; being able to watch their mistakes and improve them; and being able to slow down the video to see the details the most. The skaters reported they did not like how the intervention invaded their lesson time by having to do the same thing over and over; not being able to work on some other things that they wanted to work on in their lesson; and that the app was sometimes glitchy. The skaters recommended that in the future a research study using this intervention should take up less of their lesson time and more of their individual time as well as work on different moves instead of the same three moves, although the skater also

reported that she understood it had to be consistent for the study. Table 2 displays the results of the social validity surveys completed by skaters.

Tables 3, 4, and 5 reflect the results of the expert ratings of intervention outcomes. The expert coach was blind to the phase of the study. The primary researcher compared the coach's ratings of each outcome from baseline to intervention. Scores for each outcome are reflected as averages of the three moves reviewed for baseline and intervention. Moves were arranged randomly from baseline and intervention. Overall the expert rating results reflect that the skaters were rated higher in intervention sessions than baseline. Out of 45 intervention outcomes evaluated across all skaters and moves, only 3 were rated lower than baseline. This reflects a 93% increase in performance across all skaters and moves.

Table 1. Coach Social Validity Survey Results

	Coach
1. I enjoyed participating in this study:	4
2. I am happy with the overall results my students achieved as part of this study:	5
3. Using video feedback was helpful in improving my skaters form/technique for the Double Loop or Double Salchow:	5
4. Using video feedback was helpful in improving my skaters form/technique for the Flying Camel or Layback:	5
5. Using video feedback was helpful in improving my skaters form/technique for the Double Toe Loop or Combination spin:	5
6. The Dartfish application was easy to use during a lesson:	5
7. The Dartfish application did not disrupt the lesson:	4
8. I would like to use the video feedback more often when I am teaching skaters new skills:	4
9. What did you like most about Dartfish?	Ease of application. Cool details to show errors/positives in moves
10. What did you like least about Dartfish?	Lost footage
11. Further recommendations:	N/A
Mean	4.63

Notes. Questions were rated using a 5 point Likert type scale with a 3 rating equalling no opinion, a 5 rating equalling strongly agree, and a 1 rating equalling strongly disagree.

Table 2. Skater Social Validity Survey Results

	Emily	Ashley	Karen	Mean
1. I enjoyed participating in this study:	4	4	4	4
2. I enjoyed having Dartfish added to my lesson:	5	3	4	4
3. Dartfish was a different coaching technique for my coach to use:	4	4	5	4.33
4. I am happy with the overall results I achieved as part of the study:	5	5	4	4.67
5. The video feedback I received was helpful in improving my form/technique for the Double Loop or Double Salchow:	4	5	4	4.33
6. The video feedback I received was helpful in improving my form/technique for the Flying Camel or Layback:	5	4	5	4.67
7. The video feedback I received was helpful in improving my form/technique for the Double Toe Loop or Combination spin:	5	4	4	4.33
8. The Dartfish application did not disrupt my coaching lesson:	3	3	3	3
9. I would like coaches to use video feedback more often when I am practicing new skills:	4	5	4	4.33
10. I would like to have Dartfish included in future coaching sessions:	4	3	4	3.67
11. What did you like most about Dartfish?	How it gave a new/different view; seeing how I was jumping/spinning	I was able to go back and watch my mistakes and improve them	Being able to slow down the video really sees the details	N/A
12. What did you like least about Dartfish?	Sometimes it invaded my lesson doing the same thing over and over	I wasn't able to work on some other things I wanted to work on in my lesson	It's glitchy sometimes	N/A
13. Further recommendations:	Trying to do different things instead of the same 3	Not take as much lesson time and maybe more of my individual time	N/A	N/A
Mean	4.3	4	4.1	4.13

Notes. Questions were rated using a 5 point Likert type scale with a 3 rating equalling no opinion, a 5 rating equalling strongly agree, and a 1 rating equalling strongly disagree.

Table 3. Independent Coach Survey Results for Emily

	Layback Spin		Combination Spin		Double Salchow Jump	
	Baseline	Intervention	Baseline	Intervention	Baseline	Intervention
Control Throughout Move	2.33	4	2.33	4.33	2.33	3.67
Speed or Acceleration	2.67	4.33	4	5	3	3
Number of Revolutions	3.33	4.33	4	4.33	2.33	3.33
Centering of Spin	1	1.33	3.67	5	N/A	N/A
Body Position	2.67	3.67	3	3.67	2.33	3.67
Landing	N/A	N/A	N/A	N/A	1.67	3.33

Notes. Questions were rated using a 5 point Likert type scale with a 3 rating equalling no opinion, a 5 rating equalling strongly agree, and a 1 rating equalling strongly disagree.

Table 4. Independent Coach Survey Results for Ashley

	Flying Camel Spin		Double Toe Loop Jump		Double Loop Jump	
	Baseline	Intervention	Baseline	Intervention	Baseline	Intervention
Control Throughout Move	3.33	3.67	3.33	3.33	3.33	3.67
Speed or Acceleration	2.67	4	3	3	4	4
Number of Revolutions	3.33	4.33	4	3.67	3.67	4
Centering of Spin	1.67	4	N/A	N/A	N/A	N/A
Body Position	3	4	3.33	3.33	3.33	3.33
Landing	N/A	N/A	1	3.33	1	3.33

Notes. Questions were rated using a 5 point Likert type scale with a 3 rating equalling no opinion, a 5 rating equalling strongly agree, and a 1 rating equalling strongly disagree.

