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Using In-Vivo Audio Feedback to Improve Cycling Performance

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by

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ABSTRACT

Many behavioral interventions have attempted to increase sports performance. These interventions include: goal setting and feedback, behavioral coaching, and acoustical guidance. The use of technological devices in all areas of life continues to steadily increase. Therefore, behavioral interventions should also adapt to meet these changes in technology. One such intervention is in-vivo audio feedback in which participants receive live feedback about their current performance while practicing the skill. In-vivo audio feedback has not yet been rigorously evaluated as a means of improving sports performance. This study used a multiple baseline across participants design to evaluate the effects of in-vivo audio feedback on cycling performance. Results from this study suggest that in-vivo audio feedback was an effective method for improving cycling performance for individuals wishing to increase their average cycling speed.

CHAPTER ONE:

INTRODUCTION

Using In-Vivo Audio Feedback to Improve Cycling Performance

The U.S. Department of Health and Human Services (2008) recommends physical activity as a way to stay healthy and suggests an individual should engage in physical activity at least 2 hr and 30 min every week. The U.S. Department of Health and Human Services (2008) also states physical activity can reduce levels of stress and depression and Hefferon, Mallery, Gay, and Elliott (2013) found exercise can help decrease self-reported levels of anxiety, psychosis, and post-traumatic stress disorder. Macdonald, Ashe, and McKay (2009) found exercise also improves balance and bone mass which is important for women with osteoporosis and elderly people. One common means in which people engage in physical activity is participating in sports – whether as an amateur or professionally.

In the professional arena, the profitability and popularity of sports continues to drive athletes to break records and set new limits (By The Numbers, 2010; Heithner, 2015). Many athletes rely on traditional coaching techniques to improve skill execution. Traditional coaching utilizes instruction and feedback; however, this coaching technique typically attempts to increase performance of an entire skill and may not break the skills down into small enough components for each athlete's individual needs. Many behavior modification procedures have been used to increase performance in a variety of sports including: goal setting and feedback (Brobst & Ward, 2002), behavioral coaching (Smith & Ward, 2006), and technology-based interventions such as video modeling (Floz, 2015), TAGTeach (Quinn, Miltenberger, & Fogel, 2015) and computer applications (Valbuena, Miltenberger & Solley, 2015).

One procedure that has been effective in increasing sports performance is goal setting and performance feedback (Brobst & Ward, 2002; Smith & Ward, 2006; Todd, Reid, & Butler-Kisber, 2010). To increase performance, coaches or the athletes set goals on an aspect of the skill they want to perform better. The athletes then receive feedback from their coach after they performed the skill. Goal setting and feedback can be further improved by giving praise to others for practicing and for performing better, picking specific parts of the skill to improve, giving specific descriptive praise, and positive feedback and instructions on how to improve the parts of the skills that were not performed correctly. This was shown to be more effective than traditional coaching in increasing performance levels of athletic skills for both football and soccer players (Brobst & Ward, 2002; Smith & Ward, 2006). Brobst and Ward (2006) also added a public posting component that motivated players and improved skill scores. It also helped other players on the team not in the intervention group improve their skill scores.

Another effective intervention strategy is behavioral coaching, a modified form of behavioral skills training (BST) (Shapiro & Shapiro, 1985). Behavioral coaching includes: instruction, rehearsal, assessment, feedback, modeling and more rehearsal of the skill (Shapiro & Shapiro, 1985). Behavioral coaching enables athletes to view correct skill performance and then practice and receive feedback on the skill. Behavioral coaching has improved athletic performance in football, gymnastics, and track and field (Allison & Ayllon, 1980; Shapiro & Shapiro, 1985). One drawback to behavioral coaching is the athlete does not have a way to see themselves performing the skill and relies only on the verbal feedback of the coach.

