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The influence of vicarious experience provided through mobile technology on self-efficacy when learning new tasks

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ABSTRACT

Background: A high level of self-efficacy is a major contributor to the effectiveness of physical activity interventions. However, it is insufficiently known whether techniques that are used to influence self-efficacy in face-to-face or printed text interventions can also be successfully incorporated in modern-day, mobile technology-supported interventions. We performed an experiment to investigate whether self-efficacy regarding a specific task can be influenced through vicarious experience provided through mobile technology.
Method: 36 subjects were asked to walk from A to B in exactly 14, 16, or 18 s, wearing scuba fins and a blindfold. The task guaranteed equal level of task experience at the start of the experiment. Before every trial, subjects in group 1 viewed a video on a smartphone of a subject successfully performing the task, subjects in group 2 did not view a video.
Results and conclusion: Although subjects found the video helpful for successful performance of the task and reported high perceived similarity, subjects' level of self-efficacy regarding the task, as well as task performance did not differ significantly between the two groups. However, a secondary outcome parameter did indicate a possible difference between how subjects walked forward while wearing the scuba fins (either shuffling forward, or raising their knees high up). Future studies should investigate whether such instructional videos can contribute to higher levels of self-efficacy in mobile, technology-supported interventions in more ecologically valid settings.

1. Introduction

Smartphones and other mobile technologies like activity sensors are used more and more in coaching programs to improve physical activity patterns (Bielik et al., 2012; Consolvo et al., 2008; Lin et al., 2012). However, the present coaching programs hardly take into account knowledge from behavioral science, which is hypothesized to improve interventions in terms of persuasiveness and adherence (Achterkamp et al., submitted for publication). One way of doing this is by incorporation of tailoring, i.e. personalization of feedback or coaching based on information from the individual (Hawkins, Kreuter, Resnicow, Fishbein, & Dijkstra, 2008). op den Akker, Jones, and Hermens (2014) describe a literature survey about coaching in mobile physical activity applications in relation to techniques to apply tailoring, which have repeatedly been associated with higher effect sizes of interventions (Noar, Benac, & Harris, 2007). The techniques op den Akker et al. (2014) identified are: feedback, inter-human interaction, adaptation, user targeting, goal setting, context awareness, and self-learning. The most interesting finding: whereas the tailoring technique described as adaptation – i.e. tailoring based on constructs from behavioral science – is a common technique in traditional, non-technology supported interventions, the authors show that this specific tailoring technique is rarely applied in modern-day mobile, technology supported physical activity interventions (op den Akker et al. (2014)).

Constructs that are used for adaptation in traditional interventions include, for example, attitudes towards the target behavior, stage of change, social support, processes of change and self-efficacy (Noar et al., 2007). For example: adaptation of interventions based on stage of change means that subjects in the maintenance stage of change receive different information or feedback than subjects in the contemplation stage of change;

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subjects receive information based on their stage of change. Among the constructs used for adaptation, especially self-efficacy seems of major importance (Achterkamp et al., 2016 submitted for publication). Self-efficacy is defined as “one's belief in one's ability to succeed in specific situations” (Bandura, Adams, & Beyer, 1977). Higher levels of self-efficacy are associated with higher levels of physical activity, and the percentage increase in physical activity in a twelve week intervention period is higher when self-efficacy is high (e.g. (Achterkamp et al., 2016; submitted for publication; Trost, Kerr, Ward, & Pate, 2001). Furthermore, research shows that self-efficacy is a powerful predictor of actual performance of the desired behavior (e.g. (Bandura, 1994; Gist & Mitchell, 1992; Roach et al., 2003). So, when self-efficacy is low, it should be increased to achieve optimal result of the intervention. Bandura (1994) describes four sources of self-efficacy that can be used to achieve this, which are still widely applied (e.g. Rowbotham & Owen, 2015; Willis, 2015):

- Mastery experience: the subject successfully performs the target behavior;
- Vicarious experience: the subject observes a similar other perform the target behavior;
- Verbal (or social) persuasion: verbally expressed faith in the subject's capabilities by others;
- Physiological/affective states: (mis)interpretations of bodily states.

