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The Effect Of Modeling Type And Reflection On Dart-Throwing Skills

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Abstract

In this study we investigate the effect of modeling type and reflection on the acquisition of dart-throwing skills, self-efficacy beliefs and self-reaction scores by replicating a study by Kitsantas, Zimmerman, and Cleary (2000). Participants observing a coping model were expected to surpass participants observing a mastery model who in turn were expected to outperform participants who learned without a model. Reflection was hypothesized to have a positive effect. Ninety undergraduate students were tested three times on dart-throwing skills, self-efficacy beliefs, and self-reaction scores. Contrary to what was expected, we found no main effects of modeling type and reflection. No interaction effects were found either. There was an effect of trial, indicating that participants improved dart-throwing skills, self-efficacy beliefs, and self-reaction scores over time. Furthermore, self-efficacy beliefs and dart-throwing skill were highly correlated. Our results suggest that learners do not benefit from observing a model and reflecting, but practice makes perfect.

Keywords: observational learning; modeling type; reflection; dart throwing; motor skills

Introduction

The ability to learn from observing others is a key constituent of human social cognition. Observational learning is the process of learning a new task by watching and/or listening how someone else performs this task. It relies on multiple functions: learners should be able to infer others' intentions from action observation, process others' action outcomes (i.e. successes and errors) and combine these sources of information in order to select behaviors leading to desired outcomes later on (e.g. Monfardini, et al., 2013; Rak, Bellebaum, & Thoma, 2013).

Various studies have shown the effectiveness of observational learning in different domains, such as writing (Braaksma, Rijlaarsdam, Van den Bergh, 2002), creative design (Groenendijk, Janssen, Rijlaarsdam, & Van den Bergh, 2013) and motor skill acquisition (Kitsantas, Zimmerman, & Cleary, 2000). A possible explanation for these successes is that the cognitive effort is shifted from executing certain tasks to learning (Braaksma et al., 2002).

Modeling Type

Previous research has shown that within observational learning the type of model can influence the learning process (Braaksma, Rijlaarsdam, & Van Den Bergh, 2002; Shea, Wright, Wulf, & Whitacre, 2010; Wesch, Law, & Hall, 2007; Zimmerman & Kitsantas, 2002). The current general belief is that observing a coping model (someone who gradually improves throughout the video) is more effective than observing a mastery model (a perfect example of someone performing a task) which on its turn is more effective than no model. For example, this effect was found in a study by Kitsantas, Zimmerman, and Cleary (2000). In their study, teenage girls were taught how to play darts by either watching a coping model, a mastery model or no model at all. The girls, who had never played darts before, significantly benefited from observing a model. Additionally, the girls who had observed the coping model outperformed the girls who had observed the mastery model on dart-throwing skills. Furthermore, they found that the girls in the coping model condition had more confidence in themselves, were more satisfied with their results, showed more pleasure and interest in dart-throwing, and attributed fewer of the errors to lack of ability, effort, and practice than the girls in the mastery model condition, who scored better than the girls in the no model condition. A possible explanation for the differences between the outcomes in the coping and mastery model is that a coping model provides more information about strategy implementation and error correction than a mastery model does (Zimmerman & Kitsantas, 2002). Kitsantas, et al. (2002) also found an effect of social feedback: participants being told by the experimenter when their technique was correct. Social feedback enhanced the girls' dart-throwing skill as well as their self-efficacy beliefs and self-reaction scores. The effects of modeling and social feedback were additive, since social feedback was equally effective with all modeling groups and no interactions were found.

Reflection

In most studies on observational learning, learning through modeling is compared with learning without a model, often referred to as 'learning-by-doing'. In learning-by-doing, learners put their own knowledge and beliefs on how a certain task should be done into practice, without observing someone else performing the task. They learn by recognizing and adapting to their own trials and errors (Bandura, 1977). The main difference between observational learning and learning-by-doing is the absence of a model in the latter. However, closer inspection of the methods suggests that there might be a confounding factor;

reflection. Reflection plays an important role within observational learning; the observer watches a model and transfers the provided information to his/her own acquisition by judging which parts could be beneficial and how he/she could use them. In observational learning, reflection is often encouraged by asking participants questions about the model's performance. In learning-by-doing, reflection is not an intrinsic part of the process and thus, reflection does not automatically take place and is often not encouraged within research. Adding reflection to learning-by-doing could therefore make these two types of learning more comparable.