Table 5. Independent Coach Survey Results for Karen

	Flying Camel Spin		Double Toe Loop Jump		Double Loop Jump	
	Baseline	Intervention	Baseline	Intervention	Baseline	Intervention
Control Throughout Move	1	4.67	4	4	3.33	2.67
Speed or Acceleration	1	3.33	2.33	3	4	4
Number of Revolutions	1	4.67	5	5	2.33	3.33
Centering of Spin	1	4.67	N/A	N/A	N/A	N/A
Body Position	1	3.67	4	4	3.67	2.33
Landing	N/A	N/A	2	4	1.67	3.33

Notes. Questions were rated using a 5 point Likert type scale with a 3 rating equalling no opinion, a 5 rating equalling strongly agree, and a 1 rating equalling strongly disagree.

Discussion

This study examined the effectiveness of a video feedback coaching procedure for increasing performance using the Dartfish application. The results indicate utilizing video feedback improved figure skater's performance levels to above 80% for all of the targeted moves. Some variability in performance occurred especially when skaters landed a move or fell during a move. When skaters fell during a move it resulted in lower scores since the rest of the steps could not be completed after a fall.

This study adds to the literature on the use of video feedback as a coaching procedure for figure skaters in multiple ways. First, this study examined video feedback with the coach providing positive and corrective feedback based off of the video with no other interventions. Previous studies examined psychological interventions and treatment packages including one study that used the Dartfish app to provide video feedback as a part of an intervention package (Bateman, 2015; Hall & Rodgers, 1989; Hume et al., 1985; Law & Ste-Marie, 2005; Martin & Toogood, 1997; Ming & Martin, 1996). The participants in prior studies were higher level skaters ranging from pre-novice to intermediate level (Bateman, 2015; Hall & Rodgers, 1989; Hume et al., 1985; Law & Ste-Marie, 2005; Martin & Toogood, 1997; Ming & Martin, 1996). However, this study used the intervention with competitive figure skaters but who competed on a recreational level.

Results of this study are consistent with previous studies and supported the suggestion of previous researchers by further evaluating of component of treatment packages prior studies used (Bateman, 2015; Martin & Toogood, 1997). Social validity was rated high, as in previous studies

(Law & Ste-Marie, 2005; Martin & Toogood, 1997). All skaters reported that they felt like the intervention helped improve their moves and described how their moves were improved. Treatment integrity was high. All re-training was due to the coach missing the same step, providing positive and corrective feedback using the task analysis. The coach provided positive and corrective feedback, but it was not based on the task analysis (e.g., saying decrease your speed when the skater's speed is not on the task analysis). This indicates that the intervention may be simple to use, but it may be a challenge to have the coach provide feedback based off of a task analysis alone. Implying positive and corrective feedback may be better based off of a combination of the task analysis and other components that the coach notices that may not be on the task analysis. This would allow for feedback on parts of a move that may also be important to an individual coach. The task analysis could also be modified and individualized for each coach and skater. In this study the task analysis was created by the primary investigator based off of the definition of the skating move and then the coach provided edits and approved the task analysis after the edits were made. This could be modified by the coach having more input as to what elements may need to be added or deleted off of the task analysis.

Additionally, compared to other research in sports, the results of the skaters in intervention were consistent as well as an immediate acquisition shown. During intervention the skaters' performance was very consistent in which components of the task analysis they missed. This can be seen when reviewing the results (see figure 1, 2, and 3). The skaters tended to achieve the same score except when their performance was initially improving or when the skater fell. It could be hypothesized that this is because of the repetition of the skater performing the move six times, three times in a row during the intervention session and three times in a row for the primary investigator.

Implications for Practice

Based on the social validity questionnaires and observations made by the primary investigator, there are a few suggestions on how the intervention might be best applied in practice. The coach and skater should determine what moves they may want to use the Dartfish app for receiving video feedback together, instead of the coach deciding for the skater without her input. Instead of using the app repeatedly for the same moves in every lesson, the coach may want to use the app more sporadically as a way to enhance their typical coaching method instead of replacing their typical coaching method. It might also be used to improve specific moves that the skater is struggling to successfully complete.

Limitations

One limitation to the current study is the time between sessions with two of the skaters. Emily and Ashley only had training sessions with the coach in the study once a week. This led to a lapse of one week between sessions. While performance levels increased and variability decreased, we may have seen less variability if the skaters received the intervention more frequently.

Another limitation to the study is that some of the spins and jumps included in the study were two levels above the skater's current level. This led to some components of the task analysis not achievable for the skaters as they were too far above their skill level. Therefore, the skaters would more than likely not reach 100% mastery for some time.

The primary researcher observed all lessons during the study to confirm skaters were not coached on the move outside of the intervention; however, the skaters did sometimes practice the move independently. Thus, a potential confounding variable to the study was skater led practice. This is when the skater practices target moves on her own. This could have led to an increase in

performance during baseline or intervention due to the nature of skill acquisition. However, we did not observe increases in performance during baseline so practicing outside of sessions was most likely not a factor.

Future Research

This study focused on replication of video feedback. An application was used to provide video feedback, but the application used was not area of focus. The application was the method in which video feedback was provided to the skaters. Utilizing the Dartfish app to provide video feedback gave the coach the opportunity to use the extra features the application provides, such as drawing lines or circles within the move, determining the percent of an angle, or showing side by side videos. This study did not evaluate how frequently the coach used these features. Therefore, it is undetermined how much the features of the application played a role into the results of this study. This should be evaluated in future research.

