The Bowtie Effect: Imitation Learning in Adults

Emily Mager, Allison Maki and Holly Morgel

St. Catherine University

Abstract

48 traditional college aged females participated in this study to identify whether imitation learning had a higher quality from audio, written, demonstration, or demonstration with audio conditions. The participants were given the task of tying a bowtie in each of the above conditions and rated first on confidence by themselves and followed on the same rating scale of quality by researchers. It was found that the task was completed with better quality when the participants were presented with the task with demonstration (video) and audio.

The Bowtie Effect: Imitation Learning in Adults

The use of observation and imitation has been thought to be a "common and effective way for humans to learn new behaviors" (Gold, Pomplun, Rice, & Sekular, 2008). While most of the research on observational and imitation learning has been performed on children and animals, there is also research examining the usefulness, effectiveness and complexity of observation and imitation as a learning technique for adults. Is the use of imitation as a means to learn new behaviors an adequate learning technique for adults?

Literature Review

The research on observational and imitation learning in adults has many variables which need to be considered such as the comparison between age groups in adulthood, complexity of the task to learned and whether it is a task requiring the use of motor processes or not, and the rating of the effectiveness of the demonstration to be imitated. Studies examining imitation learning have used these as well as many other variables in the attempt to conclude whether or not observational and imitation learning is effective in adults compared with other learning techniques.

According to a study by Menz, McNamara, Klemen, and Binkofski (2009), imitation "consists of observation and later reproduction of voluntary actions." This is a very basic description of what imitation is. The human processes involved in the actions of imitation are much more complex and the study of imitation can provide "insights

into the complex processes of human actions" (Menz, et al. 2009). This may be one reason why so many researchers have examined the use of imitation learning in children, animals, and adults.

Results from one study by Blandin, Lhuisset, and Proteau (1999) suggested that "observation engages one in cognitive processes similar to those occurring during physical practice." This implies that even just watching a demonstration of an action triggers learning processes very close to those in place when actually imitating the action. Data from their study indicates that just observation of a model without physical imitation results in modest learning.

The ideomotor theory is referenced in a study performed by Aicken, Wilson, Williams, and Mon-Williams (2007). This theory "suggests that observing someone else perform an action activates an internal motor representation of that behavior within the observer" (Aicken et al. 2007). This theory closely correlates with the findings of the Blandin (1999) study. Both state that observation may result in a learning process or motor representation that closely resembles the action that is being observed. Both studies indicate that imitation, whether within or out of a learning environment, may lead to some degree of learning, even without physical practice.

Maslovat, Hodges, Krigolson, and Handy (2010) performed a study addressing the disagreement about observational practice effectiveness in the acquisition of novel coordination skills. Their study examined the effectiveness of observational practice compared with physical practice and they found that the observational group did not

differ from the physical practice group in performance measures. They concluded that observation of an action can be an aid in perception, but for the use of observational learning to be fully effective, physical practice of the observed action is also necessary.

Some researchers have come up with models of imitation processes. One of these models was studied by Tessari and Rumiati (2004) who were examining factors which can influence the selection of imitative strategies, particularly in relation to patients with brain damage. Their model suggests that there are two routes to imitative processes; either direct imitation which results in the production of meaningless actions, or imitation which is based on our semantic knowledge of familiar meaningful actions. They found that "imitation of meaningful actions is superior to imitation of meaningless actions when the two action types [meaningless and meaningful] are presented in separate blocks" (Press & Hayes, 2008). This means that imitation of actions that hold a particular meaning are freer of errors than the imitation of actions which are meaningless to the observer.

Press and Hayes (2008) also discussed a similar two-route model in which there's a direct visuospatial route which can mediate both meaningful and meaningless actions, as well as an indirect semantic route responsible only for meaningful actions. Press and Hayes wanted to investigate whether the selection of routes is strategic or stimulus driven. The results corresponded with the findings of Tessari and Rumiati in that selection appears to be mostly stimulus driven; if the action is meaningless, a direct route will be followed, but if the action is meaningful, an indirect route using semantic

knowledge may be followed leading to less errors and superiority over meaningless actions.

