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PERSONALISING APPLICATIONS TO INFLUENCE HEALTH-RELATED BEHAVIOUR: AN EXPLORATION OF DIFFERENCES IN MOTIVATION

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Abstract

To support health-related behaviour changes, consumers may use technologies such as smartphones, smartbands, sensors and other devices connected to the Internet of Things. Research has shown that personalising the interaction, including the interface, data, and feedback, can result in more effective outcomes in terms of the desired changes in behaviour. This paper reports on a pilot study that tested a smartphone step challenge application that was personalised based on the user's motivational style using the Behavioural Inhibition System/Behavioural Approach System (BIS/BAS) scales of Reinforcement Sensitivity Theory. The results indicated that participation in the step challenge did change the behaviour of the participants. For half the days of the challenge, the application delivered pep talks tailored to the two motivational styles and to the participant's behaviour (taking more or fewer steps than on the previous day). While the study found that participants with different motivational styles responded differently to the motivational cues (pep talks), their responses did not appear to be influenced by the personalisation of the pep talks.

Keywords: Personalisation, Motivation, Behaviour, Internet of Things, Health

1.0 Introduction

The Internet of Things provides a network of connected devices that may be used to support the achievement of goals related to health and wellness (which we will refer to together as “health-related” in this paper). Connected smartphones, smartbands, sensors, applications and their associated data utilise networks and the cloud to enable the collection and sharing of data across platforms and among stakeholders. We have seen the widespread adoption of consumer-focused wearable technologies that allow

tracking and monitoring (Fritz et al, 2014) as well as an explosion of smartphone applications that promote health by supporting users in setting and achieving health-related goals. Users of these systems can become active participants in the management of their own health rather than being passive recipients of healthcare services via the ability to capture and monitor health data, to set goals, and to utilise procedural support features to aid in promoting engagement and achieving goals (Ohlin et al, 2015). However, there is some question as to how well these applications support users over the long-term, and specifically how well they support health-related behaviour changes (Halko & Kientz, 2010).

Research has found that unless these applications facilitate changes in behaviour and provide strategies for maintaining the change, behaviour tends to return to the pre-use state (Fritz et al, 2014; Klasnja et al, 2011). Research has also shown that a one-size-fits-all approach is generally not successful; personalised systems for promoting behaviour change are more effective (Cole-Lewis & Kershaw, 2010; Fan & Poole, 2006; Hsieh et al, 2014; Kaptein et al, 2012). By integrating theories of motivation and personalisation for behaviour change with current technologies, we can better design and develop consumer-focused healthcare improvement systems that will be utilised over time to achieve the desired results (Klein et al, 2014; Oinas-Kukkonen & Harjumaa, 2009; Russo & Eriksson, 2016).

The purpose of this study is to investigate the impact of personalised motivational feedback on changes in behaviour. Specifically we examine changes in behaviour (engagement with the application and number of steps taken per day) as related to personalised motivational messages delivered via a smartphone application in a step-challenge competition. The motivational messages are tailored to the user's performance and the user's identified motivational style. In the next section we identify the primary theories of motivation and personalisation related to behaviour change that influenced the study. We then discuss a pilot study that tested a method of implementing personalisation based on a particular personality trait related to motivation. The paper concludes with observations and recommendations for future work.

2.0 Theoretical Background

Motivation is generally described as an internal state that activates and maintains behaviour (Kleinginna & Kleinginna, 1981). While it is possible to study motivation as a biological mechanism, for our purposes it is more useful to build on research that has examined motivation from a social psychology perspective wherein behaviour is assumed to be influenced by both internal (intrinsic) and external (extrinsic) drivers. The most widely studied of these theories in relation to health-related behaviour change is Self-Determination Theory (Deci & Ryan, 2008).

According to Self-Determination Theory (SDT), all individuals have basic needs for a sense of competence, autonomy and relatedness; the degree to which these needs are addressed influences the type of motivation (intrinsic or extrinsic) and thus the likelihood of achieving the behaviour change (Deci & Ryan, 2008). To successfully modify behaviour, individuals must know that they have the necessary skills and the ability to control the behaviour. This enables the integration and internalization of motivation, so that the driving force is intrinsic. Relatedness, which is “the sense of being respected, understood, and cared for” is also essential to the process of internalization through which individuals initiate and sustain desired behaviours (Ryan et al, 2008, p. 3).

