I Focus on Improvement: Effects of Type of Mastery Feedback on Motivational Experiences

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Abstract. Measurement technologies provide persuasive feedback to elicit motivation. However, little is known about whether different types of standards in progress feedback yield different motivational experiences. The current study investigates effects of mastery goals with either a self-based or a task-based standard on motivational experiences. An interactive dance game was developed to provide persuasive progress feedback in the form of a self- versus task-based standard. Participants played the game and reported their experiences with it. Results showed that participants in the self-based condition responded more in terms of Improvement and less in terms of Performance compared to those in the task-based condition. This finding implies that the type of standard in progress feedback can yield different motivational experiences.

Keywords: Persuasive feedback · Mastery goals · Self-based standard · Task-based standard · Motivational experiences

1 Introduction

Advances in measurement technologies provide opportunities for stimulating health related behaviour change. A promising way to let users of these technologies reach their health goals is by providing immediate, persuasive feedback about their progress towards a certain standard. Such feedback aims to elicit motivational experiences for continued engagement with the health activity.

When people begin with an activity, they may think about the goals they want to achieve (e.g. improving their skills, or achieving a certain score). People can have different types of achievement goals, or they can be triggered by the achievement goals that are suggested by measurement technologies. For example, 10.000 steps is a default daily goal that is suggested by the majority of activity trackers that are currently on the market. However, different types of achievement goals can have different effects on people's motivation.

According to the Dichotomous Achievement Goal Model, a distinction can be made between mastery and performance goals [2]. Mastery goals focus on the

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development of competence and mastering a task, whereas performance goals focus on the demonstration of competence and outperforming others [3]. Mastery and performance goals are applicable to various achievement-relevant domains such as school, sports, work, games and so on [2,3,12].

1.1 Different Standards of Competence

Within mastery goals, a distinction can be made between the standards of competence of achievement goals [6]. The standard of competence is a reference point that is used in evaluating one's competence [5]. According to the 3×2 Achievement Goal Model, the standard of competence in mastery goals is either self-based or task-based, while the standard of competence in performance goals is other-based [6]. An example of a self-based mastery goal is trying to do better than before. An example of a task-based mastery goal is doing the task well relative to an absolute demand of the task. An example of an other-based performance goal is doing better than others.

Based on the 3×2 Achievement Goal Model, progress feedback can contain self-based standards (e.g. scores of your previous self), task-based standards (e.g. minimum/maximum scores) or other-based standards (e.g. scores of others). Earlier work showed that mastery goals consistently lead to a wide range of positive processes and outcomes such as high intrinsic motivation [4,11], showing the potential benefits of having self-based standards.

1.2 The Value of Self-based Progress Feedback

Behaviour change technologies seem to focus mostly on task-based goals. Devices such as Fitbit provide daily, default or self-set goals such as an amount of steps, an amount of stairs climbed or an amount of active minutes. These predetermined goals emphasize task-based standards instead of self-based standards. Likewise, in games for health such as the Wii Fit U that turns exercise into a game, people set weight and time-frame goals after which the device provides an amount of calories to burn every day. While these devices do provide some information about one's highest scores that allows them to compare themselves with previous performance, the default goals are task-based and do not focus on self-improvement.

In the field of academic performance, studies consistently show that self-based goals are associated with higher motivation and engagement [10,17]. In addition, earlier work in the context of video games showed an increased focus on self-improvement when providing information about past performance [13]. These findings may be relevant in the field of personal informatics as well. When technologies provide feedback about an individual's achievement, it is important to know the extent to which a task-based or a self-based focus influences achievement- and motivation-relevant processes. After all, the manner in which progress feedback is presented to the user may influence motivational experiences and subsequent active behaviour. It is unclear, however, which type of mastery goal (self-based or task-based) is more effective in providing progress feedback.

1.3 Research Aims

In order to investigate whether task-based or self-based standards are more effective in providing progress feedback, a study was designed in which people's motivational experiences were measured. Based on earlier work on effects of providing self-based progress feedback, we expect that self-based goals are more likely to make people focused on self-improvement than task-based goals. This expectation is tested with an interactive dance game that provides immediate progress feedback on physical activity with a self-based or task-based standard.