Future research should replicate this study while adjusting the feedback the coach provides. Additional research could have the coach provide positive and corrective feedback using the task analysis, but also include a list of items the coach will want to address as a part of feedback (e.g., speed going into a jump, control of the move, or what led to the skater falling). This is due to the task analysis not including items like the skater's speed and acceleration of moves as determining a clear definition of the appropriate speed or acceleration for each skater would be difficult and need to be individualized. Adding these items would give the coach the ability to improve other aspects of the skater's performance that judges might evaluate during competitions such as control of a move or speed throughout a move.

This study evaluated the coach using the Dartfish app within a lesson to provide video feedback to the skater. Future research should evaluate skaters using the app themselves to

review the move to see if it could increase their performance during independent practice. It would be beneficial to evaluate if skaters could increase their performance independently on moves they are currently working on so that lessons with the coach could focus on learning new moves.

The behaviors chosen for this study were determined by the coach. To improve social validity, future research could evaluate the skater choosing the target moves. This would allow the skater to work on moves he/she felt were of most importance or a move he/she really wanted to learn.

Lastly, future research should evaluate the use of video feedback as a way of enhancing a typical lesson. This would allow the coach to provide video feedback at any point the coach determined appropriate throughout a lesson as well as work on moves the skater is already working on within the lesson. This empowers the coach to determine the manner in which video feedback is utilized. For example, three times throughout a lesson instead of three times in a row. This would then add to the implications of how video feedback might fit more naturally within a practice session. Despite these limitations, the results of this study indicated video feedback was effective in improving a figure skaters performance. The current study was the first to examine the component of video feedback exclusively in figure skating.

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Appendices

Appendix A. Task Analysis Checklist

Date: _____ Data Collector: _____

Session: _____ Figure Skater: _____

Skill Set: <i>Combination Spin (forward camel, forward sit spin, backward sit spin)</i>	Position:	Completed:
1. Approach made from a forward outside entry edge	Entrance	Y / N
2. Free leg extended behind the heel of the skating foot	Free leg position	Y / N
3. Free leg held at least as high as the skating hip	Free leg position	Y / N
4. Arms extended	Arm position	Y / N
5. Back arched	Back position	Y / N
6. Head held erect	Head position	Y / N
7. Spins on one foot for a minimum of 3 revolutions	Spin	Y / N
8. Free leg swung forward	Free leg change	Y / N
9. Skater remains on one foot (not changing skating foot)	Skating foot	Y / N
10. Skater moves into a sitting position	Body change position	Y / N
11. Free leg held in forward position (not wrapped around spinning foot)	Free leg position	Y / N
12. Skating hip no higher than skating knee	Hip position	Y / N
13. Minimum 3 revolutions on one foot	Revolutions	Y / N
14. Back straight	Back position	Y / N
15. Skater rises on one foot out of spin (if other foot touches ice, does not count)	Body change position	Y / N
16. Changes skating foot to other foot (Free foot from forward sit spin)	Change of skating leg	Y / N
17. Spinning on one foot in a backward direction (counter clockwise)	Spin position	Y / N
18. Minimum 3 revolutions on one foot	Revolutions	Y / N

19. Skating hip no higher than skating knee for a minimum of 3 revolutions	Hip position	Y / N
20. Free leg held in forward position (not wrapped around spinning foot)	Free leg position	Y / N
21. Back straight	Back position	Y / N
22. Skater rises on one foot out of spin (if other foot touches ice, does not count)	Body change position	Y / N
23. Swings free leg behind body	Free leg change	Y / N
24. Knee of skating leg slightly bent (greater than 100 degrees less than 180 degrees)	Knee position	Y / N
25. Back upright (straight or with slight arch)	Back position	Y / N
26. Shoulders parallel to the ice	Shoulder position	Y / N
27. Holds position for 3s or more	Position length	Y / N
Total Completed:		
Score:		

Appendix B. Task Analysis Checklist

Date: _____ Data Collector: _____

Session: _____ Figure Skater: _____

Skill Set: <i>Layback Spin</i>	Position:	Completed:
1. Approach from a forward outside entry edge	Entrance	Y / N
2. Free leg extended in back	Free leg position	Y / N
3. Knee of free leg behind free hip	Knee position	Y / N
4. Knee of free leg bent	Knee position	Y / N
5. Free leg toe pointed	Toe position	Y / N
6. Half swing free leg to side of body	Hip position	Y / N
7. Knee of free leg bent behind body (e.g., behind free leg hip, not to side of body)	Knee position	Y / N
8. Free leg toe pointed	Toe position	Y / N
9. Hips pushed forward	Back position	Y / N
10. Back arched	Hip position	Y / N
11. Free leg continues the curve of the arched back	Free leg position	Y / N
12. Head below the shoulders	Head position	Y / N
13. Chin pointed towards ceiling	Chin position	Y / N
14. Shoulders straight (does not have to be parallel to the ice)	Shoulder position	Y / N
15. Six revolutions	Revolutions	Y / N
16. More than six revolutions	Revolutions	Y / N
17. Steps down onto free leg and pushes out with skating foot	Push	Y / N
18. Lifts skating foot behind body (now free leg)	Change foot	Y / N
19. Knee of skating leg slightly bent (greater than 100 degrees less than 180 degrees)	Knee position	Y / N