Another study related to the study performed by Press and Hayes (2008) looked at the influence of past experience on imitation (Spilka, Steele, & Penhune, 2010). The past experience used in this study was musical training and how that can influence imitation of simple sign language gestures. Participants with musical training were found to be more accurate in their imitations when asked to imitate the gestures immediately after their presentation than participants with no musical training, perhaps due to the fine motor skills involved in experience with musical training. The idea that past experience, in this case the motor skills involved in musical training, can influence imitation links with Press and Hayes's indirect semantic route to reproduce meaningful actions. If there is a subconscious link between semantic knowledge and an action to be imitated, that action will become more meaningful and acquisition and retention of that action should be improved.

Spika, Steele, and Penhune (2010) also mention the generalist theories of motor imitation in their study which "explain imitation in terms of links between perceptual and motor action representations that become strengthened through experience." As a particular motor action is being observed and imitated, internal links are made between what is being observed and what is physically being replicated. These links get stronger as a person repeats this imitated action. This indicates that with repeated exposure to the demonstration with physical practice, imitation becomes more accurate.

Many studies emphasize the indication that repeated exposure to a demonstration both before and during physical practice of the action improves acquisition and retention of the imitated action (Weeks & Anderson, 2000). A group of 10 participants were shown a demonstration 5 times before beginning practice as well as five times again shortly after practice began. This group was found to have the best rating scores compared with two other groups of equal size given either only pre-practice demonstrations, or demonstrations interspersed throughout practice attempts.

Age can play a role in how effective imitation learning can be. Hayes, Hodges, Scott, Horn and Williams (2007) performed a study in which, during one part of the experiment, adults and children were asked to imitate a video model of a movement skill. The adults in the experiment performed more accurately than the children, in general. In a latter part of the study, adults and children were shown either a video or a point-light display of the same action. The adults performed equally whether viewing the video or point-light display, but the children who viewed the point-light display performed much poorer than the children who had viewed the video. This results indicate that adults are more effective in using imitation as a learning technique than children, even when using a more abstract form of demonstrating the action.

Another study addressing age differences in imitation learning was by Maryott and Sekuler (2009) who investigated changes in visual imitation among younger and older adults. In this experiment, both age groups viewed sequences of movements and were then asked to reproduce them from memory. The older adults made more errors

than the younger adults, but were able to retain the gist of the movements. Later experiments show that most of the cause of errors in older adults can be attributed to "reduced ability to accommodate for increases in memory load, likely caused by diminished ability to encode or retain detailed information about movement sequences" (Maryott & Sekuler, (2009). Older adults tend to have a reduced memory load and therefore cannot remember demonstrated movements in as much detail as younger adults can, however the older adults supplemented their memory through the use of abstracted representation. Imitation learning can still be beneficial to older adults, but the effects of age on memory load must be taken into account when this learning technique is used.

Gold, Pomplun, Rice, and Sekuler (2008) note that "the study of imitation has been hampered by the challenge of measuring how well an attempted imitation corresponds to its stimulus model." Hayes et al. (2007) also state that "the effectiveness of demonstrations needs to be judged relative to the task context." When studying imitation learning, measurement of the imitation is a difficult obstacle to get around. A study performed by Mynttinen, Sundstrom, Koivukoski, Hakuli, Keskinen, and Hendriksson (2009) assessed novice drivers and their confidence in their driving competence. The researchers noted that, based on their findings, "When Perceived competence is related to actual competence instead of the skills of the average driver, the majority of drivers are no longer found to overestimate their skills." Instead of using as average as a measuring point, competence and reproduction of a demonstration

should be rated considering that person's own skills and abilities. If a higher standard is used in measuring, then a person's performance may be underscored, which could potentially sway the results. The way imitation learning is measured in an experiment needs to be carefully thought out in order to provide honest results.