2 Method

2.1 Participants and Design

Forty-four participants, 20 females and 24 males (M_{age} = 25.6, SD_{age} = 3.8, Range = 18 to 34) were recruited using a participant database open to students and employees of Eindhoven University of Technology. The study had two between-subjects conditions: Task-based vs. Self-based progress feedback. Four participants communicated with each other about the study and therefore may have been aware of the goal of the study. For this reason they were excluded from any analyses, leaving 40 participants (20 females and 20 males).

Each participant played several rounds in an activity game that will be explained in the next section. They received progress feedback on their performance in the game that was based on either their own previous performance (Self-based) or the percentage of the maximum score they reached (Task-based). The experiment took about 30 min to complete for which participants were compensated with either course credits or €5.

2.2 Game and Feedback Design

In order to investigate people's motivational experiences with Self-based versus Task-based standards in progress feedback, an interactive dance game was developed in Adobe Flash™. The game was inspired by Dance Revolution, in which a player stands on a dance mat with different arrows. During the game, a music track is played while arrows of various orientations move from the bottom of the screen to the top. Players need to step on the corresponding arrow on the dance pad at the correct time to receive points. A visualization of the game in action is provided in Fig. 1.

Each participant could play a maximum of five game rounds, where one round took approximately 2 min. A very large numerical score consisting of seven digits was shown during the rounds. This number grew with participants' performance. With such large numbers we could make sure to manipulate the scores without causing any suspicion among participants. As such, final scores that were presented were similar across the whole sample.

After each round, a progress bar was shown that indicated performance. This bar was programmed to be approximately filled for 25% after the first round,

Fig. 1. Visualization of the game in action. The game is displayed on a Digi board, connected to a laptop, and the player stands on a dance mat.

35% after the second, 50% after the third, 66% after the fourth and 75% after the fifth and final round. These scores were experimentally controlled to avoid confounding factors and to ensure increasing progress in each round.

The feedback that was coupled with the progress bar depended on the experimental condition the participants were in, and was based on earlier work on gaming goals [12]. The Self-based feedback was based on 'doing better than before', and thus represented past performance. Hence, the achieved score was visualized as a comparison with the participants' previous score. The Task-based feedback was based on 'beating the game', and thus represented a predefined endpoint. This score was visualized as a comparison to the maximum dance score. The two types of feedback are shown in Fig. 2.

(a) (b)

Fig. 2. Visualization of the feedback participants received after one of the game rounds in the (a) self-based and (b) task-based conditions.

In the final screen, a message was provided to emphasize the reference point. In the Self-based condition, this message was "Well done, you did better than

your previous dance score". In the Task-based condition, this message was "Well done, you did better than 35% of the maximum dance score".

2.3 Materials and Procedure

At the start of the experiment, participants read and signed an informed consent form that informed them about their rights and the procedure of the experiment. Next, they were asked to hand over their phones and take off their watch if they were wearing one. The first round of the game was a trial round for participants to get used to the game. After each round, the game asked participants whether they wanted to play the next round or not. They could step on one of the buttons of the dance pad to indicate whether they wanted to continue.

All participants were required to play the trial round and two game rounds. After this, the experimenter left the room with some papers to "make a copy". Participants were now free to choose whether they continued playing or not. Due to technical issues, however, we were not able to use any data from this free-choice period. After 4 min the experimenter returned back in the room and asked participants to complete a questionnaire consisting of open questions about participants' motivational experiences. These questions asked (1) how participants felt when receiving the feedback on their dance score, (2) how they interpreted this feedback, (3) why the feedback made them feel in a certain way, and (4) what their main goals were during the game.

Participants also completed the Situational Motivation Scale [8] (16 items, $\alpha = 0.86$) and a Task Enjoyment scale [9] (5 items, $\alpha = 0.88$). Since the power of the study is too low to draw statistically valid conclusions from these scales, we decided to not include them in our analyses. Instead, we coded all responses into a description of one or a few words–two coders were used, showing an inter-coder reliability of 81%–, and categorized those codes into themes. We then counted how often each theme occurred in the Self-based and Task-based conditions, so we could get an understanding of participants' motivational experiences while playing the game. At the end of the experiment, participants were thanked for their participation, debriefed and compensated.