20. Back upright (straight or with slight arch)	Back position	Y / N
21. Shoulders parallel to the ice	Shoulder position	Y / N
22. Holds position for 3s or more	Position length	Y / N
Total Completed:		
Score:		

Appendix C. Task Analysis Checklist

Date: _____ Data Collector: _____

Session: _____ Figure Skater: _____

Skill Set: <i>Double Salchow</i>	Position:	Completed:
1. Takeoff foot is from the backward inside edge of one foot	Entrance	Y / N
2. Knee of takeoff leg is bent over toe	Knee Position	Y / N
3. Arm of takeoff foot is forward	Arm position	Y / N
4. Arm of free leg is checked back	Arm position	Y / N
5. Free leg is stretched back	Free leg position	Y / N
6. Free leg swung around towards front of skater	Swing	Y / N
7. Skater begins to turn forward (counter clockwise)	Turn	Y / N
8. The skater springs into the air from the takeoff foot with the bent knee while lifting the free leg away from the ice	Jump	Y / N
9. Two rotations made in the air in the direction of the curve of the takeoff edge	Rotations	Y / N
10. Posture is upright	Posture	Y / N
11. Back is straight	Back position	Y / N
12. Head held erect	Head position	Y / N
13. Left leg held close to landing leg	Leg position	Y / N
14. Arms pulled in across the chest	Arm position	Y / N
15. Toe of landing foot is pointing towards the ice	Toe position	Y / N
16. Body is in a vertical line	Body position	Y / N
17. Lands on the backward outside edge of the other foot (originally free foot)	Land	Y / N
18. Lifts skating foot behind body (now free leg)	Free leg position	Y / N

19. Knee of skating leg slightly bent (greater than 100 degrees less than 180 degrees)	Knee position	Y / N
20. Back upright (straight or with slight arch)	Back position	Y / N
21. Shoulders parallel to the ice	Shoulder position	Y / N
22. Holds position for 3s or more	Position length	Y / N
Total Completed:		
Score:		

Appendix D. Task Analysis Checklist

Date: _____ Data Collector: _____

Session: _____ Figure Skater: _____

Skill Set: Flying <i>Camel</i>	Position:	Completed:
1. Steps forward onto an outside edge	Entrance	Y / N
2. Free leg stretched behind the body (leg can be straight or with slight bend)	Free leg position	Y / N
3. Deep bend in skating knee	Skating knee position	Y / N
4. Free leg swings around to front of body	Free leg swing	Y / N
5. Free leg is brought up to hip height or higher while it is swung around	Free leg height	Y / N
6. While free leg at hip height, skater simultaneously jumps off of the toe pick of the takeoff foot	Jump position	Y / N
7. Body position near horizontal while skater is in the air	Body position	Y / N
8. As the free leg comes down, the jumping leg lifts higher	Leg change	Y / N
9. Jumping leg is brought up to hip height or higher	Jumping leg position	Y / N
10. Skater completed full revolution (landed facing in opposite direction from start of jump)	Revolution	Y / N
11. Landed on the opposite foot from the takeoff foot	Landing foot	Y / N
12. Skater landed in camel position (skating leg straight, free leg extended behind body at least as high as the skating hip)	Land position	Y / N
13. Arms extended	Arm position	Y / N
14. Back arched	Back position	Y / N
15. Head held up	Head position	Y / N
16. Completed six revolutions holding camel position	Revolutions	Y / N
17. Completed more than six revolutions holding camel position	Revolutions	Y / N

18. Free leg brought down towards side while skater is still spinning	Free leg position	Y / N
19. Free leg is swung behind body	Free leg swing	Y / N
20. Knee of skating leg slightly bent (greater than 100 degrees less than 180 degrees)	Skating leg position	Y / N
21. Back upright (straight or with slight arch)	Back position	Y / N
22. Shoulders parallel to the ice	Shoulder position	Y / N
23. Holds position for 3s or more	Position held	Y / N
Total Completed:		
Score:		

Appendix E. Task Analysis Checklist

Date: _____ Data Collector: _____

Session: _____ Figure Skater: _____

Skill Set: <i>Double Toe Loop</i>	Position:	Completed:
1. Takeoff from the backward outside edge of one foot	Entrance	Y / N
2. Reaches back with a straight free leg	Free leg reach	Y / N
3. Deepens bend in knee of takeoff leg	Bend	Y / N
4. Free side arm reaches forward	Arm reach	Y / N
5. Jumping side arm reaches backwards	Arm reach	Y / N
6. The toe of the free leg foot is pushed into the ice to push off	Toe pick	Y / N
7. Takeoff leg moves forward across the body	Takeoff leg position	Y / N
8. Two rotations in the air in the direction of the picking toe	Rotations	Y / N
9. Posture is upright	Posture position	Y / N
10. Back is straight	Back position	Y / N
11. Head held erect	Head position	Y / N
12. Left leg held close to landing leg	Leg position	Y / N
13. Arms pulled in across the chest	Arm position	Y / N
14. Toe of landing foot is pointing towards the ice	Toe position	Y / N
15. Body is in a vertical line	Body position	Y / N
16. Lands on the backward outside edge of the takeoff foot	Landing	Y / N
17. Lifts free leg behind body	Free leg position	Y / N
18. Knee of skating leg slightly bent (greater than 100 degrees less than 180 degrees)	Skating leg position	Y / N
19. Back upright (straight or with slight arch)	Back position	Y / N

20. Shoulders parallel to the ice	Shoulder position	Y / N
21. Holds position for 3s or more	Position held	Y / N
Total Completed:		
Score:		