Ashford, Edmunds, and French (2010) showed that using mastery experience is the most powerful source to increase self-efficacy, followed by vicarious experience. Although little is known about applying these techniques in mobile, technology supported interventions, recent research does indicate that mastery experience can indeed be an effective source to influence self-efficacy in these types of intervention (Achterkamp, Hermens, & Vollenbroek-Hutten, 2015). Considering that the systematic review with meta-analysis by Ashford et al. (2010) indicates vicarious experience as the most powerful source to influence self-efficacy after mastery experience (Ashford et al., 2010), the goal of the current study is to investigate whether it is possible to successfully apply vicarious experience when using mobile, technology supported feedback strategies.

Regarding vicarious experience, traditional face-to-face interventions typically involve a model and an observer. The observer learns from the model who demonstrates how the task should be performed. By observing the model, the observer can identify certain principles, rules or responses relevant for successful performance (Strecher, McEvoy DeVellis, Becker, & Rosenstock, 1986; Schunk & DiBenedetto, 2016). Bandura, Adams, and Beyer (1977) states that through this observation of others, subjects obtain knowledge about how new behavioral patterns are formed, which they can then use when performing the new behavior themselves. Two aspects are of major importance for this to lead to an actual increase in self-efficacy:

1) The model should be similar to the observer, so that the observer can identify with the model; comparable age, gender and appearance are crucial (Bandura et al., 1977; Kassin, Fein, & Markus, 2010; Schunk & DiBenedetto, 2016; Strecher et al., 1986).
2) The model should perform the target behavior with some difficulty; research shows that phobic subjects benefit more from observing models who overcome their problem by exerting effort than from models who overcome their problem easily (Bandura et al., 1977; Schunk & DiBenedetto, 2016).

Summarizing, traditional non-technology supported physical activity interventions commonly apply knowledge from behavioral sciences, leading to larger effect sizes, whereas modern-day mobile technology supported physical activity interventions do not apply this type of knowledge. Therefore, the focus is on investigating whether this knowledge from behavioral sciences can contribute to the effectiveness of mobile technology supported physical activity interventions in the same way as in traditional interventions. More specifically, we tested whether vicarious experience leads to an increase in self-efficacy when using mobile technology-supported feedback strategies. Two groups were compared in a lab experiment: subjects in group 1 viewed an instructional video before performing a new task, subjects in group 2 did not view this video. Thereby, the aim is to answer the following questions: what is the effect of a feedback strategy that incorporates vicarious experience and is delivered through technology on 1) self-efficacy regarding a specific task, and 2) task performance?

2. Method

2.1. Participants

Convenience sampling was applied in this study. The call for participation was distributed through e-mail, social media and the involved researchers personally. Subjects were included if they were Dutch-speaking and did not have walking disabilities.

In total, 36 subjects were included; 17 women and 19 men. Age ranged from 19 to 61 years and averaged 25.6 ($SD = 7.2$). All participants signed an informed consent. A local ethics committee reviewed and approved the study.

2.2. Procedure

The study used a repeated measures design. Subjects came to the lab of Roessingh Research and Development once, but performed the required task six times. Subjects first signed an informed consent, after which they completed a questionnaire assessing demographical variables. Hereafter, they were randomly assigned to one of two groups.

Group 1 – vicarious experience: subjects in this group viewed a video of a same sex model who successfully performs the task before the start of every trial.

Group 2 – control: subjects in this group did not view a video. Otherwise the procedure was equal to group 1.

Next, subjects received information about the task they would have to perform. See below for a detailed description. The goal was to walk from A to B in exactly 14, 16, or 18 s, wearing scuba fins and a blind fold. They were asked to put on scuba fins and were allowed to practice walking in a straight line, after which the subjects were asked to put on a blindfold and could again practice walking. Following this introduction, subjects completed a total of six trials of the task.