A second procedure commonly used to improve athletic performance is video modeling. In video modeling, the athlete can watch him or herself or an expert perform the skill. When the athlete is recorded, he or she can see what component of the skill(s) he or she is performing correctly and what skills need improvement. Video modeling can be even more effective when the athlete watches a video of his or her performance side by side with that of an expert performing the skill (Floz, 2015). Boyer, Miltenberger, Batsche, and Fogel (2009) showed this was effective in improving gymnasts' performance for a variety of skills. Flotz (2015) used video modeling in a different fashion to improve field hockey performance. Instead of using experts, the coach recorded many of the players' own shots on goal and helped each player select their best two shots. The field hockey players then watched the videos every day. This resulted in improving skill performance for collegiate level athletes, even without the use of experts. Video modeling is less intrusive than traditional coaching because the coach does not need to give instructions during the performance of the skill and may not need to review the video with the athletes (Boyer et al., 2009; Flotz, 2015). However, this method may not be as effective if the athlete cannot perform the skill at a high level at least occasionally.

Acoustical feedback is another procedure that does not require the coach to give verbal feedback during the performance of the skill. The Teaching with Acoustical Guidance (TAGteach) procedure is used to improve specific components of an athletic skill such as a dance move or the blocking skill of a football player (Quinn et al., 2015; Stokes, Luiselli, Reed, & Fleming, 2010). This technology uses shaping of targeted component skills to improve the overall performance of a skill. When using TAGteach, the athletes identify a specific part of the skill that needs to be improved called the TAGpoint (Quinn et al., 2015). Then, while the athlete is performing the skill, the coach uses a short, audible stimulus, such as a beep or a click, to signal to the athlete the TAGpoint was performed correctly. This allows the athlete to execute the skill chain without stopping for the coach to provide verbal feedback (Quinn et al., 2015). Stokes et al. (2010) showed TAGteach improved performance on the TAGpoint and for the skill as a whole.

Although the aforementioned interventions are effective in increasing athletic performance, more people rely on technological devices than ever before (Ariel, 2015). These improvements in technological devices also give researchers more tools that could improve behavioral technologies. Therefore, it is important that applied behavior analysts continue to advance behavioral technologies by developing effective interventions using these devices. According to Ariel (2015), the sports and fitness applications category had the second highest growth rate in 2014 out of all application categories. Sports and fitness applications are used to create public posting forums which can increase motivation to improve sports performance (Kang, Ha, & Hambrick, 2015). In addition to applications, other technological devices can be used to accurately record data that researchers could not feasibly collect by traditional direct observation methods, such as the number of steps walked per day. Fitbits are wrist bands that can be used to track steps and activity whereas the Nike+ App uses a small chip placed in the shoe to measure number of steps, gait, speed, and distance (Valbuena et al., 2015; Wack et al., 2014). Both of these studies combined wearable technology, computer-based applications, and behavioral procedures to increase physical activity. The technology used in these interventions allowed participants to easily track and view their progress towards their physical activity goals (Valbuena et al., 2015; Wack et al., 2014).

One type of app-based intervention that has not been evaluated extensively is in-vivo audio feedback. In-vivo audio feedback incorporates auditory information regarding skill performance such as speed or distance travelled while the athlete is engaging in the activity. This audio feedback is provided from an application instead of an in-person coach. The flexibility and smaller financial commitment of in-vivo audio feedback may allow more people to increase physical activity and improve athletic skills. In addition, traditional and behavioral coaching may be difficult to do during some sports activities; however, in-vivo audio feedback from an app is not limited by needing a coach to be present. This increases the accessibility of feedback during their activity, which may improve performance more than traditional or behavioral coaching.

Currently, there is very little research evaluating the effectiveness of in-vivo audio feedback. Additionally, no behavioral research has looked at improving cycling performance, only increasing exercise in the form of cycling (Todd et al., 2010). This may be due to the difficulty for a coach to remain close enough to provide feedback during a cycling session. Other complications come from the amount of time and distance the cyclist may travel during a session. Since audio feedback has been shown to be effective and in-vivo audio feedback could overcome some of the difficulties of traditional or behavioral coaching, the purpose of this study was to evaluate the effects of in-vivo audio feedback on improving cyclists' speed.