Appendix F. Task Analysis Checklist

Date: _____ Data Collector: _____

Session: _____ Figure Skater: _____

Skill Set: Double <i>Loop</i>	Position:	Completed:
1. Takeoff from the backward outside edge of jumping foot	Entrance	Y / N
2. Jumping side arm reaches backwards	Arm reach	Y / N
3. Free leg foot flat on ice in-front of jumping foot	Free leg position	Y / N
4. Free side arm reaches forwards	Arm reach	Y / N
5. Deepens bend in knee of jumping leg while non-jumping leg foot moves slightly forward	Bend	Y / N
6. Two rotations made in the air in the direction of the curve of the takeoff edge (turning towards the free leg)	Rotations	Y / N
7. Posture is upright	Posture position	Y / N
8. Back is straight	Back position	Y / N
9. Head held erect	Head position	Y / N
10. Free leg held close to landing leg	Leg position	Y / N
11. Arms pulled in across the chest	Arm position	Y / N
12. Toe of landing foot is pointing towards the ice	Toe position	Y / N
13. Body is in a vertical line	Body position	Y / N
14. Landed on the backward outside edge of the takeoff foot	Landing	Y / N
15. Lifts free leg behind body	Free leg position	Y / N
16. Knee of skating leg slightly bent (greater than 100 degrees less than 180 degrees)	Skating leg position	Y / N
17. Back upright (straight or with slight arch)	Back position	Y / N
18. Shoulders parallel to the ice	Shoulder position	Y / N
19. Holds position for 3s or more	Position held	Y / N

	Total Completed:
	Score:

Appendix G. Fidelity Checklist

Dartfish App Intervention

Date: _____ Data Collector: _____

Session: _____ Coach: _____

Circle Yes, No, or N/A	Step	Comments
Each step is completed in sequential order.		
Yes / No / N/A	1. Pulled up Dartfish app on iPad,	
Yes / No / N/A	2. Instructed skater to perform the target behavior.	
Yes / No / N/A	3. Used the Dartfish App to record the skater performing the move.	
Yes / No / N/A	4. When skater finished move, showed skater video using Dartfish App.	
Yes / No / N/A	5. Provided skater positive and corrective feedback based on the task analysis while showing the video.	
Yes / No / N/A	6. When positive and corrective feedback completed with video, instructed skater to perform the move again.	
Yes / No / N/A	7. Videoed skater using the Dartfish App while the skater performed the target behavior following feedback three times.	
Yes / No / N/A	8. Then completed steps 4-7 again.	

Appendix H. Social Validity Questionnaire for Figure Skater Participants

Please rate the following by circling the number:

1. I enjoyed participating in this study:

Strongly Disagree Disagree No Opinion Agree Strongly Agree

1 2 3 4 5

Why: _____

2. I enjoyed having Dartfish added to my lesson:

Strongly Disagree Disagree No Opinion Agree Strongly Agree

1 2 3 4 5

Why: _____

3. Dartfish was a different coaching technique for my coach to use:

Strongly Disagree Disagree No Opinion Agree Strongly Agree

1 2 3 4 5

Why: _____

4. I am happy with the overall results I achieved as part of the study:

Strongly Disagree Disagree No Opinion Agree Strongly Agree

1 2 3 4 5

Why: _____

5. The video feedback I received was helpful in improving my form/technique for the Double Loop or Double Salchow:

Strongly Disagree Disagree No Opinion Agree Strongly Agree

1 2 3 4 5

Why: _____

6. The video feedback I received was helpful in improving my form/technique for the Flying Camel or Layback:

Strongly Disagree Disagree No Opinion Agree Strongly Agree

1 2 3 4 5

Why: _____

7. The video feedback I received was helpful in improving my form/technique for the Double Toe Loop or Combination spin:

Strongly Disagree Disagree No Opinion Agree Strongly Agree

1 2 3 4 5

Why: _____

8. The Dartfish application did not disrupt my coaching lesson:

Strongly Disagree Disagree No Opinion Agree Strongly Agree

1 2 3 4 5

Why: _____

9. I would like coaches to use video feedback more often when I am practicing new skills:

Strongly Disagree Disagree No Opinion Agree Strongly Agree

1 2 3 4 5

Why: _____

10. I would like to have Dartfish included in future coaching sessions:

Strongly Disagree Disagree No Opinion Agree Strongly Agree

1 2 3 4 5

Why: _____

11. What did you like MOST about Dartfish?

12. What did you like LEAST about Dartfish?

13. Further Recommendations:

Appendix I. Social Validity Questionnaire for Coach Participants

Please rate the following:

1. I enjoyed participating in this study:

Strongly Disagree Disagree No Opinion Agree Strongly Agree

1 2 3 4 5

Why: _____

2. I am happy with the overall results my student achieved as part of the study:

Strongly Disagree Disagree No Opinion Agree Strongly Agree

1 2 3 4 5

Why: _____

3. Using video feedback was helpful in improving my skaters form/technique for the

Double Loop or Double Salchow:

Strongly Disagree Disagree No Opinion Agree Strongly Agree

1 2 3 4 5

Why: _____

4. Using video feedback was helpful in improving my skaters form/technique for the Flying

Camel or Layback:

Strongly Disagree Disagree No Opinion Agree Strongly Agree

1 2 3 4 5

Why: _____

5. Using video feedback was helpful in improving my skaters form/technique for the

Double Toe Loop or Combination spin:

