

USING *MOBILE* Devices FOR Motor-learning



Laboratory Exercises

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HISTORICALLY, LABORATORY EXPERIMENTS HAVE BEEN USED to help physical education students better understand various motor learning-related concepts. A solid understanding of motor learning theories and concepts should help future teachers and coaches perform successful, real-world applications. At many institutions access to motor behavior laboratories and/or equipment is not possible due to space or budget constraints. The apparatuses traditionally used in such laboratories, such as rotary pursuits, tapping styluses, and mirror tracing devices, are not readily available. Even as such apparatuses are referenced in lab manuals and journals, the apparatuses are not accessible or practical. Also, online courses are growing in popularity, and this presents another situation in which traditional lab equipment would not be available. Consequently, alternatives must be used. Some published and many unpublished lab manuals used at the university level have adapted various lab experiments by incorporating readily available equipment such as pens and paper, tennis balls, rope, stopwatches, and rulers. There are also options for using desktop computers with software and online experiments in place of bulky and expensive lab equipment (McGraw, Tew, & Wiliams, 2001).

Another alternative is the use of mobile devices such as smartphones and tablets. Many students, without requiring them, already bring devices to class every day, and the number of students using mobile devices is almost certainly going to increase (Ireland & Woollerton, 2010). In addition, mobile devices can be

transported and taken home so that experiments can be conducted with various subjects and in various settings. Such portability has been shown to foster a more learner-centered environment and to lead to greater levels of student autonomy (Attard, 2011; Kukulska-Hulme, 2013). Understood is the fact that mobile devices and the associated applications (apps) are not always suitable for rigorous research. To name a few confounding variables, the speed, responsiveness, and resolution of the screen and the reliability of the application can vary from one device to another. However, for the very basic, elementary laboratory experiments found in a typical motor-learning laboratory manual, mobile devices should be more than adequate. Furthermore, students should always be ready to offer explanations when lab results are not as expected.

As with all newer technologies, teachers should always be cautious of misguided tendencies to use technology for the sake of using technology, with little regard for learning outcomes. Wieder (2011) referenced some of the challenges associated with the use of mobile devices in the classroom: the high cost for equipment that gets little use, an increase in off-task behaviors, and clumsy note-taking that is more time-consuming. Despite the challenges, mobile devices have been useful in providing motor-learning laboratory

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exercises for undergraduate university students. The majority of the time spent using mobile devices for motor learning labs is outside of class, so many of the challenges associated with the use of mobile devices are nonissues. Three ideas for the use of mobile devices to help students better understand motor learning concepts will be presented. These simple labs are used in a university introductory course and could be used with high school students as well. These three labs, in particular, were chosen because the concepts covered have been included in the physical education Praxis exam that all teachers must pass in several states to get certified.

The three examples that follow are intended to reinforce a few basic but important concepts related to motor learning. In particular, questions regarding Hick's law and Fitts's law have been included in the physical education Praxis test, so a thorough understanding is necessary. Admittedly, these labs only require the use of fine motor skills, and the ultimate goal is for physical educators to be able to apply such concepts to teaching the various gross motor skills needed for the sports and activities they are sure to coach and teach. Ideally, there will be many more opportunities in methods classes and elsewhere for students to apply motor learning theory to help others acquire and improve sport skills. Nonetheless, these types of lab exercises can reinforce important concepts and build a base for practical application.

Hick's Law

Schmidt and Wrisberg (2004) observed that Hick's law "describes the stable relationship that exists between the number of stimulus-response alternatives and choice reaction time; specifically, as the number of stimulus-response pairs increases, choice reaction time increases in a linear fashion" (p. 61). A teacher or coach who understands Hick's law is in a better position to instruct players. For instance, at a crucial point in a tennis match a knowledgeable coach might instruct a player returning a high-velocity serve to assume a continental grip (between a forehand and a backhand) and return the ball to the middle of the opponent's court, regardless of where the serve lands. By reducing the number of possible responses, the player will be able to react faster.