CHAPTER TWO:

METHODS

Participants

Three cyclists participated in this study, that we renamed Phil, Stu, and Alan and they were 37, 25, and 26 years old respectively. Phil was recruited from the Abilities Experience team roster and had started to train on his own. He had about a month of self-training before the study. He was interesting in participating in the study to help him improve his training for a cross country cycling trip. Stu was recruited though a community flier and was interested in getting into better shape and thought biking was a fun way to do it. Stu had biked some in the past for casual exercise but had no formal training. Alan was recruited from a past Abilities Experience team roster, had not been biking lately but was interested in getting back into biking. He used to average around 18 to 20 miles an hour and wanted to get back to that speed. He had the most experience of all three participants since he has biked for over 5000 miles and had some formal training. For inclusion in this study, each cyclist needed to be currently averaging under 16 MPH during their rides. Wood (2013) reports that 14 mph is a reasonable average training speed for biking with speeds of 16 mph and above being a very vigorous pace. In addition, each participant's typical ride length had to be at least 1 hr, and they had to ride at least 15 miles. Participants had to have access to an iPhone with a data plan and GPS tracking and a road-style bicycle. Participants also were emailed the Physical Activity Readiness Questionnaire (PAR-Q) (Appendix A) to fill out. The participants had to score a "no" on all the questions in order to participate in the study.

Cyclists were recruited from future Abilities Experience team rosters. These events are charity rides that happen every summer and most participants have minimal cycling experience before they start training. Emails were sent to each team member with a brief description of the study and the primary investigator's email. The emails also include the Informed Consent Form for them to read through, Participant Information Questionnaire (Appendix B) and a Motivation and Abilities Assessment (Appendix C) to sign and send back to the researcher. Further recruitment was carried out via community fliers (Appendix D) posted around the University of South Florida campus as well as local gyms. If these participants contacted the researcher they were emailed the same information as the Abilities Experience team members. If the potential participant had any questions they were instructed to email the researcher for clarification. Interested participants then completed an in-person or video interview with the primary investigator to determine eligibility of the potential participant and further discuss the study. Participants received $25 donated to their fundraising page and were provided the elite version of the Cyclemeter app for participating in the study.

Setting

This study was done with participants from all over the U.S. therefor there was no formal setting. The research team was based out of Tampa Florida but only Stu cycled in that area. Phil did all of his sessions in Memphis Tennessee. Alan was in Washington D.C. for his Rides. This was only a possibility due to the use of App based data collection procedures and video conferencing.

Materials

Participants used their own personal road style bicycle, helmet, and iPhone for the study. Participants were instructed to avoid making any modifications to their bikes during the study.

Each participant downloaded the standard Cyclemeter app. The Cyclemeter app is an iPhone app that can track the participants through GPS. The app gave them a visual display of where they were geographically and their current speed, time, and distance. However this was only avalible for the participants to view after the ride. When the participants had the video conference with the researcher they were upgraded to the elite version of the app. The specific feature that was be added by upgrading to the elite version and used for the intervention was in-vivo audio feedback. This feedback was given every 5 min and told the participant their current speed, average speed, and their pace compared to their best or median sessions.

Target Behavior and Data Collection

The target behavior that was assessed in this study was the average speed in miles per hour for each session. Data was collected by the researcher using the Cyclemeter application. The iPhones A-GPS data was used to calculate speed (distance/time). Cyclemeter is an app that can be found on the iPhone app store and is only available for iPhone at this time. You can find it by going to the app store and then going to search and typing Cyclemeter into the search bar. The app has a standard version and an elite version. The elite version was used in both the baseline and intervention phases. However the In-Vivo audio feedback was not set up until they completed the intervention set up meeting. The Cyclemeter Elite application has a feature that allows one to view details about other people's rides by setting up automatic email notifications when someone completes a ride. Doing so gives the person who was emailed access to the data such as average speed (the dependent variable for this study) and other useful information on their rides. Each participant added the researcher and research assistant's to the auto email list so the researcher and research assistants could log in and view the data from their computer. This data was used for both primary data collection and IOA purposes. No other individuals were added therefore no one other than the study personnel had access to participant data.