3 Results

Responses to the open questions were categorized into themes, leading to six different themes: (1) Motivation (related to enjoying the game and feelings of motivation), (2) Failure (related to making mistakes), (3) Performance (related to achieving high scores), (4) Improvement (related to improving oneself, (5) Physical exercise (related to being physically active), and (6) Self-orientation (that are self-involved, such as referring to 'my score' instead of 'the score').

For each open question, the frequency in which answers fell in the categories was compared between the two conditions, and Pearson adjusted residuals representing the difference between observed and expected values were calculated. A positive residual means that there are more observed responses than are

expected, and a negative residual means that there are fewer observed responses than expected. Residual value that exceed ±2.00 indicate that there is a significant difference between observed and expected values [14]. The remainder of this section will present the findings on each of the four open questions.

3.1 How Participants Felt When Receiving the Feedback on Their Dance Score

This question provides insights into participants' feelings about the feedback in general. A Chi-square test indicated that the pattern of responses to this question differed significantly between the two conditions, $\chi^2(5) = 14.15$, $p < 0.05$. Table 1 shows that this effect is mainly caused by the differences in responses related to Performance.

Table 1. Contingency table of responses to Question 1. For each condition and each category, the table shows the observed response frequency, the expected frequency and the Pearson adjusted residual. Residuals greater or smaller than ±2 are bold printed.

Condition	Motivation	Failure	Performance	Improvement	Physical exercise	Self-orientation
Self-based	14	1	1	14	1	9
	14.0	3.0	5.0	11.5	0.5	6.0
	0.0	−1.7	**−2.7**	1.2	1.0	1.9
Task-based	14	5	9	9	0	3
	14.0	3.0	5.0	11.5	0.5	6.0
	0.0	1.7	**2.7**	−1.2	−1.0	−1.9

As can be seen in Fig. 3, feedback during the game was perceived as motivating in both conditions. This should not come as a surprise given that the game was designed in such a way that all participants improved their scores over time. Interestingly, participants in the Task-based condition were more concerned with their performance, as indicated by the high frequency of performance-related answers. Participants in the self-based condition were more concerned with improving themselves, as seen by the high frequency of improvement-related answers. These findings show that providing self-based feedback makes people more focused on improvement than providing task-based feedback.

3.2 How Participants Interpreted the Feedback

This question provides insights into how participants interpreted the feedback itself while they were playing the game. A Chi-square test indicated that the pattern of responses to this question differed significantly between the two conditions, $\chi^2(4) = 18.06$, $p < 0.05$. As can be seen in Table 2, this effect is mainly caused by the differences in responses related to Performance and Improvement.

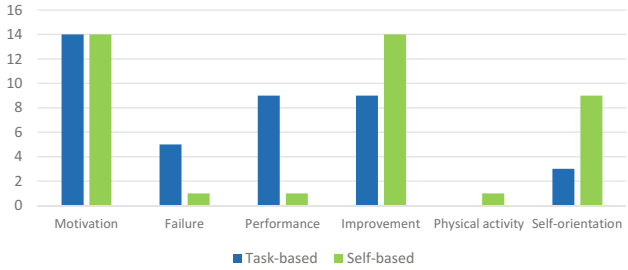

Fig. 3. Response frequencies per category and condition on Question 1.

Table 2. Contingency table of responses to Question 2. For each condition and each category, the table shows the observed response frequency, the expected frequency and the Pearson adjusted residual. Residuals greater or smaller than ±2 are bold printed.

Condition	Motivation	Failure	Performance	Improvement	Physical exercise	Self-orientation
Self-based	4	1	3	15	0	14
	3.6	1.2	10.2	11.3		10.7
	0.4	−0.3	**−4.2**	**2.1**		1.9
Task-based	2	1	14	4	0	4
	2.4	0.8	6.9	7.7		7.3
	−0.4	0.3	**4.2**	**−2.1**		−1.9

An interesting pattern or findings occurred. As can be seen in Fig. 4, the feedback was interpreted as highly performance-related in the task-based condition, showing that participants interpreted the feedback in such a way that it was designed to increase their performance in the game. Participants in the self-based condition, however, interpreted the feedback as improvement-related, showing that they were concerned more with improving themselves over time. This finding clearly shows how the type of feedback made people concerned