This raises the question whether reflection could account for the differences found between observational learning and learning-by-doing. Reflection within observational learning has been studied by Braaksma, et al. (2002). In their experiment participants observed two models performing a writing task. One group started with the writing task immediately after the observation, whereas two other groups reflected upon the models. Both reflection groups outperformed the no reflection group on the writing tasks. However, this was not compared to learning-by-doing.

Additionally, the influence of reflection on learning in general has been studied. Reflection is found to be beneficial under certain circumstances (see i.e. Bulman & Schutz, 2013; Moon, 2004). Learners can be asked to monitor or record their performances during their learning process. They note their results and/or their own perception on the cause of success or failure. This process is said to enable a learner to detect, attribute and correct their errors (Ferrari, 1996; Zimmerman & Kitsantas, 2002).

Current Study

The common belief in educational research seems to be that both observational learning and reflection have a positive effect on learning. Additionally, the type of model within observational learning seems be of influence. However, how reflection interacts with observational learning is not clear yet. This raises the question whether reflection causes the differences between observational learning and learning-by doing and whether these differences can still be found when reflection is added to learning-by-doing. To study this we will attempt to replicate the previously mentioned study by Kitsantas, et al. (2000) in which the influence of modeling type and social feedback on the acquisition of dart skills was investigated. In this study we will however replace social feedback with reflection. Since Kitsantas, et al. (2002) found no interaction between modeling type and social feedback, we do not expect the replacement of social feedback with reflection to influence the effect of modeling type.

In line with Kitsantas, et al. (2000) we hypothesize that modeling type influences the acquisition of a novice motor skill, self-efficacy beliefs and self-reaction scores (H1). More specifically, we expect that observing a model leads to better acquisition of a novice motor skill, self-efficacy beliefs, and self-reaction scores than not observing a model (H1a) and that observing a coping model leads to better acquisition of a novice motor skill, self-efficacy beliefs and self-reaction scores than observing a mastery model (H1b).

Secondly, based on earlier findings concerning the influence of reflection (e.g. Braaksma, et al., 2002; Bulman & Schutz, 2013), we expect reflection to lead to better acquisition of a novice motor skill, self-efficacy beliefs and self-reaction scores than no reflection (H2)

Thirdly, we hypothesize that reflection reduces the effect of modeling type on the acquisition of a novice motor skill, self-efficacy beliefs and self-reaction scores (H3).

Method

Participants

Ninety undergraduate students at a Dutch University participated in this study. Six participants were removed because they had played darts more than twice in the last six months even though participants were informed about this restriction. This resulted in a sample of 84 participants, of whom 24 were male and 60 were female. The mean age was 21.4 years (SD = 3.27) and 82 participants indicated to have played darts once or zero times in the last six months. All participants were right-handed in order for the instruction videos to be accurate and useful.

Design

A 3 x 2 design was used in this experiment, with modeling type (coping model, mastery model and no model) and reflection (yes or no) as the independent variables. This resulted in six conditions to which the 84 participants were randomly assigned. In line with Kitsantas et al. (2000) all participants were tested on dart-throwing skills, self-efficacy and self-reaction. Whereas Kitsantas et al. (2000) measured these variables once, we did this in three trials within the experiment: at the start of the experiment, after the experimental treatment, and after a ten-minute practice session in order to detect possible improvements as a result of instructions, modeling, and/or practice.

Material

Identical to the study by Kitsantas, et al. (2000), a dart board with regular concentric circles was used instead of a regular dart board. In the study by Kitsantas, et al (2000) the dart board had seven circles, with each circle having a width of 2.54 centimeter, whereas in this study, the circles had the exact same width, but the dart board consisted of nine circles instead of seven. The dartboard was positioned at the official distance of 2.37 meters of the throwing line and with the bull's-eye at a height of 1.73 meters from the ground. Six regular darts were given to the participants in order for them to make six consecutive throws in the tests.