Interobserver Agreement (IOA)

IOA was not collected since the data was collected by the Cyclemeter application. Cyclemeter uses the phones A-GPS system in order to track the riders and collect data on the ride. The iPhones A-GPS automatically calculated speed (distance/time). Zandbergen (2009) conducted a study that showed that the A-GPS data had an average accuracy of 8 meters. Therefore, as the A-GPS tracks the phone it can calculate the phones position at any given time to an average accuracy of 8 meters.

Experimental Design

A non-noncurent multiple baseline across participants design was used to evaluate the effects of the intervention in this study.

Procedures

Baseline/standard. Prior to baseline the researcher conducted a video conference with each participant to train him on the Cyclemeter app. Each participant was provided with a task analysis of how to download and use the app for each session (See Appendix E). They were instructed how to download the Cyclemeter app, open the app, upgrade to Cyclemeter Elite, how to select a route, and how to press start before they went on a ride. In order to ensure the participants acquired all of the steps for using the app, the participants were instructed to complete all steps a minimum of three times at 100% accuracy (without feedback or help from the researcher) during the video conference. After completing the baseline training participants cycled using the Cyclemeter app without the in-vivo audio feedback. Participants were instructed to cycle at least twice a week. The Cyclemeter app notified the researchers any time a participant logged a ride. Researchers then went to their email to see the participants DVs for each cycling session. The app visually displayed their current speed, distance, and time. However, participants were instructed to keep the phone in their pocket throughout the ride and participants could only see their performance after they finished each ride. Researchers recorded data from the auto generated email, but otherwise did not initiate contact with the participants after they were trained on the app. Participants were able to contact the researcher with questions about the app or to let the researcher know that they were having trouble biking some weeks due to weather. This occurred on a couple of occasions for Stu and Allen but did not occur for Phil.

In-vivo audio feedback. Prior to this phase participants had another video conference with the researcher to train them on the in-vivo audio feedback announcements in the Cyclemeter Elite app. Each participant was provided a task analysis that described the steps to using the in-vivo audio feedback announcements (See Appendix F). Each of the steps were described during the video conference. Similar to baseline each participant was instructed to complete all steps a minimum of three times at 100% accuracy (without feedback or help from the researcher) during the video conference in order to complete training. During this phase, the participants were given audio feedback every 5 min directly from the app on their current speed, average speed, ride time, distance, and their time and distance ahead of their best, median and worst rides. Once the in-vivo audio feedback announcements setting was set up the participant received the feedback automatically during their cycling sessions. Again researchers recorded data from the auto generated email, but otherwise did not initiate contact with the participants. As in baseline, participants could contact the researcher with questions about the app or to let the researcher know that they were having trouble biking due to weather. Both Stu and Alan had some issues with weather and Stu was unable to bike for a couple of days due to an event that was being held that blocked his cycling route.

Treatment Integrity

An audio recording was made during both video conferences to train participants on the Cyclemeter app. A second researcher scored the researcher conducting the training using the checklist for baseline and intervention (Appendix E and F) on whether or not all steps were explained/described correctly during the video conference. Treatment integrity was calculated for each video conference by dividing the number of completed steps by the total number of steps on the checklist. Treatment integrity was calculated for 66% of the trainings and a score of 100% was achieved for all scored trainings. Since 100% fidelity was always met, additional video conferences were not necessary.

Social Validity

Participants were given a 10 question survey at the end of the study to assess their opinions about the benefits of the intervention and the study procedures (Appendix G). Seven questions were asked and participants rated their responses on a 5 point Likert type scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree) and for each question they were also asked to explain why they scored the question the way they did. Three additional short answer questions were asked to assess what the participants liked most and least about the study.