Many older lab manuals call for the use of a chronoscope. The subject is presented with either a visual stimulus or an auditory stimulus, which also starts the timer. When the subject responds by pressing a button, the timer stops (Carron, 1971; Lockhard & Johnson, 1977). Purchasing, housing, and maintaining such equipment is just not practical for some schools. One alternative is an app from Apogee Studio (2013) called Check Your Reaction. Using this app, one can set the difficulty level on *easy* before playing a game that calls for simple reactions. The first 10 attempts are scored and averaged. When the difficulty level is set to *hard* or *insane*, the students can measure choice reaction times. This is the simplest of all choice reaction-time experiments because it simply calls for the student to react or not react, often called a "go/no go" reaction. This particular app is useful because it lists the reaction times on the screen, and students can easily use them for writing

up lab results. While the entire lab handout is not shown, Figure 1 represents portions of the lab that relate to the mobile app by showing typical responses.

Fitts's Law

Fitts's law is commonly known as the law that describes the speed-accuracy tradeoff. Fitts's law states that "movement time is linearly related to the index of movement difficulty" (Schmidt & Wrisberg, 2004, p. 163). Movement difficulty can be altered by adjusting the size of the targets or the distance between targets. All physical educators struggle with questions of accuracy versus speed tradeoffs. As one of thousands of examples, teaching a new tennis player how to balance the need to serve the ball into the box with the need to produce enough velocity to maintain an offensive advantage requires knowledge of this accuracy versus speed tradeoff.

Some lab manuals contain lab exercises that require students to use a handheld stylus and a tapping board to record the speed and accuracy with which subjects can tap the targets (Carron, 1971; Husak & Young, 1988). The experiments are essentially no different from those performed by Fitts himself in his landmark experiment. One alternative is an app called Ultra Reaction by Fabio Bassan (2012). In particular, the *responsive activity* was used. Students first complete the task under the *medium* condition (large targets closely spaced) and then again under the *ultra* condition (small targets with greater spacing). After five targets are hit, an average time is provided. If at any time a target is missed, there is a "game over" message, and no average time is given. Students can easily get friends, family, and peers to complete the tasks while recording the average times and the number of errors. This information can then be used for writing

up lab reports. Screen captures of the app are shown in Figure 2. Typical student responses to lab portions relating to the Ultra Reaction app can be seen in Figure 3.

Massed versus Distributed Practice

Massed practice is used to describe practice situations where the amount of time spent practicing is greater than the amount of time spent resting. Distributed practice occurs when one spends more time resting than practicing (Fairbrother, 2010). Many lab manuals use a mirror tracing task for labs that focus on distribution of practice time (Lockhard & Johnson, 1977; University of Northern Iowa, 2010). Such tasks can be done on a computer or with pen and paper; however, the setup for the pen and paper method is cumbersome. Typically, continuous skills are used to study the influence of massed or distributed practice. That is why the Labyrinth Lite app (Codify AB, 2012) is an acceptable alternative for lab exercises focusing on distribution of practice time. Most of the levels take about five to 30 seconds to complete, depending on the participant's skill level. The subjects in the massed group simply continue



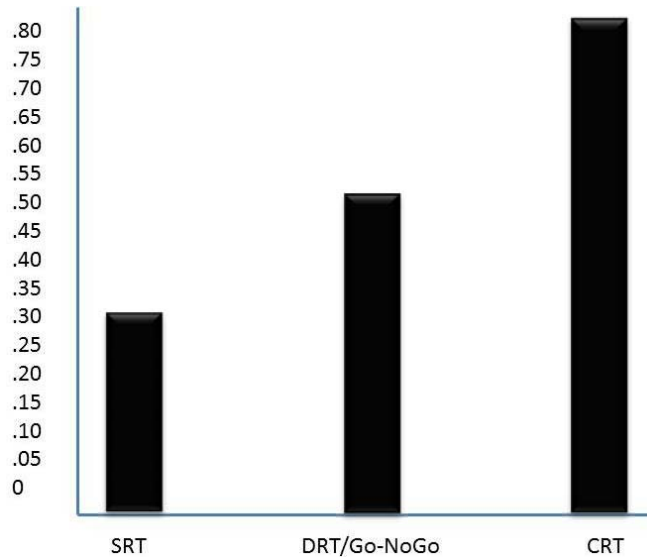
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Hick's Law Lab

Record and graph the mean reaction times. Although the Check Your Reaction Time app does not allow you to measure your choice reaction time, estimate on the graph what your choice reaction (4 possible choices) time might be.