2.3. Task

Subjects were asked to walk from one side of the lab to the other (8 m), in exactly 14, 16, or 18 s (target time), wearing scuba fins and a blindfold. Subjects were explained that the goal was to get as close to the target time as possible; the closer they were, the better they performed. However, subjects did not receive feedback after trials. Subjects started between a red light laser and reflector, which functioned as a starting gate on one side of the lab. A second laser and reflector combination functioned as a finishing gate and was placed at the other side of the lab. The distance from start to finish was approximately eight meters. The sensors were linked to a computer to measure the exact time subject needed to reach the finishing gate. Subjects were reassured that the experimenter would correct their course if they deviated too much. Otherwise, the experimenter did not intervene during the task; the instructions for every trial were provided through the smartphone and speakers.

Subjects in group 1 would start by viewing the example of successful performance on the smartphone. Hereafter, all subjects were asked the following automated question via speakers: “To what extend do you think you can successfully accomplish this task on a scale of 0–100”. The experimenter entered the subject's answer in the computer. Next, the following automated message sounded: “After the countdown, walk to the other side of the lab in exactly X seconds”, where X corresponded to 14, 16 or 18 s. The computer randomly picked on of the three options, such that every target time was prompted two times. These times were chosen based on results of a pilot study that showed that these target times corresponded to fast, normal, and slow walking speeds respectively. Following the countdown, the subject walked from the starting gate to the finishing gate. Upon reaching the finishing gate, another automated message would sound: “stop, you have reached the destination.” After this, the speakers prompted: “prepare for the following attempt.”

To eliminate the effect of mastery experience on level of self-efficacy, subjects in none of the two groups received information after each trial about how close they were to the target time or whether they were too slow or too fast. After hearing the message “prepare for the following attempt”, subjects in group 1 would proceed to again view the video of a successful attempt on the smartphone, whereas subjects in group 2 would not view this video and simply prepare for the following attempt. Subjects were allowed to remove the blindfold while preparing for the following trial. This procedure was equal for all following trials.

2.4. Data analysis

The two primary outcome parameters were:

1) Self-efficacy regarding the task: the answer to the question “To what extend do you think you can successfully accomplish this task on a scale of 0–100” that was prompted at the start of every trial.
2) Performance: measured by calculating the difference between the target time and the time the subject took to walk from the starting gate to the finishing gate in milliseconds.

Secondary outcome parameters (qualitative):

1) Identification with model: subjects in the vicarious experience group were asked to rate to what extend they could identify themselves with the model on a scale of 0–100 and what lead them to give this score.
2) Helpfulness of video: subjects in the vicarious experience group were asked whether viewing the model helped them perform the task and which aspects they thought were most important for that.
3) Walking strategy: after the instructional videos were shot we noticed that the two models used different techniques of walking with scuba fins. The male model shuffled his feet forward with the scuba fins on the ground, whereas the female model bent her knee and raised her feet up high in front of her to step forward. Although this was unintentional, it was decided to include this as a last qualitative variable. Subjects in the group with vicarious experience were categorized as either matching, or not matching the model's technique.

2.5. Statistical analysis

A Repeated Measures Analysis of Variance was performed to test the effect of Group (vicarious experience vs. control), Time (trial 1 to 6) and the interaction between Group and Time on level of self-efficacy and task performance. We did not correct for age or gender.

3. Results

3.1. Primary outcome parameters

The average level of task-specific self-efficacy did not differ significantly between the group with vicarious experience and the control group ($F(1,34) = 0.678$, $p = 0.416$): the group with vicarious experience scored 66.2 ($SD = 17.4$) on average, while the control group scored 60.7 ($SD = 22.3$). The main effect of time was also non-significant ($F(5,30) = 1.175$, $p = 0.345$), meaning self-efficacy scores did not differ per trial. Furthermore, the RM ANOVA showed that the interaction between group and time was non-significant ($F(5,30) = 1.359$, $p = 0.267$), indicating that in this experiment, no difference existed between how subjects responded over time per condition. These results are summarized in Fig. 1, which clearly shows that the differences are small.