Two different videos were recorded, one of a coping model playing darts (see Figure 1) and one of a mastery models playing darts. The same model was used in both videos. In the coping model condition, the model started out by making several errors in his dart-throwing technique. These errors were made by not following the instructions to dart-throwing that were used, for instance by holding the dart with all five fingers instead of the three mentioned in the instruction. The model commented on his own performance and gradually improved his dart-throwing skills. In the mastery model video, the model started out with a flawless technique and good skills, and maintained this throughout the video. A right-handed model was used. In order to transfer the model's performance to the participants, all participants were right-handed, otherwise interpretational errors might have occurred. Participants were shown one of the videos if they were in a coping model or mastery model condition and after they had read the instructions.

An online question form was created in order to collect all scores. Participants were seated at a desk with a laptop on which the question form was presented to them and they could independently fill in the questions. All scores were collected and stored in an online database.

Figure 1. Screenshot of the coping model playing darts.

Measures

Dart-throwing skills These were measured by adding up the points for all six consecutive throws. The minimum score per dart was zero and the maximum score was ten. Dart-throwing skill was measured in all three trials. The average dart-throwing score per dart was calculated by dividing the total score by six.

Self-efficacy Before each dart-throwing test, participants were asked how confident they felt that they could (1) throw 9 points with one dart, (2) throw 7 points with one dart, (3) throw 5 points with one dart, and (4) throw 3 points with one dart. Their scores were measured on a scale from 0 to 100 with 10-point intervals, with 0 being not sure and 100 being very sure. This self-efficacy measure was used because the same measure was used by Kitsantas, et al. (2000), with a minor change because of the difference in dart boards. For all three trials, the average score of these four questions was used as their self-efficacy score.

Self-reaction Participants scored their satisfaction with their own performance per test on a 0 to 100 scale for all three trials, with 0 being not satisfied and 100 being very satisfied. As with the self-efficacy measure, this measurement is identical to that of Kitsantas, et al. (2000).

Procedure

Participants were individually taken into a room. First they filled in a consent form, a form with demographic information, and they performed a baseline test in which their self-efficacy, dart-throwing skills, and self-reaction were measured. Within this test, participants first filled in an online form with the question about self-efficacy, then they threw six consecutive darts, and after throwing the darts, they answered the self-reaction question.

As a next step, they were given the instructions to dart throwing on paper. The participants were asked to study these for a few minutes, until they felt confident that they knew what to do. After having read the instruction, the procedure depended on the condition participants were assigned to.

No model, no reflection Participants were tested again straight after reading the instructions. Then, they got to practice dart throwing for 10 minutes.

Coping model, no reflection Participants were shown a video of a dart-thrower who started out by making certain mistakes, but significantly improved over the rounds, the model threw 15 darts in total. After having watched the video, the participants performed the same test again, thus, their self-efficacy, dart-throwing skills, and self-reaction were measured. Then, they got to practice dart throwing for 10 minutes.

Mastery model, no reflection Participants were shown a video of a dart-thrower who made 15 good throws. After having watched the video, the participants performed the same test again, thus, their self-efficacy, dart-throwing skills, and self-reaction were measured. Then, they got to practice dart throwing for 10 minutes.

No model, with reflection Participants were asked to make their first fifteen practice throws. After that, they were asked to reflect upon their own performance according to the five basic skills (grip, stance, sighting, throw, and follow through). After the reflection, they were tested on self-efficacy, dart-throwing skills, and self-reaction and are free to continue practicing afterwards. Because, the practice time had to be equal across all conditions, the duration of the first fifteen throws of the participants in the no model, with reflections group, was part of their total ten minutes of practice. Thus, if a participant performed his/her first fifteen throws in three minutes, he/she had an additional seven minutes to practice after the reflection.

Coping model, with reflection After having read the instructions, participants were shown a video of a dart-thrower who started out by making certain mistakes, but significantly improves over the rounds, the model threw 15 darts in total. Participants were asked to reflect on the model on the aspects explained in the instruction and to report the improvements to be made. After having watched the entire video, they were provided with a form with the five basic skills (grip, stance, sighting, throw, and follow through) as a memory aid. Participants were asked to reflect upon all of these items and write down as much as they remembered. After having watched the video and having reflected on the models performance, the participants performed the same test again, thus, their self-efficacy, dart-throwing skills, and self-reaction was measured. Then, they got to practice dart throwing for 10 minutes.