Simple Reaction Time (easy level): .318

Discrimination Reaction Time (Hard level): .521



1. Based on what you know about reaction times from the information presented in class, does the graph look like you would expect? Explain. *Yes, the graph shows that as the tasks required more decision making, processing time increased and thus reaction time increased.*
2. How could this app be changed to include a choice reaction time test? What would the graph look like if we could keep adding tasks with more and more response alternatives? *Instead of having just one circle to tap, you would need 2,3,4... circles that could be tapped when a specifically assigned color was shown on the screen. When you see green you are supposed to tap circle 1, when you see blue you are supposed to click circle 2, etc... As you increase the response alternatives the reaction times would continue to get larger, but not by much because the increases would be logarithmic like this:*



3. If **reaction** time is an *ability*, why do baseball and softball players get better at **responding** to fast pitches as they practice? *1) Response time may improve due to an improved movement time as they get stronger and more coordinated. 2) Better players get experience at anticipating what and where pitches will be thrown. They can often rule out certain pitches by knowing the situation or spotting clues from the pitcher's motion. This basically reduces the number of decisions they have to make, which will reduce reaction time.*

Figure 1.
Typical lab results and write-up for the Hick's law lab

practicing for a set period of time. Once the level is completed, the option is given to go to the next level; there are 10 levels in all. At any point the user can quickly tap the screen and see arrow keys that take him or her back to the previous level. Therefore, a single

level can be repeated as many times as desired. Subjects in the distributed group simply rest for 30 seconds between each attempt. The experimenter can record errors (the ball falls through the holes), the time needed to complete the level, or some combination

of the two. After participants from each group have made a predetermined number of attempts, a never-before-seen level can be used as a transfer task. One of the *hard* levels can be used for the transfer task. If a retention task is possible, one could just repeat the same level used for all the practice trials several days later. The typical lab results are shown in Figure 4.

Benefits and Limitations of Using Mobile Devices

When more traditional means of providing motor-behavior laboratory experiences are not available, mobile devices may provide acceptable alternatives. The use of mobile devices with free or inexpensive apps can be educational and meaningful. This was not unexpected, as studies conducted in other disciplines where mobile devices were used in lab settings have also shown positive learning outcomes (Powell et al., 2011; Wong, Chao, Lien, & Wu, n.d.). One benefit of using mobile devices is that every student must assume responsibility for leading the experiment. The author's experience has shown that in many of the lab exercises performed in class, certain students tend to watch and participate minimally

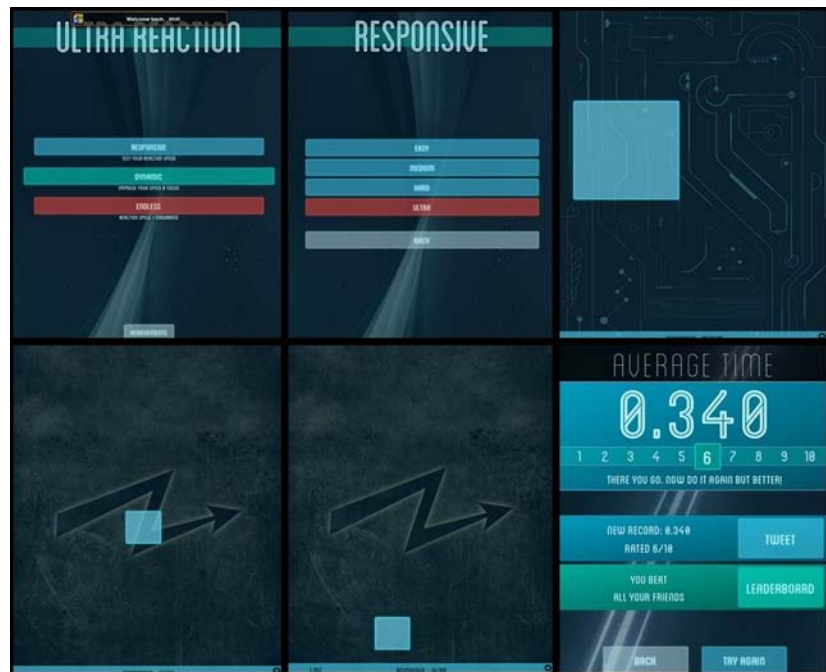


Figure 2.
Screen captures of the app used for Fitts's law experiment

From Ultra Reaction (version 1.1), © Fabio Basson. Reproduced by permission of Fabio Basson. Permission to reuse must be obtained from the rightsholder.