CHAPTER THREE:

RESULTS

All three participants in the study showed improvement in their average speed with the in-vivo audio feedback intervention. Small but variable improvements in the average speed of each ride were observed for all participants during baseline; however, only Phil had an overall positive trend during that phase. Once in-vivo audio feedback was implemented all three participants showed increases in their average speed with less variability. Figure 1 shows the results for Phil, Stu, and Alan. Phil had an increase in average speed from a baseline mean of 12.95 MPH to a mean of 15.11 MPH in the last three sessions of intervention. Phil also had an improvement in the rate at which he increased his average, which is shown by the trend lines in Figure 1. The data shows a change in slope with an R score of positive 0.380. Stu increased his mean average speed of 12.95 MPH from the last three sessions of baseline to a mean of 15.11 MPH in the last three sessions of intervention. He had a slight negative trend during baseline that flipped to a positive trend during the in-vivo audio feedback intervention giving yeild to an R score of negative 0.551. Stu had one outlier data point during baseline and two during intervention. We were able to look at the weather data from the Cyclemeter app and it showed that he was riding with very favorable tail winds during the session two ride. Stu also had one difficult ride into 18 MPH head winds for ride 17. Alan had a mean average of 15.76 during his last three baseline session. He improved to a mean of 17.68 during the last three sessions of the intervention. Alan had a fairly stable baseline with a slight decreasing trend. This trend also reversed and became positive and maintained stability when in-vivo audio feedback was introduced. His data shows an R score of positive 0.005.

The social validity questionnaires showed that all three participants enjoyed participating in the study (5), were happy with their individual results (4.3), and found the In-Vivo feedback helpful during the rides (5). All three participants also indicated they were likely to continue to bike after the study. Phil and Alan liked that they could use the in-vivo audio feedback to compete against themselves. Stu said he enjoyed being able to see the improvements he made after each ride. When asked what the participants liked the least about the study they all had different answers. Phil said he thought the feedback every 5 minutes was too much. Stu said he did not like having to ride the same route every ride. Alan did not like not being able to look at the phone screen and see its readout during the ride.