Mastery model, with reflection After having read the instructions, participants were shown a video of a dart-thrower who made 15 good throws. They were asked to judge the model on the aspects explained in the instruction and to report the improvements to be made. After having watched the entire video, they were provided with a form with the five basic skills (grip, stance, sighting, throw, and follow through) as a memory aid. Participants were asked to reflect upon all of these items and write down as much as they remembered. After having watched the video and having reflected on the models performance, the participants performed the same test again, thus, their self-efficacy, dart-throwing skills, and self-reaction were measured. Then, they got to practice dart throwing for 10 minutes.

After the ten-minute practice, all participants were tested for one last time.

Analysis

The data were analyzed with a 3 (type of modeling) x 2 (level of reflection) repeated measures multivariate analysis of variance, with dart-throwing skills, self-efficacy, and self-reaction as dependent measures. A repeated measures ANOVA was conducted in order to discover the changes in the dependent scores over the three trials that were conducted within the experiment. Mauchly's test for sphericity was used to test for homogeneity of variance, and when this test was significant we applied a Greenhouse-Geisser correction on the degrees of freedom.

Results

An overview of the mean scores and standard deviations for all three trials in all six groups are shown in Table 1.

Dart-throwing skills

A within-subjects main effect of trials was found for dart-throwing skills (F (2,156) = 32.96, p < .01), with the mean scores gradually increasing each trial (M_{trial1} = 4.63, *C.I.* [4.26 , 5.00], M_{trial2} = 4.91, *C.I.* [4.55 , 5.26], M_{trail3} = 5.94, *C.I.* [5.64 , 6.24]). The difference between trial 1 and 3 (M = -1.31) was significant, p < .01, *CI* [-1.73 , -.89] and so was the difference between trial 2 and 3 (M = -1.03), p < .01, *CI* [-1.46 , -.61]). However, the difference between trial 1 and 2 (M = -.28) turns out not to be significant, p = .29, *CI* [-.68 , .13].

No significant main effect of modeling type on dart-throwing skills was found, F (2,78) = 2.33, p = .10. Even though the data numerically suggest that best results are obtained by observing a mastery model (M = 5.55, *C.I.* [5.08 , 6.02]), followed by a coping model ((M = 5.13, *C.I.* [4.65 , 5.61]) and learning-by-doing (M = 4.80, *C.I.* [4.28 , 5.32]), this effect did not yield significance.

Reflection was discovered not to have a significant main effect on dart-throwing skill either, F (1,78) = 0.88, p = .35. No reflection even led to numerically higher scores on dart-throwing skills (M = 5.29, *C.I.* [4.89 , 5.70]) than reflection (M = 5.03, *C.I.* [4.64 , 5.42]), even though this difference was not significant.

In addition, none of the interaction effects were found to be significant (F_s < 1.52, p_s > .2).

Self-efficacy

A main effect of trials on self-efficacy was found, F (1.80, 135.10) = 145.52, p < .01. Self-efficacy scores on the first test (M = 36.86, CI [33.37 , 40.36]), the second test (M = 49.77, CI [45.92 , 53.62]), and the third test (M = 61.10, CI [57.20 , 64.99]) were significantly different. All the individual differences were significantly different at a p-value of < .01.

The main effect of modeling type did not yield significance, F (2,75) = 2.10, p = .13. Again, the data numerically suggest that best results are obtained by observing a mastery model (M = 53.45, CI [47.82, 59.07]), followed by observing a coping model (M = 49.44, CI [43.72 , 55.17]) and learning-by-doing (M = 44.84, CI [38.66 , 51.02]). However, this effect failed to reach significance.

The main effect of reflection was not found to be significant either, F (1,75) = 3.40, p = .07. Similar to the effect of reflection on dart-throwing skills, the data numerically suggest that best results are obtained by not reflecting (M = 52.37, CI [47.62 , 57.12]) instead of reflecting (M = 46.12, CI [41.32 , 50.92]).

Again, no significant interaction effects were found (F_s < 1.37, p_s > .26).