Strongly Disagree Disagree No Opinion Agree Strongly Agree

1 2 3 4 5

Why: _____

6. The Dartfish application was easy to use during a lesson:

Strongly Disagree Disagree No Opinion Agree Strongly Agree

1 2 3 4 5

Why: _____

7. Using the Dartfish application did not disrupt the lesson:

Strongly Disagree Disagree No Opinion Agree Strongly Agree

1 2 3 4 5

Why: _____

8. I would like to use video feedback more often when I am teaching skaters new skills:

Strongly Disagree Disagree No Opinion Agree Strongly Agree

1 2 3 4 5

Why: _____

9. What did you like MOST about Dartfish?

10. What did you like LEAST about Dartfish?

11. Further Recommendations:

Appendix J. Expert Ratings of Intervention Outcomes

Flying Camel Rated by Coaches

Please rate the following videos based on the definitions from the USFSA to the best of your ability. On a scale of 1-5, please circle the number that best identifies the skater's control throughout move; speed or acceleration of spin; number of revolutions; centering of spin; and body position. The video clips have been placed in random order and are not in the order in which the study was conducted.

Flying Camel

Control Throughout Move - A 5 represents the skater having full control in a fluid motion throughout entire move; a score of 1 represents a skater cannot hold any part of the move (e.g., wobbly, change in speed).

Video 1	1	2	3	4	5
Video 2	1	2	3	4	5
Video 3	1	2	3	4	5
Video 4	1	2	3	4	5
Video 5	1	2	3	4	5
Video 6	1	2	3	4	5

Speed or Acceleration of Spin - A 5 represents consistent speed throughout; a 1 represents a spin too slow or changing speed.

Video 1	1	2	3	4	5
Video 2	1	2	3	4	5
Video 3	1	2	3	4	5
Video 4	1	2	3	4	5
Video 5	1	2	3	4	5
Video 6	1	2	3	4	5

Number of Revolutions - A 5 represents 6 or more revolutions per spin; a 1 represents no full revolution.

Video 1	1	2	3	4	5
Video 2	1	2	3	4	5
Video 3	1	2	3	4	5
Video 4	1	2	3	4	5
Video 5	1	2	3	4	5
Video 6	1	2	3	4	5

Centering of Spin - A 5 represents a spin that is centered and not traveling; a 1 represents a spin that is not centered and travels more than 2 ft.

Video 1	1	2	3	4	5
Video 2	1	2	3	4	5
Video 3	1	2	3	4	5
Video 4	1	2	3	4	5
Video 5	1	2	3	4	5
Video 6	1	2	3	4	5

Body Position - A 5 represents high quality positioning; a 1 represents a position that does not look like a flying camel.

Video 1	1	2	3	4	5
Video 2	1	2	3	4	5
Video 3	1	2	3	4	5
Video 4	1	2	3	4	5
Video 5	1	2	3	4	5
Video 6	1	2	3	4	5

Appendix K. Expert Ratings of Intervention Outcomes

Double Loop Rated by Coaches

Please rate the following videos based on the definitions from the USFSA to the best of your ability. On a scale of 1-5, please circle the number that best identifies the skater's control throughout move; speed or acceleration of jump; number of revolutions; body position; and landing. The video clips have been placed in random order and are not in the order in which the study was conducted.

Double Loop

Control Throughout Move - A 5 represents the skater having full control in a fluid motion throughout entire move; a score of 1 represents a skater cannot hold any part of the move (e.g., wobbly, leg falling down).

Video 1	1	2	3	4	5
Video 2	1	2	3	4	5
Video 3	1	2	3	4	5
Video 4	1	2	3	4	5
Video 5	1	2	3	4	5
Video 6	1	2	3	4	5

Speed or Acceleration of Jump - A 5 represents consistent speed throughout; a 1 represents a jump too slow.

Video 1	1	2	3	4	5
Video 2	1	2	3	4	5
Video 3	1	2	3	4	5
Video 4	1	2	3	4	5
Video 5	1	2	3	4	5
Video 6	1	2	3	4	5

Number of Revolutions - A 5 represents 2 or more revolutions; a 1 represents no full revolution.

Video 1	1	2	3	4	5
Video 2	1	2	3	4	5
Video 3	1	2	3	4	5
Video 4	1	2	3	4	5
Video 5	1	2	3	4	5
Video 6	1	2	3	4	5

Body Position - A 5 represents high quality positioning; a 1 represents a position that does not look like a double loop.

Video 1	1	2	3	4	5
Video 2	1	2	3	4	5
Video 3	1	2	3	4	5
Video 4	1	2	3	4	5
Video 5	1	2	3	4	5
Video 6	1	2	3	4	5

Landing - A 5 represents landing on the correct foot and edge with a full check out holding the position; a 1 represents a fall or no check out.

Video 1	1	2	3	4	5
Video 2	1	2	3	4	5
Video 3	1	2	3	4	5
Video 4	1	2	3	4	5
Video 5	1	2	3	4	5
Video 6	1	2	3	4	5

Appendix L. Expert Ratings of Intervention Outcomes

Double Toe Rated by Coaches

Please rate the following videos based on the definitions from the USFSA to the best of your ability. On a scale of 1-5, please circle the number that best identifies the skater's control throughout move; speed or acceleration of spin; number of revolutions; centering of spin; and body position

The video clips have been placed in random order and are not in the order in which the study was conducted.