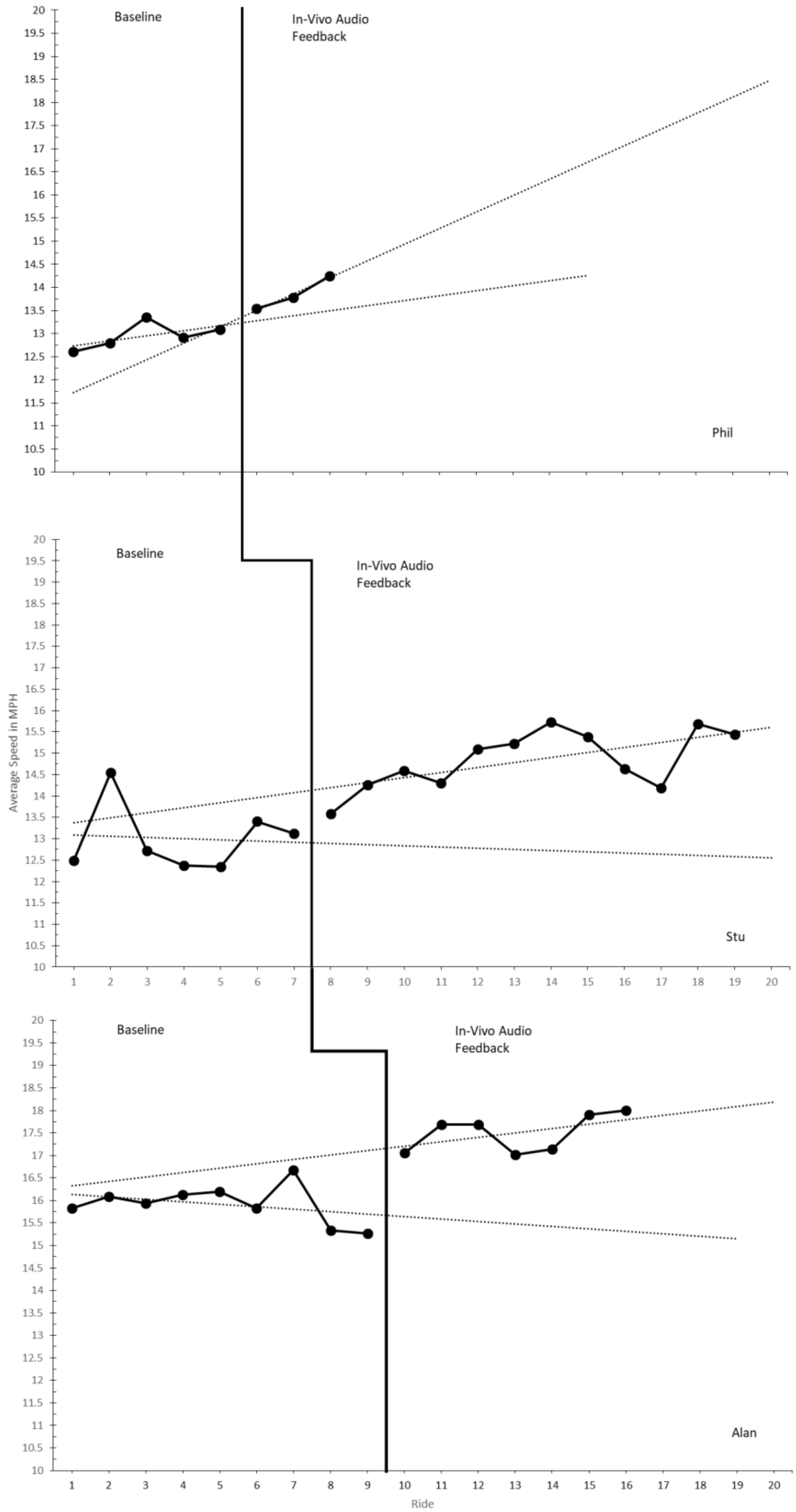

Figure 1. Speed in miles per hour for Phil (top), Stu (middle) and Allan (Bottom).

CHAPTER FOUR:

DISCUSSION

The purpose of this study was to examine the effects of in-vivo audio feedback on improving the cycling speed and rate of improvement for three cyclists. All three participants had different data patterns during baseline but all showed substantial improvements between rides and an overall improvement once in-vivo audio feedback was added in the intervention phase. This indicates that in-vivo audio feedback was an effective tool for improving sports performance for cycling. One major advantage to using audio feedback with an application, such as the one used in this study, is that can be automatically programmed and does not require a coach or trainer resulting in a very cost effective intervention. Behavioral coaching and BST strategies like the ones used in Shapiro and Shapiro (1985) and Smith and Ward (2006) can be very time consuming and require much more set up and personnel than an in-vivo audio feedback system like the one used in this study.

The social validity questionnaire given to the participants after they completed the intervention showed very high social validity. All participants indicated they liked participating in the study, were happy with their results, and that they would keep riding after the study concluded. They also indicated that the Cyclemeter app and in-vivo audio feedback was very helpful for them to stay motivated by competing with their paces from past rides and keeping track of their distance. This made every training session feel like a race against themselves and their prior speed on previous rides. This is also a competitors feature in the app that would let participants import rides that other cyclists have done. Future research could evaluate the effectiveness of having a virtual competitor to bike against during training to improve average speed.

This study had three male participants that varied in age, weight, and geographic location. Future research should evaluate the use of in-vivo audio feedback for different types of participants including females and differing levels of cyclists such as professional and semi-professional cyclists to promote generalization across subjects. The setting of the participants can also create difficulties when evaluating the data. Due to the participant's locations in Tennessie, D.C. and Florida, the research team could not be present to view any portion of the participant's rides during baseline or intervention. However the technology involved in this study made it possible to collect accurate data from participants in multiple distances spanning much of the U.S. without the research team needing to go visit the participants. The participants also cycled outside with variable weather conditions that could certainly influence results, such as wind direction and excessive cold or heat. Head and tail winds may have affected several of Stu's rides and created some variability in his data. We also had to stop collecting data with Alan because it started to snow up in D.C. and he could no longer participate. Future research may want to evaluate in-vivo audio feedback on cycling on an indoor track or on stationary bikes to better control for outside variables.

There was one unexpected result during base line with was two of the participants having overall negative trends. The research team expected all the participants to have a somewhat stable and upward trend in baseline however that was only the case with Phil. While Phil had an upward trend it was gradual and stable which is what one would expect when someone is trying to improve their cycling performance. The team throughout that we would see a greater trend once intervention was introduced which is what happened.