Self-reaction

The results for self-reaction were very similar to those of self-efficacy. A significant main effect of trial on self-reaction scores was found, F (2, 156) = 4.56, p = .01. Again, the scores on the first test (M = 65.93, CI [61.84 , 70.02]), were significantly different from scores on the second test (M = 59.24, CI [54.74 , 63.74]) and the third test (M = 67.02, CI [62.53 , 71.52]). The difference between the first test and the second test (M = 6.69, CI [0.89 , 12.48], p = .02), and that between the second test and the third test (M = -7.78, CI [-13.53 , -2.03], p = .01) were significant. The difference between the first and the third test, however, did not turn out to be significant (M = -1.09, CI [-6.18 , 3.99], p = .67).

No significant main effect of modeling type, (F (2,78) = 1.61, p = .21) or reflection (F (1,78) = 0.58, p = .45) was found, indicating that learning-by-doing (M = 60.33, CI [54.91, 65.75]), observing a mastery model (M = 66.79, CI

Table 1: Average Dart-throwing, Self-efficacy and Self-reaction Scores (with SDs) as a function of Group (Reflection, No reflection), Model (No Model, Mastery, Coping) and Trial (1, 2, 3)

		No Model			Mastery			Coping		
	Trial nr	1	2	3	1	2	3	1	2	3
Dart skills	No reflection	4.22	4.68	5.97	5.18	5.34	6.34	5.14	4.82	5.93
		(1.90)	(2.07)	(1.52)	(1.75)	(1.57)	(0.82)	(1.59)	(1.46)	(1.16)
	Reflection	3.78	4.55	5.60	4.98	5.53	5.92	4.48	4.82	5.89
		(1.61)	(1.50)	(1.35)	(1.43)	(1.67)	(1.37)	(1.84)	(1.91)	(1.84)
Self-efficacy	No reflection	35.73	44.31	56.69	44.57	59.88	67.65	41.38	55.71	65.39
		(17.05)	(17.42)	(17.19)	(15.79)	(16.09)	(13.80)	(16.69)	(19.81)	(17.47)
	Reflection	33.42	42.19	56.71	37.57	49.64	61.36	28.52	46.88	58.79
		(16.15)	(19.76)	(19.23)	(13.20	(13.76)	(19.05)	(15.51)	(16.89)	(18.38)
Self-reaction	No reflection	66.92	57.83	65.08	70.20	61.60	73.33	67.07	56.43	68.36
		(16.80)	(26.73)	(22.26)	(20.68	(11.83)	(14.72)	(21.14)	(17.78)	(18.64)
	Reflection	51.46	55.92	64.77	67.70	63.07	64.80	72.20	60.60	65.80
		(26.22)	(24.63)	(14.58)	(9.67)	(21.69)	(25.56)	(14.75)	(19.69)	(24.39)

[61.85 , 71.73]) and observing a coping model (M = 65.08, CI [60.04, 70.11]) do not lead to significantly different self-reaction scores, and neither do not reflecting (M = 65.20, CI [60.96 , 69.45]) and reflecting (M = 62.93, CI [58.79 , 67.07]). Again, the numerical differences suggest best results are obtained by observing a mastery model, followed by a coping model and learning by doing, and by not reflecting instead of reflecting.

For self-reaction, no significant interaction effect were found ($F_s < 0.87$, $p_s > .49$).

Correlations

To further explore the relationships between dart-throwing skills, self-efficacy and self-reaction, we used a Pearson's correlation test. In the first trial the results show a strong correlation between self-efficacy and dart-throwing skills, $r(81) = .60, p < .01$., and a medium strong correlation between self-reaction and dart-throwing skills, $r(84) = .47, p < .01$. The correlation between self-efficacy and self-reaction was less strong, but still significant, $r(81) = .25, p < .05$.

For the second trial, again the correlation between self-efficacy and dart-throwing skills, $r(81) = .52, p < .01$., and the correlation between self-reaction and dart-throwing skills, $r(84) = .49, p < .01$.are significant and of medium strength. However, the correlation between self-efficacy and self-reaction is not significant and weak in this second test.

The correlation scores of the dependent variables on the third trial show that self-efficacy and dart-throwing skill, $r(81) = .41, p < .01$. and self-reaction and dart-throwing skill, $r(84) = .67, p < .01$. are again strongly connected, whereas a weaker, but significant connection can be observed between self-efficacy and self-reaction, $r(81) = .15, p < .05$.