Implications for Future Research

It is apparent from the many studies conducted concerning imitation learning that it is generally an effective learning technique for adults. However, there are many different factors to be considered when using imitation learning such as age constraints, the task being learned and its complexity and context, how the information attained from observation is processed and reproduced and how the reproduction is measured. There can always be more research done to examine the effects of these variables on the effectiveness of imitation learning in adults and ways to make imitation learning more effective given the effects of these variables. There is a lack of research directly examining the effectiveness of imitation learning against other learning techniques of motor skills outside of direct observation, such as receiving written or audio instructions on a task. This information might be useful in determining if the use of imitation learning is a more beneficial learning technique for adults than other techniques.

Method

Participants

Forty eight female college students ranging in ages (18-25) and major fields of studies participated in this research project. Participants were presented materials upon signing consent form of participation at different times of the day.

Materials

Students were presented with written instructions, audio instructions, visual (demonstration) instructions, or audio-visual instructions (audio-demonstration). For all conditions participants are given a form to fill out with their age and major field of study as well as their confidence on the task of tying a bowtie so the researchers would be aware of any previous knowledge that may skew the data. The confidence scale was presented in a three point scale of 1= no confidence, 2= slightly confident, 3=extremely confident, where the participant was to evaluate themselves before reviewing any instructions or attempting the task. The written instructions were typed in a numerical list format in a size 12 font (see appendix A). The audio condition was recorded on a separate device (recorder) from a videotaped demonstration condition, but was recorded to coordinate with the demonstration condition in a video lasting 1 min 14s long. The audio instructions were the exact same as the written just read aloud and recorded by one of the group members. The videotaped demonstration was created for this research project and was a recording of one of the group members performing the

task of tying a bowtie. For students participating in the audio condition they would listen to the recorded audio instructions only. For the demonstration they would watch the video on the laptop only and for the audio-visual the participants would have the aid of both the recorded audio and video. After participating in the instructed condition, participants would be given a bowtie made of felt material to then attempt to perform the task they were presented with (tying a bowtie). They were given the time amount of four minutes, but prompted if they felt they were done or could not accomplish the task to let the researcher know and at that time the timer would be stopped and recorded at that time and evaluated once again on a scale of 1, 2, or 3, but this time the researchers would evaluate the quality of the attempt of the participant. This 3 point scale was of our evaluation of the performance in which 1=poor, 2=good, and 3=excellent. For this evaluation we judged that a 1 (poor) would be an incomplete or an attempt lacking any familiar bowtie shape. A 2(good) would be when the participant followed most of the instructions, but seemed to lack the full concept. There was a somewhat apparent bowtie shape. Lastly a 3(excellent) would be a completed bowtie in which you can see the familiar bowtie shape and the steps for the most part were followed correctly.

Procedure

Participants were first told what the task at hand would be and informed of which condition (audio, written, demonstration, or audio-demonstration) they would be a part of. Participants would then be given the form to evaluate their confidence as

well as the consent form to sign off on. Participants were then told how the experiment would work with their particular condition and how it would be presented to them as well as how they would afterwards be allowed to attempt it for up to a four min time period. Participants were tested at different times of the day and asked on a volunteer basis if they would like to participate in a research project. These procedures took place in classrooms, the library, and the dining room. These different locations may lead to some levels of distraction, to which we did not address during the study.

The written instructions were presented on a typed numerical list format with wording similar to the other conditions instructions. They were given to read over the written instructions and then given four minutes to attempt to tie a bowtie. During the four minute period participants were able to give up and stop trying the task or complete the task to the best of their ability. For the audio condition, the participants were given the recorder to listen to the full length of instructions and then given the bowtie to attempt under the same rules as the other conditions (four minutes and ability to give up or finish at any time). Participants in the demonstration condition watched the video on the laptop and then allowed to imitate what they saw in the time period and the audio-demonstration condition participants were to watch the video and use the aid of the audio recorded instructions at the same time to also follow the same imitation instructions.