Future studies should consider extending the length of the intervention to determine if in-vivo audio feedback maintains high cycling speeds once a maximum speed level is reached. Unfortunately, for one participant (Phil), his intervention was only three rides. While he showed a substantial increase in his average speed, we were not able to continue to collect data due to his cycling trip starting. Collecting data during this trip would have added many confounding variables that would invalidate any data for intervention and later generalization probes. On the trip he was biking an average of 75 miles a day instead of the 20 miles he was doing for the study. He was also riding in a pace line during the trip. This allows the cyclist to not have to deal with head wind and even draft of the cyclist in front of them can give them more speed. The pace line also keeps you motivated to maintain pace with your line members. Lastly he was biking every day which is a much more rigorous schedule than the twice a week required for this study.

In conclusion in-vivo audio feedback was effective for all three participants. Large increases in all three participants' trends are observed once the in-vivo audio feedback was introduced. All participants also showed a much higher average speed than what would be projected if they would have kept biking in baseline without the introduction of in-vivo audio feedback. The participants also rated the intervention's social validity highly for its results, accessibility, and usability.

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APPENDICES

Appendix A: The Physical Activity Readiness Questionnaire (PAR-Q)PAR-Q

Regular physical activity can be fun and healthy, and increasingly more people are starting to become more active every day. Being more active is very safe for most people. However, some people should check with their doctor before they start becoming much more physically active.

If you are planning to become much more physically active than you are now, start by answering the seven questions in the box below. If you are between the ages of 15 and 69, the PAR-Q will tell you if you should check with your doctor before you start.

Common sense is your best guide when you answer these questions. Please read the questions carefully and answer each one honestly: answer YES or NO.

1. Has your doctor ever said that you have a heart condition <u>and</u> that you should only do physical activity recommended by a doctor?

2. Do you feel pain in your chest when you do physical activity?

3. In the past month, have you had chest pain when you were not doing physical activity?

4. Do you lose your balance because of dizziness or do you ever lose consciousness?

5. Do you have a bone or joint problem (for example, back, knee or hip) that could be made worse by a change in your physical activity?

6. Is your doctor currently prescribing drugs (for example, water pills) for your blood pressure or heart condition?

7. Do you know of <u>any other reason</u> why you should not do physical activity?

If you answered yes to any of these questions you will need to check with your doctor before participating in the study.

Appendix B: Participant Information Questionnaire

Name: ________________________________ Age:_____

Height: __________ Weight:________

1. Biggest motivator to engage in exercise (check all that apply):

¨ Lose weight ¨ Improve appearance

¨ Increase muscle ¨ Build endurance

¨ Become healthier ¨ Other (please specify)_____________________

2. How many days a week do you currently bike? _______ How far? ________

3. How many days a week are you able to bike? ________

Please list what times you could bike on each day listed below:

SUN	MON	TUES	WED	THUR	FRI	SAT

4. Could you commit 2 days per week to meet in order to go over the weeks progress and set a new goal? ________

5. How far can you bike right now in one session? _______

6. In approximately 12 weeks how far do you want to be able to bike?_______

7. In the past year what is the farthest distance you biked ________

Approximately how long did that take you ?___________

8. Is there a specific time of the day that you bike your “best”? __________

9. Do you currently own an iPhone? _________

10. What do you prefer to bike on:

¨ Street ¨ Paved Trail

Regular Exercise is any *planned* physical activity (e.g., brisk walking, aerobics, jogging, bicycling, swimming, rowing, etc.) performed to increase physical fitness. Such activity should be performed *3 to 5 times* per week for *20-60 minutes* per session. Exercise does not have to be painful to be effective but should be done at a level that increases your breathing rate and causes you to break a sweat.

11. Do you exercise regularly according to that definition? (please check only one)

- Yes, I have been for MORE than 6 months. ¨
- Yes, I have been for LESS than 6 months. ¨
- No, but I intend to in the next 30 days. ¨
- No, but I intend to in the next 6 months. ¨
- No, and I do NOT intend to in the next 6 months. ¨

Appendix C: Motivation and Abilities Assessment

Please answer each question and sign at the bottom of the page affirming that you have answered each question truthfully.