Fitts's Law Lab

Record the average reaction times using the Ultra Reaction app.

Average Reaction Time (medium level): .339

Discrimination Reaction Time (Ultra level): .462

1. Based on what you know about the speed-accuracy trade off, are the results what you would expect? Explain. *Yes, the medium level had targets that are larger and spaced closer together while the ultra level presented smaller targets that were spaced farther apart. To be accurate at the ultra level I had to slow down a little bit.*
2. Give an example of a motor skill that follows Fitts's Law. *walking on a balance beam. The faster a person moves, the more difficult it is to maintain balance. The speed is how quickly you move and the accuracy is where you place your feet.*
3. Give an example of a motor skill that does not follow Fitts's Law. *Hitting a baseball might not completely follow Fitts's law because it requires a very forceful swing and it requires the hitter to time the swing so that the bat is over the plate at the exact same time as the ball. Some researchers show that for such skills moderate force (50%) is actually less accurate than maximal force (85%).*

Figure 3.
Typical lab results and write-up for the Fitts's law lab

Massed vs. Distributed Practice Lab

- Record the scores for both groups in the Excel template. The time is displayed on the finish screen but be sure to add four seconds for each error. For instance, if it takes a subject three tries to complete the level and his final score is 17.25, you will add eight seconds for the first two errors and the recorded score will be 25.25. Both groups will repeat Labyrinth Lite level 2 until a total of nine trials have been completed. The transfer task will be lite level 9.

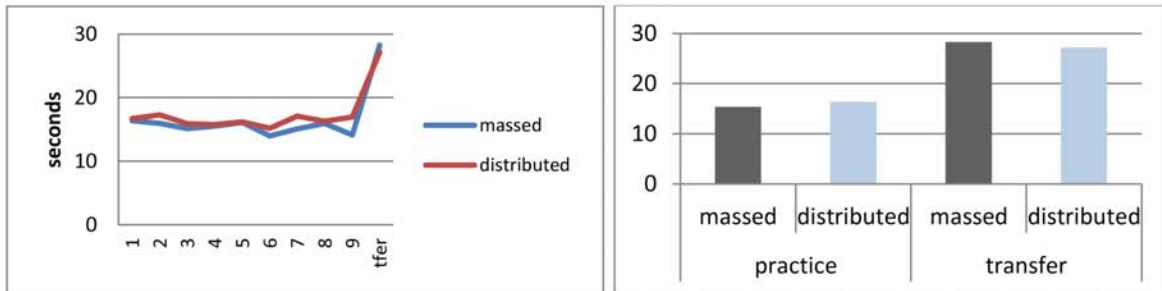
Massed practice group: There is no rest. When one practice trial is done, begin the next one.

Distributed practice group: The subject must rest for 30 seconds after each practice trial.

	Massed Group				
	Mike	Jarrold	Sean	Roland	average
trial 1	16.23	17.33	15.23	16.78	16.39
trial 2	15.78	17.26	14.29	16.52	15.96
trial 3	14.16	16.33	14.76	15.245	15.12
trial 4	14.57	15.22	17.45	14.895	15.53
trial 5	14.67	15.87	18.55	15.27	16.09
trial 6	13.68	14.45	13.78	14.065	13.99
trial 7	18.24	14.29	13.87	13.98	15.10
trial 8	13.73	18.08	14	18.015	15.96
trial 9	14.01	13.89	14.56	13.95	14.10
average	15.01	15.86	15.17	15.41	
Transfer	25.93	34.03	25.95	27.07	28.25

	Distributed Group				
	Sara	Joseph	Nick	DeShawn	average
trial 1	14.59	19.18	17.7	15.34	16.70
trial 2	16.94	18.92	17.35	16.01	17.31
trial 3	14.75	17.645	15.92	15.21	15.88
trial 4	14.83	17.295	15.92	14.92	15.74
trial 5	14.91	18.36	16.57	14.83	16.17
trial 6	14.23	16.465	15.07	15.02	15.20
trial 7	14.93	18.665	18.46	16.39	17.11
trial 8	16.93	17.65	15.69	14.88	16.29
trial 9	20.84	16.35	15.18	15.43	16.95
average	15.88	17.84	16.43	15.34	
Transfer	23.97	30.09	28.94	25.68	27.17

- Use the data to create two graphs expressing the findings.