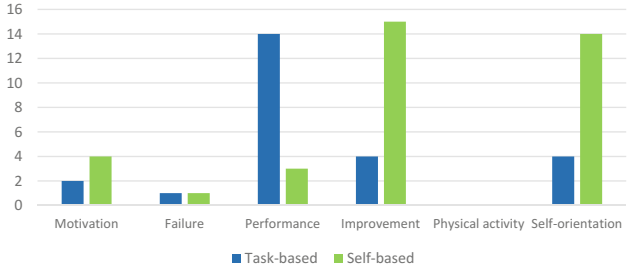

Fig. 4. Response frequencies per category and condition on Question 2.

with either demonstrating or developing competence. Moreover, participants in the Self-based condition provided many self-oriented answers, showing that the feedback manipulation had the intended effects.

3.3 Why the Feedback Made Participants Feel in a Certain Way

This question provides insights into participants' attributions regarding their affective responses to the feedback. A Chi-square test indicated that the pattern of responses to this question did not differ significantly between the two conditions, $\chi^2(5) = 9.23$, $p > 0.05$. As can be seen in Table 3, however, a significant difference did occur on Performance-related answers, showing that participants in the Task-based condition mentioned performance more often than expected, while those in the Self-based condition mentioned performance less often than expected.

Table 3. Contingency table of responses to Question 3. For each condition and each category, the table shows the observed response frequency, the expected frequency and the Pearson adjusted residual. Residuals greater or smaller than ±2 are bold printed.

Condition	Motivation	Failure	Performance	Improvement	Physical exercise	Self-orientation
Self-based	7	2	5	14	1	9
	5.4	2.7	10.2	11.2	1.1	7.5
	1.1	−0.6	**−2.8**	1.4	−0.1	0.9
Task-based	3	3	14	7	1	5
	4.7	2.3	8.8	9.8	0.9	6.5
	−1.1	0.6	**2.8**	−1.4	0.1	−0.9

As can be seen in Fig. 5, responses to this question in general are comparable with those to Question 2. That is, performance was mentioned more often by participants in the Task-based condition, while improvement was mentioned more often by those in the Self-based condition. Though the differences in frequencies are small, they do follow the same pattern in which feedback based on an absolute demand of the task makes people disregard their growth in competence and instead focus on their ability to correctly perform the task.

3.4 What Participants' Main Goals Were During the Game

This question provides insights into what participants regarded as their goals while playing the game. A Chi-square test indicated that the pattern of responses to this question did not differ significantly between the two conditions, $\chi^2(5) = 6.56$, $p > 0.05$. Moreover, no significant effects were found on any of the six categories of responses, see Table 4. This means that the frequencies of responses did not differ significantly from the expected frequencies.

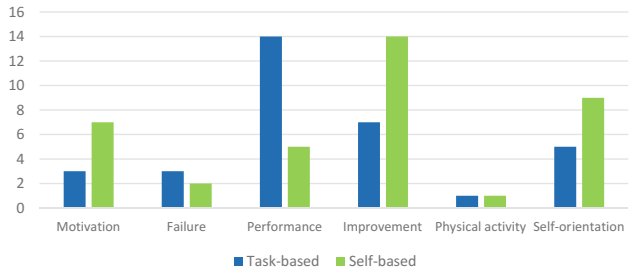

Fig. 5. Response frequencies per category and condition on Question 3.

Table 4. Contingency table of responses to Question 4. For each condition and each category, the table shows the observed response frequency, the expected frequency and the Pearson adjusted residual.

Condition	Motivation	Failure	Performance	Improvement	Physical exercise	Self-orientation
Self-based	14	2	10	14	10	10
	13.1	3.6	13.1	13.7	9.5	7.1
	0.5	−1.3	−1.5	0.2	0.3	1.8
Task-based	8	4	12	9	6	2
	8.9	2.4	8.9	9.3	6.5	4.9
	−0.5	1.3	1.5	−0.2	−0.3	−1.8

As can be seen in Fig. 6, many of the categories show relatively high response frequencies. This can be explained by the fact that the question specifically asked participants to list their three most important goals. Many participants therefore provided answers that were categorized into multiple categories. A participant could thus have provided three goals that fell into the categories Improvement, Motivation, and Performance. This is a consequence of the way in which the question was asked that we did not foresee beforehand, and is something that should be taken into account in future studies.