Task performance, as measured by the deviation from the target time in milliseconds, did not vary significantly over time ($F(5,30) = 0.950$, $p = 0.463$) or per condition ($F(1,34) = 0.508$, $p = 0.481$). The interaction was also non-significant ($F(5,30) = 1.008$, $p = 0.430$). However, Fig. 2 does show an interesting trend: performance seems better in the group with vicarious experience (mean = 9, $SD = 3030$) than in the control group (mean = 917, $SD = 4473$), especially when looking at the first three trials. Whereas the group with vicarious experience shifts towards a lower deviation from the target time, the deviation from the target time in the control group increases over time.

3.2. Secondary outcome parameters

With respect to the vicarious experience group, male and female subjects indicated to moderately identify with the model, showing mean scores of 71,7 ($SD = 14.7$), and 71,4 ($SD = 19.0$) respectively. Subjects named several factors that contributed to higher identification: equal gender (mentioned by 15 subjects), comparable age (mentioned by 9 subjects), comparable length (mentioned by 5 subjects) and comparable body composition (mentioned by 4 subjects). Subjects also named factors that negatively influenced identification with the model: different walking strategy (mentioned by 3 subjects), higher perceived confidence of the model (mentioned by 2 subjects), different clothing style (mentioned by 2 subjects), different age (mentioned by 1 subject) and different hair color (mentioned by 1 subject).

Of the eighteen subjects in the vicarious feedback group, twelve found the videos helpful for successful performance of the task. Subjects named various factors that could be distilled from the video which helped them while executing the task: number of steps necessary to walk from A to B (mentioned by 10 subjects), estimating how many steps to take per second (mentioned by 5 subjects), step length (mentioned by 5 subjects) and the rhythm of the sound of the scuba fins (mentioned by 5 subjects). Six subjects rated the videos unhelpful, because the model had a different walking strategy (mentioned by 3 subjects) or because subjects mistakenly thought that the same video was presented six times, but with a different target time presented on the screen (mentioned by 3 subjects).

Regarding walking strategy, fifteen out of eighteen subjects matched the walking strategy of the model during all trials, while

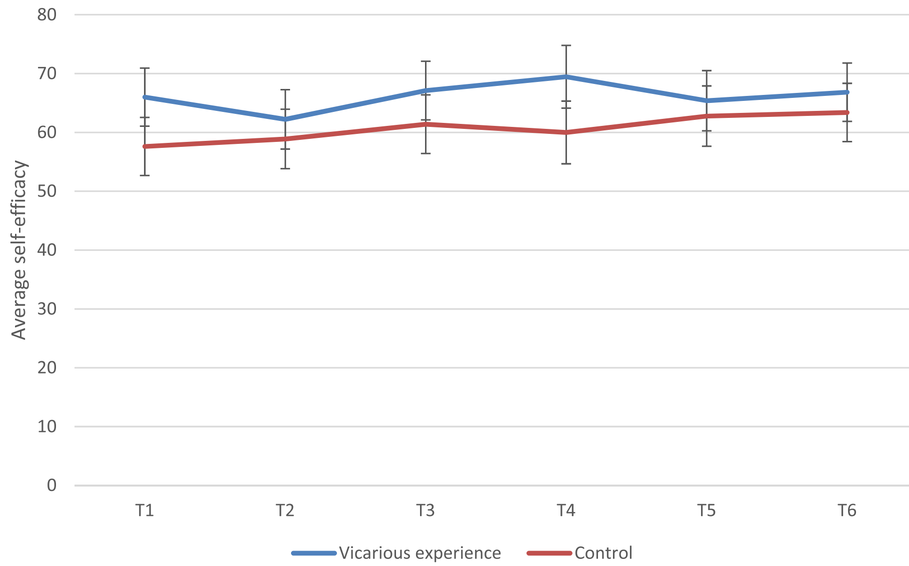

Fig. 1. Self-efficacy regarding the task over time per condition including Standard Error bars.

three out of eighteen inconsistently switched between strategies. Specifically, six out of seven male subject and nine out of eleven female subjects used the same walking strategy as the model they viewed in the video before every trial.