Double Toe

Control Throughout Move - A 5 represents the skater having full control in a fluid motion throughout entire move; a score of 1 represents a skater cannot hold any part of the move (e.g., wobbly, change in speed).

Video 1	1	2	3	4	5
Video 2	1	2	3	4	5
Video 3	1	2	3	4	5
Video 4	1	2	3	4	5
Video 5	1	2	3	4	5
Video 6	1	2	3	4	5

Speed or Acceleration of Jump - A 5 represents consistent speed throughout; a 1 represents a jump too slow.

Video 1	1	2	3	4	5
Video 2	1	2	3	4	5
Video 3	1	2	3	4	5
Video 4	1	2	3	4	5
Video 5	1	2	3	4	5
Video 6	1	2	3	4	5

Number of Revolutions - A 5 represents 2 or more revolutions; a 1 represents no full revolution.

Video 1	1	2	3	4	5
Video 2	1	2	3	4	5
Video 3	1	2	3	4	5
Video 4	1	2	3	4	5
Video 5	1	2	3	4	5
Video 6	1	2	3	4	5

Body Position - A 5 represents high quality positioning; a 1 represents a position that does not look like a double toe.

Video 1	1	2	3	4	5
Video 2	1	2	3	4	5
Video 3	1	2	3	4	5
Video 4	1	2	3	4	5
Video 5	1	2	3	4	5
Video 6	1	2	3	4	5

Landing - A 5 represents landing on the correct foot and edge with a full check out holding the position; a 1 represents a fall or no check out.

Video 1	1	2	3	4	5
Video 2	1	2	3	4	5
Video 3	1	2	3	4	5
Video 4	1	2	3	4	5
Video 5	1	2	3	4	5
Video 6	1	2	3	4	5

Appendix M. Expert Ratings of Intervention Outcomes

Combination Spin Rated by Coaches

Please rate the following videos based on the definitions from the USFSA to the best of your ability. On a scale of 1-5, please circle the number that best identifies the skater's control throughout move; speed or acceleration of spin; number of revolutions; centering of spin; and body position. The video clips have been placed in random order and are not in the order in which the study was conducted.

Combination Spin (Forward Camel, Forward Sit, Backward Sit)

Control Throughout Move - A 5 represents the skater having full control in a fluid motion throughout entire move; a score of 1 represents a skater cannot hold any part of the move (e.g., wobbly, change in speed).

Video 1	1	2	3	4	5
Video 2	1	2	3	4	5
Video 3	1	2	3	4	5
Video 4	1	2	3	4	5
Video 5	1	2	3	4	5
Video 6	1	2	3	4	5

Speed or Acceleration of Spin - A 5 represents consistent speed throughout; a 1 represents a spin too slow or changing speed.

Video 1	1	2	3	4	5
Video 2	1	2	3	4	5
Video 3	1	2	3	4	5
Video 4	1	2	3	4	5
Video 5	1	2	3	4	5
Video 6	1	2	3	4	5

Number of Revolutions - A 5 represents 3 or more revolutions per spin; a 1 represents no full revolution in any spin.

Video 1	1	2	3	4	5
Video 2	1	2	3	4	5
Video 3	1	2	3	4	5
Video 4	1	2	3	4	5
Video 5	1	2	3	4	5
Video 6	1	2	3	4	5

Centering of Spin - A 5 represents a spin that is centered and not traveling; a 1 represents a spin that is not centered and travels more than 2 ft.

Video 1	1	2	3	4	5
Video 2	1	2	3	4	5
Video 3	1	2	3	4	5
Video 4	1	2	3	4	5
Video 5	1	2	3	4	5
Video 6	1	2	3	4	5

Body Position - A 5 represents high quality positioning; a 1 represents a position that does not look like a combination spin.

Video 1	1	2	3	4	5
Video 2	1	2	3	4	5
Video 3	1	2	3	4	5
Video 4	1	2	3	4	5
Video 5	1	2	3	4	5
Video 6	1	2	3	4	5

Appendix N. Expert Ratings of Intervention Outcomes

Layback Spin Rated by Coaches

Please rate the following videos based on the definitions from the USFSA to the best of your ability. On a scale of 1-5, please circle the number that best identifies the skater's control throughout move; speed or acceleration of spin; number of revolutions; centering of spin; and body position. The video clips have been placed in random order and are not in the order in which the study was conducted.

Layback Spin

Control Throughout Move - A 5 represents the skater having full control in a fluid motion throughout entire move; a score of 1 represents a skater cannot hold any part of the move (e.g., wobbly, change in speed).

Video 1	1	2	3	4	5
Video 2	1	2	3	4	5
Video 3	1	2	3	4	5
Video 4	1	2	3	4	5
Video 5	1	2	3	4	5
Video 6	1	2	3	4	5

Speed or Acceleration of Spin - A 5 represents consistent speed throughout; a 1 represents a spin too slow or changing speed.

Video 1	1	2	3	4	5
Video 2	1	2	3	4	5
Video 3	1	2	3	4	5
Video 4	1	2	3	4	5
Video 5	1	2	3	4	5
Video 6	1	2	3	4	5

Number of Revolutions - A 5 represents 6 or more revolutions; a 1 represents no full revolution.

Video 1	1	2	3	4	5
Video 2	1	2	3	4	5
Video 3	1	2	3	4	5
Video 4	1	2	3	4	5
Video 5	1	2	3	4	5
Video 6	1	2	3	4	5

Centering of Spin - A 5 represents a spin that is centered and no traveling; a 1 represents a spin that is not centered and travels more than 2 ft.