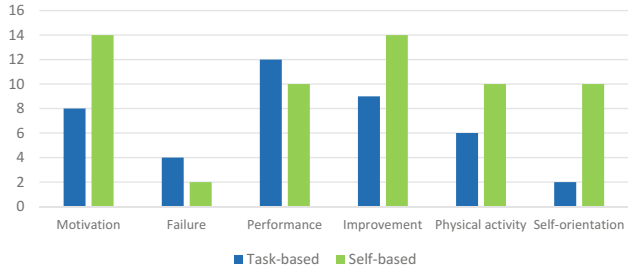

Fig. 6. Response frequencies per category and condition on Question 4.

4 Discussion

The current study was designed to investigate effects of feedback type on people's motivational experiences during a physically active game. Feedback was provided that was either task-based (i.e. focused on the absolute demands of the task) or self-based (i.e. focused on ones own past performance). It was expected that task-based feedback would make people more focused on demonstrating their performance on a task, while self-based feedback would make people more focused on developing their performance by improving themselves.

To test these expectations, an interactive dance game was designed that was able to display feedback on people's performance based on either a maximum reachable score or a player's past performance. People played the game and evaluated the feedback they received through answering open questions. Results confirmed our expectation that different types of mastery feedback yield different motivational experiences. More specifically, self-based feedback mainly elicited motivational experiences in terms of enjoyment, improving oneself, and being self-oriented, whereas task-based feedback mainly elicited motivational experiences in terms of performance and competition.

For the development of feedback systems such as self-tracking devices that are designed to motivate people to live healthier lives, this means that implementing self-based feedback could steer people's focus towards self-improvement. An inquiry in what motivates people to track their own health showed that all important factors are self-related [7], emphasizing the importance of self-knowledge for self-trackers. An important component that enhances the success of health apps is for the feedback or information provided by the app to be event-based [16]. Self-based feedback by default is event based, since it provides information about how one performs compared with an earlier event.

Results of this study could be used for designing and tailoring progress feedback in devices that collect personal information in such a way that it supports engagement and behaviour change. This means that for people who want to live healthier lives, the feedback of personal informatics devices should allow them to compare their current activity level with their previous activity level, instead of mainly allowing them to compare their current activity level with a task-based standard which is often the focus in current self-tracking devices.

4.1 Limitations and Future Work

Because of technical issues we were not able to compare people's motivational experiences with their actual behaviour during the free-choice period. It would be interesting to test whether people who are more focused on self-improvement than on mere performance also continue playing the game for a longer period of time. If this would be the case, this would strengthen our conclusion that progress feedback on activity behaviour should focus on a person's past performance rather than an absolute demand of a task. Future studies could investigate whether this relationship between motivational experiences and actual behaviour exists.

We did not include any measure for whether participants believed that the progress feedback was their true feedback. If participants did not believe that the scores were theirs, this could have influenced their answers to the open questions. However, when participants were asked what they thought the experiment was about, none of the participants who were included in the analysis showed any suspicion. Nevertheless, the credibility of feedback of self-tracking devices is an important issue, because they can evoke emotional responses [1,15]. Future studies that investigate effects of feedback type on people's motivational experience and behavior should include a measure for testing whether the feedback is believed to be true.

As this study is a first attempt of investigating effects of different types of mastery feedback on motivational experiences, more research in this field is needed to validate the results. For example, it could be investigated whether the mastery standards influence people's true performance or whether these effects also occur on health related behaviour (rather than in an activity game context). Future studies could also focus on more longitudinal designs to investigate effects of feedback on motivational experiences and apply combinations of task and self-based goals strategies.

4.2 Conclusions

The current study shows how different types of mastery feedback can influence people's motivational experiences while playing a physically active game. These findings are relevant for the design of self-tracking devices or behaviour change technologies in general, as they show that feedback based on past performances increase people's focus on self-improvement. We hope that these findings ultimately contribute to creating devices that truly motivate people to live healthier lives.

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