After the four minute period of time to attempt the task of tying a bowtie or the time until the participant stopped attempting, the researcher would then evaluate the

finished (or unfinished quality of their bowtie on the same sheet that the participant had rated her confidence.

Results

As hypothesized, the condition demonstration with audio was performed with the highest quality. The mean quality rating was 2.5 (*SD*=0.80). The mean quality rating for the demonstration condition was 2.2 (*SD*=0.72). The mean quality rating for the audio condition was 1.58 (*SD*=0.58). The mean quality rating for the written condition was 1.25 (*SD*=0.62). In a one-way ANOVA between quality and condition, there was a statistically significant difference (df=3,44, f=8.44, p<.001). The Tukey Post Hoc shows that the demonstration with audio condition had the best overall quality. It was more significant than the audio condition and the written condition. The second best quality overall was the demonstration condition, it was more significant than the written condition.

The mean confidence rating in the demonstration condition was 1.75 (*SD*=0.62). The mean confidence rating in the demonstration with audio was 1.58 (*SD*=0.79). The mean confidence rating for the audio condition was 1.41 (*SD*=0.51). The mean confidence rating for the written condition was 1.33 (SD=0.65). In a one-way ANOVA between confidence and condition, there was no statistical significant difference (df=3,44, f=0.96, p=0.42).

The mean time for the audio condition was 100.75s (*SD*=31.73). The mean time for demonstration with audio was 93.17s (*SD*=48.92). The mean time for the demonstration condition was 86.83s (*SD*=44.55). The mean time for the written condition was 76.17s (*SD*=45.21). In a one-way ANOVA, there was no statistical significant difference between time and condition (*df*=3,44, *f*=0.70, *p*=0.56).

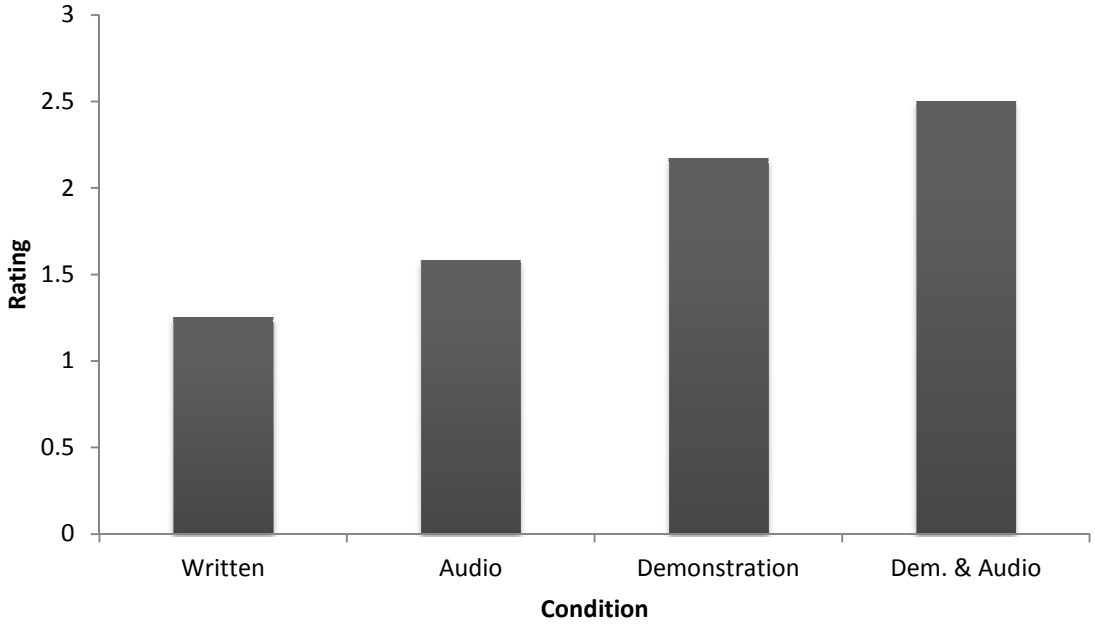

Figure 1. Mean quality scores across conditions.