3.3. Post-hoc analyses

A post-hoc RM ANOVA was performed to investigate differences in performance between subjects with a lower level of self-efficacy and subjects with a higher level of self-efficacy. As suggested by literature (Schwarzer & Jerusalem, 1995), the median level of self-efficacy was used to categorize subjects into two groups: (1) subjects with a score below the median level of self-efficacy over all trials (67.03), and (2) subjects with a score above this median. Results, however, do not indicate a significant main effect of group ($F(1,34) = 2.755$, $p = 0.106$), nor a significant interaction effect ($F(5,30) = 0.705$, $p = 0.624$); in this experiment, subjects with a lower level of self-efficacy did not show a different level of performance than subjects with a higher level of self-efficacy. Also, performance over time does not differ significantly between the two groups (see Fig. 3).

4. Discussion

The main aim of the current experiment was to investigate whether vicarious experience leads to an increase in self-efficacy when using technology-supported feedback strategies. Specifically, we focused on the effect of a feedback strategy that used vicarious experience on 1) level of self-efficacy regarding a specific task, and 2) task performance. The task was to walk from A to B (eight meters), in exactly 14, 16, or 18 s (target time), wearing scuba fins and a blindfold. The subjects' goal was to get as close to the target time as possible. A group in which subjects viewed a video in which a model performs the task successfully (vicarious

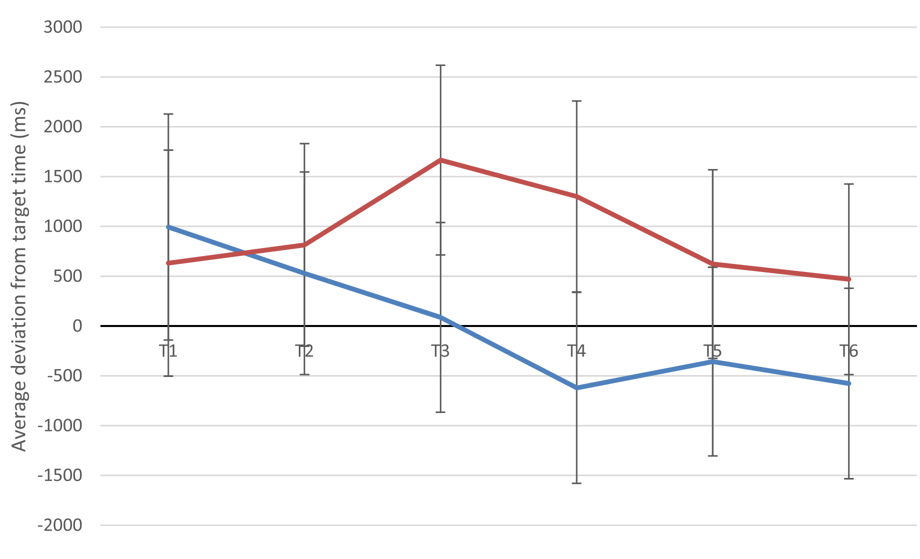

Fig. 2. Deviation from target time (performance) over time per condition including Standard Error bars.

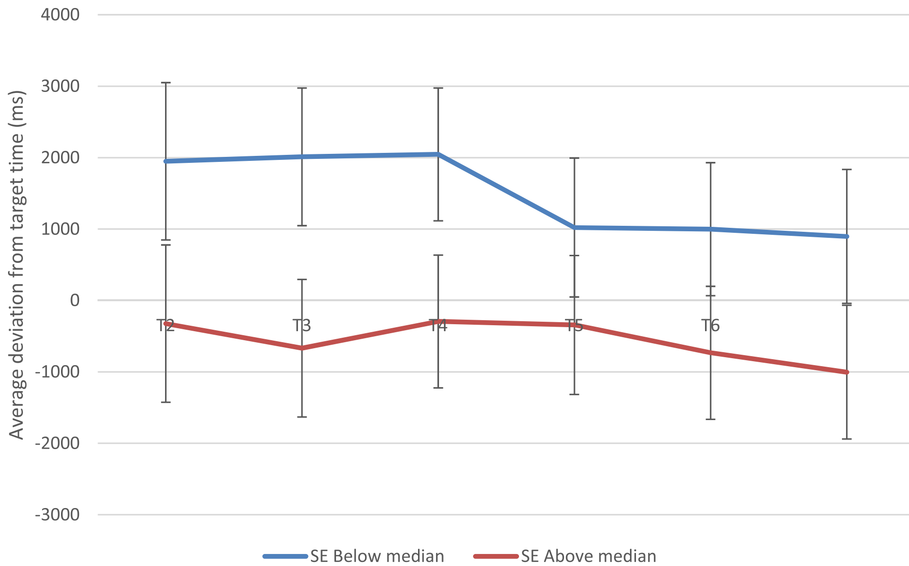

Fig. 3. Deviation from target time (performance) over time per level of self-efficacy including Standard Error bars.

experience) was compared to a control group in which subjects did not view a model perform the task.