Motivation

1. How interested are you in improving your average cycling speed?

   1 2 3 4 5

2. How willing are you to put in effort to increase your average cycling speed and participate in this study?

   1 2 3 4 5

3. Are you willing and able to bike at least two times a week?

   Yes No

4. Why are you interested in improving your average cycling speed?

____

____

____

Ability

1. Can you cycle for at least an hour during one session?

   Yes No

2. Can you cycle for at least 15 miles during one session?

   Yes No

3. What is your average speed in miles per hour during a session that is at least an hour long and you go at least 15 miles?____

Appendix D: Recrutment Flier

UNIVERSITY OF SOUTH FLORIDA
COLLEGE OF BEHAVIORAL & COMMUNITY SCIENCES

Looking to *increase* your cycling speed

PARTICIPATE IN A RESEARCH OPPORTUNITY!

Using In-Vivo Audio Feedback to Improve Cycling Performance

USF IRB # Pro00029384

Purpose: Evaluate the effects of in-vivo audio feedback on improving cyclists' speed.

Participants: Individuals between the ages of 18-50 looking to increase their cycling speed.

In order to participate Cyclists must

- be able to commit at least 2 days per week for training (for about 6-12 weeks)
- cycle at least 1hr and go at least 15 miles per session
- be in good health (i.e. no ongoing medical condition that could worsen with physical activity)
- Have an iPhone and road style bicycle

For more information please contact the investigator conducting this research:
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Appendix E: Participant Checklist for Baseline

Instructions: Place a checkmark next to each task that is completed, place an “x” next to any step that isn’t completed.

Downloading Cyclemeter

1. Open the iPhone App Store
2. Select Search
3. Enter Cyclemeter into the search bar
4. Select Cyclemeter
5. Press Download

Using Cyclemeter

1. Open Cyclemeter
2. Select new route in the upper left corner of the screen
3. Press the + sign
4. Type in name you want
5. Hit done
6. Select the route you made
7. Press Start and GO on your ride
8. Try to use the same route for every ride

For the following rides skip steps 2-5

Percent correct:

Appendix F: In-Vivo Audio Feedback Intervention Instruction Checklist

Instructions: Place a checkmark next to each task that is completed, place an "x" next to any step that isn't completed.

1. Open the Cyclemeter app
2. Select More
3. Select Settings
4. Select Announcements
5. Set time for 5 minutes
6. Edit announcement by clicking the + button at the top right of the screen
7. Add speed/pace, average speed/pace, and from best median worst (time)
8. Remove all other announcements
9. Set distance, end split, and end interval to off
10. Leave on demand set to on iPod pause
11. Before rides plug in headphones and put them in your ears
12. Start ride as normal

Percent complete:

Appendix G: Social Validity Questionnaire

Please rate the following:

1. I enjoyed participating in this study:

☐ Strongly Disagree ☐ Disagree ☐ No Opinion ☐ Agree ☐ Strongly Agree

Why:____

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

☐ Strongly Disagree ☐ Disagree ☐ No Opinion ☐ Agree ☐ Strongly Agree

Why:____

3. The In vivo feedback procedure helped to keep me motivated throughout each ride:

☐ Strongly Disagree ☐ Disagree ☐ No Opinion ☐ Agree ☐ Strongly Agree

Why:____

4. The performance feedback I received was a helpful during the and on following rides:

☐ Strongly Disagree ☐ Disagree ☐ No Opinion ☐ Agree ☐ Strongly Agree

Why:____

5. The Cyclemeter app was a beneficial way to keep track of my distance:

☐ Strongly Disagree ☐ Disagree ☐ No Opinion ☐ Agree ☐ Strongly Agree

Why:____

6. I plan to keep biking even after the study concludes:

☐ Strongly Disagree ☐ Disagree ☐ No Opinion ☐ Agree ☐ Strongly Agree

Why:____

7. My overall opinion of the study:

☐ Great ☐ Good ☐ Okay ☐ Bad ☐ Very Bad

Why:____

8. What did you like MOST about the study?

9. What did you like LEAST about the study?

10. Further Recommendations:

Appendix H: Data Sheet

Participant	Date & Time	Treatment Phase	Average Speed