General Discussion and Conclusion

The aim of this study was to determine what the effects of modeling type and reflection are on the acquisition of dart-throwing skills, self-efficacy beliefs and self-reaction scores. First of all, modeling type was expected to have an effect, with participants observing a coping model surpassing participants observing a mastery model who in turn were expected to outperform participants who learn without observing a model. Even though we found numerical differences between the modeling type conditions, with participants in the mastery condition scoring higher on dart-throwing skills, self-efficacy and self-reaction scores, than participants in the coping model condition, who on their turn scored higher than the participants in the no model condition, these differences were not significant. This indicates that in this study it did not matter if the learner observed a coping model, a mastery model, or no model at all. This was the case for dart-throwing skill, self-efficacy beliefs and self-reaction scores. Thus, in this study we found no support for H1a and H1b: observing a model did not lead to a better learning process than not observing a model, and observing a coping model did not lead to a better learning process then observing a mastery model, which is not in line with what was found by Kitsantas et al. (2000).

Similar results were found for reflection. We expected reflection to have a positive effect, but we found no significant effects for reflection. The no reflection group even scored numerically higher than the reflection group. Thus, in this study H2 was not supported: reflection did not lead to a better learning process than no reflection.

No interaction effects were found either. It was hypothesized that reflection would reduce the difference between observational learning and learning-by-doing (H3), but as no such effect was found, reflection could not influence this effect. In addition, no other interaction effects between number of trials, modeling type, reflection were found on dart-throwing skills, self-efficacy beliefs, or self-reaction scores.

It was however found that dart-skills and self-efficacy beliefs significantly improved with each trial. Thus, our data suggest that it did not matter how someone was taught how to play darts, as long as they practiced, their scores improved and they felt more confident. Additionally, dart-throwing skills and self-efficacy beliefs were highly correlated, meaning that how higher the self-efficacy beliefs of a person were, the higher their dart-throwing score was.

In the current study we were not able to replicate the findings by Kitsantas, et al. (2000) who found very clear effects of modeling type. Our test was sufficiently powered: the sample was larger than in Kitsantas et al. (respectively 90 and 60) and the test was sensitive enough to find statistical differences for trial, indicating that the participants did learn from the interventions. The question that can be raised therefore is why there are such substantial differences between the findings of this study and that of Kitsantas, et al. (2000).

Perhaps the change in population contributes to the differences between the current study and the Kitsantas et al. study. Whereas Kitsantas, et al. made use of 14 to 16 year old girls, both male and female students with an average age of 21.4 years were used as participants in this study. Because of the higher age, it is plausible that our participants have watched someone else play darts before, either on television or in real life. This observational experience could lead to them not being so inexperienced. Lee and White (1990) discovered that participants who merely observed someone performing a certain motor task, acquired some amount of skill themselves. Thus, participants who have taken part in the present study might unconsciously have been more experienced than expected.

The girls in the Kitsantas, et al. study (2000) had never played darts before. Our participants were more likely to have played darts before. We tried to control for this by using a dart-experience restriction. Since the majority of the participants had played darts once or more, we made a post hoc distinction between the participants who had never played darts (N = 32) and the ones who had played (N = 52). The repeated measures multivariate analyses of variance was run again, but now split in two separate groups, the group with no experience at all and the one with some experience. The analysis with the average number of point as the repeated measures variable showed no significant results for either group. Thus, even in the no experience group, no effects of modeling type or reflection were found. The same can be said for the analyses with self-efficacy and self-reaction as the repeated measures. The outcomes of those analyses were not found to be significant either.

In sum, the results of Kitsantas, et al. (2000) were not replicated in this study, even though the experimental procedures and measurements were very similar. Learners did not benefit from observing a model or reflecting. However, they did improve by practicing. The results of this study are also not in line with earlier findings by Braaksma, et al. (2002), Ferrari (1996), Shea, et al. (2010), Wesch, et al. (2007), and Zimmerman and Kitsantas (2002). Our results indicate that the effects of observational learning and the role of reflection are still not clear and therefore more research into this subject is needed.

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