Results indicate partial success. Although Figs. 1 and 2 do indicate a difference between the two groups in the expected direction, the differences are too small in relation to the inter-subject variability to be significant. As such, the vicarious experience strategy was unsuccessful in influencing both self-efficacy (1) and task performance (2). This is contrary to theory from Bandura (1994) who states that observing a model leads to an increase in self-efficacy and changes in task performance or behavior. Traditional face-to-face or TV/video, interventions frequently successfully apply these techniques (Bautista, 2011; Hagen, Gutkin, Wilson, & Oats, 1998). The lack of a significant effect in the current experiment cannot be attributed to too low similarity between observer and model; average to high identification scores were reported by all subjects in the vicarious experience group and subjects named many factors that increased their perceived similarity and only few factors that negatively influenced it. Furthermore, two thirds of the subjects indicated the video as helpful for successful performance of the task. Why vicarious experience did not lead to the expected effect might be due to several reasons:

- The task that was used is rather artificial and has a low ecological validity. Therefore it might not be comparable to the traditional interventions. The reason for choosing this specific task was to guarantee equal task experience of subjects at the start of the experiment and thereby increase comparability of the two groups.
- Vicarious experience is most powerful when subjects see that the model is rewarded upon finishing the task (Bandura, 1977). This was intentionally left out of the current experiment to exclusively focus on vicarious experience and not mastery experience.
- Other factors such as: the low number of participants per condition, high inter-subject variability, too small differences between conditions, insufficient difficulty of the task, or, considering the relatively high self-efficacy scores on the first trials, a ceiling effect regarding self-efficacy.

Although the primary outcome parameters indicated no significant effect of vicarious experience, one of the secondary outcome parameters seems interesting: 83% of the subjects in the group with vicarious experience copied the walking strategy of the model in the video they viewed before the start of every trial, indicating that subjects might have picked up some elements from the video and incorporated these in their strategy. Male subjects tended to shuffle forward, whereas female subjects raised their knees up high and stepped forward, corresponding to the model in the video male and female subjects viewed. Although observers may identify and use only certain principles that are demonstrated by a model (Schunk & DiBenedetto, 2016; Strecher et al., 1986), alternative explanations cannot be ruled out and should be investigated more thoroughly in a future experiment in which, for example, subjects are randomly assigned to either a group viewing a model performing the task shuffling or a group viewing a model that uses an alternative strategy.

Overall, future studies should investigate whether vicarious experience can contribute to higher levels of self-efficacy in modern day mobile, technology-supported physical activity interventions, but in a more ecologically valid setting than the case in the current experiment. For example, it would be interesting to investigate whether providing a video that shows instructions for physical activity, instead of providing coaching through text messages, is more effective when applied in daily life physical activity interventions. Earlier research on study behavior of students already showed that showing an animated version or a live video of task performance by a model is more effective than providing spoken text (van Gog & Rummel, 2010).

5. Conclusion

This study aimed to influence self-efficacy and task performance through vicarious experience using mobile, technology-supported feedback strategies based on behavioral sciences. Results indicate partial success; self-efficacy and task performance did not change significantly, although a trend in improvement of task performance was present. Secondary outcome parameters do seem promising, indicating that vicarious experience could have contributed to differences in walking strategy. However, our findings are subject to several limitations such as small number of subjects per group, ceiling effects and, with respect to the secondary outcome parameters, lack of a control group. Future research should therefore investigate the effect of vicarious feedback in mobile technology supported interventions more thoroughly and, importantly, in a more ecologically valid setting.

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