Video 1	1	2	3	4	5
Video 2	1	2	3	4	5
Video 3	1	2	3	4	5
Video 4	1	2	3	4	5
Video 5	1	2	3	4	5
Video 6	1	2	3	4	5

Body Position - A 5 represents high quality positioning; a 1 represents a position that does not look like a layback spin.

Video 1	1	2	3	4	5
Video 2	1	2	3	4	5
Video 3	1	2	3	4	5
Video 4	1	2	3	4	5
Video 5	1	2	3	4	5
Video 6	1	2	3	4	5

Appendix O. Expert Ratings of Intervention Outcomes

Double Salchow Spin Rated by Coaches

Please rate the following videos based on the definitions from the USFSA to the best of your ability. On a scale of 1-5, please circle the number that best identifies the skater's control throughout move; speed or acceleration of jump; number of revolutions; body position; and landing. The video clips have been placed in random order and are not in the order in which the study was conducted.

Double Salchow

Control Throughout Move - A 5 represents the skater having full control in a fluid motion throughout entire move; a score of 1 represents a skater cannot hold any part of the move (e.g., wobbly, change in speed).

Video 1	1	2	3	4	5
Video 2	1	2	3	4	5
Video 3	1	2	3	4	5
Video 4	1	2	3	4	5
Video 5	1	2	3	4	5
Video 6	1	2	3	4	5

Speed or Acceleration of Jump - A 5 represents consistent speed throughout; a 1 represents a jump too slow.

Video 1	1	2	3	4	5
Video 2	1	2	3	4	5
Video 3	1	2	3	4	5
Video 4	1	2	3	4	5
Video 5	1	2	3	4	5
Video 6	1	2	3	4	5

Number of Revolutions - A 5 represents 2 or more revolutions; a 1 represents no full revolution.

Video 1	1	2	3	4	5
Video 2	1	2	3	4	5
Video 3	1	2	3	4	5
Video 4	1	2	3	4	5
Video 5	1	2	3	4	5
Video 6	1	2	3	4	5

Body Position - A 5 represents high quality positioning; a 1 represents a position that does not look like a double salchow.

Video 1	1	2	3	4	5
Video 2	1	2	3	4	5
Video 3	1	2	3	4	5
Video 4	1	2	3	4	5
Video 5	1	2	3	4	5
Video 6	1	2	3	4	5

Landing - A 5 represents landing on the correct foot and edge with a full check out holding the position; a 1 represents a fall or no check out.

Video 1	1	2	3	4	5
Video 2	1	2	3	4	5
Video 3	1	2	3	4	5
Video 4	1	2	3	4	5
Video 5	1	2	3	4	5
Video 6	1	2	3	4	5

Appendix P. USF IRB Approval



RESEARCH INTEGRITY AND COMPLIANCE
Institutional Review Boards, FWA No. 00001669
12901 Bruce B. Downs Blvd., MDC035 • Tampa, FL 33612-4799
(813) 974-5638 • FAX (813) 974-7091

October 17, 2017

Lori Greenberg
ABA-Applied Behavior Analysis
Tampa, FL 33604

RE: **Expedited Approval for Initial Review**
IRB#: Pro00032423
Title: Using Video Feedback to Increase Figure Skaters' Performance

Study Approval Period: 10/17/2017 to 10/17/2018

Dear Ms. Greenberg:

On 10/17/2017, the Institutional Review Board (IRB) reviewed and **APPROVED** the above application and all documents contained within, including those outlined below.

Approved Item(s):

Protocol Document(s):

[Protocol_9.17.17.docx](#)

Consent/Assent Document(s)*:

[Parental Consent for Skater.pdf](#)

[Skater Assent.pdf](#)

[Skating Coach Consent.pdf](#)

[Verbal Assent](#)

*Please use only the official IRB stamped informed consent/assent document(s) found under the "Attachments" tab. Please note, these consent/assent documents are valid until the consent document is amended and approved. The Child Verbal Assent is not a stamped form.

It was the determination of the IRB that your study qualified for expedited review which includes activities that (1) present no more than minimal risk to human subjects, and (2) involve only procedures listed in one or more of the categories outlined below. The IRB may review research through the expedited review procedure authorized by 45CFR46.110. The research

proposed in this study is categorized under the following expedited review category:

(6) Collection of data from voice, video, digital, or image recordings made for research purposes.

(7) Research on individual or group characteristics or behavior (including, but not limited to, research on perception, cognition, motivation, identity, language, communication, cultural beliefs or practices, and social behavior) or research employing survey, interview, oral history, focus group, program evaluation, human factors evaluation, or quality assurance methodologies.

Study involves children and falls under 45 CFR 46.404: Research not involving more than minimal risk.

As the principal investigator of this study, it is your responsibility to conduct this study in accordance with IRB policies and procedures and as approved by the IRB. Any changes to the approved research must be submitted to the IRB for review and approval via an amendment. Additionally, all unanticipated problems must be reported to the USF IRB within five (5) calendar days.

We appreciate your dedication to the ethical conduct of human subject research at the University of South Florida and your continued commitment to human research protections. If you have any questions regarding this matter, please call 813-974-5638.

Sincerely,

A handwritten signature in black ink, appearing to read 'Kristen Salomon', followed by a horizontal line.

Kristen Salomon, Ph.D., Vice Chairperson
USF Institutional Review Board