- Did the data look like you expected? Yes and no. The massed practice group performed slightly better in the practice sessions and the distributed group performed slightly better on the transfer task and this was consistent with what we learned in class. The better performance on the transfer tasks indicates that the process or "forgetting and relearning" that occurs with distributed practice paid off and those subjects actually learned the skill better. However, I thought the differences would be greater and I thought that the times would decrease from practice trial 1 to 9 as the subjects practiced more. The line graph looks pretty straight though.

Figure 4.
Typical lab results and write-up for the massed versus distributed practice lab



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or only when required, while other students take the lead. For instance, when a student is responsible for organizing and explaining the procedures for the experimental group and the control group, that student develops a deeper understanding of the concept being examined. Additionally, the students seem to enjoy involving friends and family in the experiments. A fact that should not be dismissed is that attitude is an important factor when getting students to buy into using the mobile devices for lab experiences (Cheon, Lee, Crooks, & Song, 2012). Students were also more likely to conduct the experiments honestly, since all the necessary supplies were literally in the palms of their hands. Lab exercises could be carried out anytime, anywhere.

Using mobile devices will not be the best solution in every instance. Since most students are planning on coaching and teaching, it is beneficial to include several lab activities that require gross motor skills and more sport-specific skills. Many motor behavior concepts are simply better learned with standardized equipment in class with the instructor available to help. As with any homework, the possibility that some students may not complete the assignments or falsify the results in some way should be considered. The more familiar the teacher becomes with the apps, the better able he or she will be to offer advice and detect instances when students might not be executing the labs in good faith. Studies have indicated the importance of instructor familiarity for student learning with mobile devices (Mang & Wardley, 2012).

Barriers to using such apps do exist. The author has had to deal with off-task behaviors as students “play” on their mobile device. Generally, those types of behaviors have been limited to lecture time, and once in-class lab work begins the students have had to stay on task to finish in a timely manner. When allowing the students to perform these three labs as homework, it is a nonissue. There have also been instances when different versions of the app have caused confusion. The iPhone version may not look and operate exactly like the iPad version or the Android version. These issues were normally addressed quickly on a case-by-case basis.

On rare occasions a departmental iPad needed to be loaned to a student who did not have access to a usable device. When using mobile devices, connectivity disruptions can also be a problem. Fortunately, the apps discussed here do not require a Wi-Fi connection to operate; once downloaded, they can be used from any location. Typically, students do not use their mobile devices during class as they are normally charged with performing the experiments outside of class. Never has any student been required to purchase a mobile device for a course. To date, they have all had access to one or have been able to borrow one from the department.

Conclusion

There are occasions when the use of mobile device apps can enhance learning in physical education courses that address motor learning. Even if

only a few lab experiences are offered via mobile device, they can be beneficial for make-ups or extra credit or just to supplement the traditional labs performed in class. The author’s experiences so far have been positive, and the process is evolving. For example, students have started using screen captures and video clips as evidence that the labs were carried out. The responses to the lab questions have been of the same quality seen in the more traditional labs. In summary, there are several benefits to using mobile devices in teaching motor learning concepts; the effort spent researching the apps and creating the labs is well spent. Lab exercises performed on mobile devices can be a useful tool in a teacher’s toolbox.

Any experience that leads a student to a solid grasp of the theoretical concepts will likely allow that student to make better choices when teaching skills. For example, a better understanding of Hick’s law has countless applications. The ability to help a young fielder eliminate response alternatives will allow him or her to react quicker and more confidently. The same can be said of a tennis player returning a serve or a batter awaiting the pitch. An understanding of Fitts’s law can be especially useful for someone teaching beginners. Slowing the speed and increasing the target size has helped many youngsters learn tennis quicker and more efficiently. Last, the idea that distributed practice can produce superior learning also has infinite applications. As one example, those who are just learning to swim might be taught to think about their strokes. The distributed practice schedule allows them to improve without getting as tired or drifting into poor technique; plus they learn to assess their own performance and do not rely on a coach as a crutch. Using lab questions and discussions to promote practical application is crucial. Although the apps used were probably created as fun, time-diverting games, the concepts to be learned and applied later must be stressed and reinforced. Whether using a reaction app on an iPad or completing a mirror tracing task, it is up to the teacher to reinforce the learning objectives and prevent the task from regressing into just a “fun game” with no educational benefit.

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