The correlation between time and quality was not statistically significant (*r*=0.25, *p*=.09). The correlation between confidence and quality was not statistically significant(*r*=0.09, *p*=.57). In the quality ratings the demonstration and audio condition was statistically significant. CHANCE PROBABILITY!

Discussion

These findings support our hypothesis that people learn better when given visual and auditory instruction. The original predictions were supported; the mean quality of the participant's bowties was 2.5 out of 3 for the demonstration and audio condition. Participants in the demonstration alone condition performed second best under demonstration with audio, having a quality mean of 2 out of 3. The difference between these two conditions may be because when demonstration is supplemented with audio, the participants are given more material to use as cues in physical practice as well as more detailed instructions to encode and retain.

Participants in written and audio instruction conditions performed worst. Without any physical cues, as given in the demonstration conditions, the instructions may have been confusing and hard to understand for the participants, resulting in poorer performance.

References

Aicken, M. D., Wilson, A. D., Williams, J. H. G., & Mon-Williams, M. (2007). Methodological issues in measures of imitative reaction times. *Brain and Cognition, 63*, 304-308.

Al-Abood, S. A., Davids, K., & Bennett, S. J. (2001). Specificity of task constraints and effects of visual demonstrations and verbal instructions in directing learners' search during skill acquisition. *Journal of Motor Behavior, 33*, 295-305.

Blandin, Y., Lhuisset, L., & Proteau, L. (1999). Cognitive processes underlying observational learning of motor skills. *The Quarterly Journal of Experimental Psychology A: Human Experimental Psychology, 52A*, 957-979.

Gold, B. J., Pomplun, M., Rice, N. J., & Sekuler, R. (2008). A new way to quantify the fidelity of imitation: Preliminary results with gesture sequences. *Experimental Brain Research, 187*, 139-152.

Hayes, S. J., Hodges, N. J., Scott, M. A., Horn, R. R., & Williams, A. M. (2007). The efficacy of demonstrations in teaching children an unfamiliar movement skill: The effects of object-orientated actions and point-light demonstrations. *Journal of Sports Sciences.Special Issue: Observational Learning, 25*, 559-575.

Maryott, J., & Sekuler, R. (2009). Age-related changes in imitating sequences of observed movements. *Psychology and Aging, 24*, 476-486.

Maslovat, D., Hodges, N. J., Krigolson, O. E., & Handy, T. C. (2010). Observational practice benefits are limited to perceptual improvements in the acquisition of a novel coordination skill. *Experimental Brain Research, 204*, 119-130.

Menz, M. M., McNamara, A., Klemen, J., & Binkofski, F. (2009). Dissociating networks of imitation. *Human Brain Mapping, 30*, 3339-3350.

Mynttinen, S., Sundström, A., Koivukoski, M., Hakuli, K., Keskinen, E., & Henriksson, W. (2009). Are novice drivers overconfident? A comparison of self-assessed and examiner-assessed driver competences in a finnish and swedish sample. *Transportation Research Part F: Traffic Psychology and Behaviour, 12*, 120-130.

Press, C., & Heyes, C. (2008). Stimulus-driven selection of routes to imitation. *Experimental Brain Research, 188*, 147-152.

Spilka, M. J., Steele, C. J., & Penhune, V. B. (2010). Gesture imitation in musicians and non-musicians. *Experimental Brain Research, 204*, 549-558.

Tessari, A., & Rumiati, R. I. (2004). The strategic control of multiple routes in imitation of actions. *Journal of Experimental Psychology: Human Perception and Performance, 30*, 1107-1116.

Weeks, D. L., & Anderson, L. P. (2000). The interaction of observational learning with overt practice: Effects on motor skill learning. *Acta Psychologica, 104*, 259-271.