Technology can be used to influence individuals’ attitudes and behaviour. These so called persuasive systems may reinforce current attitudes or behaviours, making them more resistant to change, or attempt to change attitudes or behaviours towards a desired outcome. (Oinas-Kukkonen, & Harjumaa, 2009). Persuasion can be accomplished through targeted use of messages, interfaces and modes of communication that are personalised to particular individuals or groups of individuals. The use of personalised feedback has been shown to be more effective than generic feedback in a number of health-related areas (Berkovsky et al, 2012; Dijkstra & De Vries, 1999; Halko & Kientz, 2010; Kaptein et al, 2012; Noar et al, 2007).

Advances in sensor technologies and the ability to rapidly process data related to personal preferences and behaviours enable the personalisation of persuasive

technologies to more effectively support behaviour change. “This type of personalisation can help tailor different technologies to be more effective at behaviour change by looking at users’ unique motivations, personalities, or preferences, which will make them more likely to be effective in evoking change” (Hsieh et al, 2014, p. 108).

Personalisation may address a number of dimensions. Fan and Poole (2006) identified three potential personalisation dimensions: what, who, and how. The first dimension refers to the particular information that is provided, the user interface, the media by which the information is provided, and functionality regarding what the user can do with the information. The ‘who’ dimension of personalisation can be targeted to a group of users (based on some specified criteria) or to a specific individual. The third, or ‘how’ dimension describes the role of automation in creating the personalised experience. If the personalisation is user-initiated, the user drives the explicit personalisation by selecting options or by providing information. System-initiated, or implicit, personalisation is driven by contextual data and algorithms. In addition, personalisation may be static or dynamic (Fan & Poole, 2006). Dynamic personalisation implies that the feedback given to the user may be dynamically customised based on the user’s current context, possibly based on the current state, attitudes, behaviours, etc. A meta analysis of health behaviour studies found that studies which involved more intervention contact points with feedback that changed based on the context “were more effective in stimulating health behaviour change than those that did not” (Noar et al, 2007, p. 686).

Reinforcement Sensitivity Theory (Gray, 1991) relates motivation to aspects of an individual’s personality. The theory suggests that two dimensions of personality – the behavioural approach system and the behavioural inhibition system – are related to individual differences in responses to particular stimuli, including behaviours in response to motivational stimuli. The behavioural approach system (BAS) responds positively to stimuli related to rewards and reacts impulsively to move toward positive outcomes. The behavioural inhibition system (BIS) reacts to avoid negative outcomes which cause anxiety, such as punishment or change. Individuals have different motivational dispositions, or sensitivities, to positive and negative stimuli, and can be identified as having a dominant BIS-activation or a dominant BAS-activation. If we

know an individual's dominant activation system, persuasive technologies can be personalised so that the information provided (feedback, status, encouragement, etc.) are congruent with the individual's personality and thus more likely to result in motivating the individual to achieve the desired behaviour change.

While this of course is just one of many different theories related to personality types, its parallels with other major personality scales and the availability of relatively concise measurement scales made it appear suitable for our purpose. For example, Cloninger's Temperament Character Inventory (TCI), a personality index which runs over four temperamental factors and three more character specific categories (Hansenne, Delhez, & Cloninger, 2005) includes aspects of motivation. The theory's scales for temperamental factors "harm avoidance" and "reward dependence" have been found to be correlated with BIS-activation and "novelty seeking" and "persistence" have been shown to be good predictors of BAS-activation (Mardaga & Hansenne, 2007).

In summary, previous research indicates that it is possible to personalise persuasive technology to align it with individual personality characteristics in order to motivate individuals to change behaviour. In this exploratory study, our aim was to evaluate our ability to implement these concepts in a fairly simple prototype, and then to test the prototype with users to determine (1) if there are differences in behaviour between the users identified as BIS-dominant and BAS-dominant using a common, concise instrument (described below) and (2) if we can create targeted motivational feedback based on these personality types (BIS/BAS) that is more effective in achieving behaviour change.

3.0 The Study: Step Challenge

As part of a broader interest in designing responsive, context-aware Internet of Things systems, we sought to examine changes in behaviour (engagement with the application and number of steps taken per day) as related to personalised motivational messages delivered via a smartphone application in a step-challenge competition. Increasing the number of steps taken per day is a positive change in behaviour to improve health. The personalisation would take the form of different types of

feedback messages (called “pep talks”) delivered via pop-up messages in the smartphone application. The messages would be geared to support a particular motivational style, which we identified as dominantly BIS-activated or BAS-activated, and dynamically tailored to the participant’s behaviour (steps). In addition to accessing the device’s pedometer (step counter), the application would also have information regarding when the user opened the application and for how long (engagement).

Each of the participants was randomly assigned a partner in the step challenge. The purpose of this was to provide a standard level of “relatedness” which has been identified as one of the necessary states for motivation (Deci and Ryan, 2008). The participants could see the name of their partner (who was in the same location), and step data was shared between the partners.

The application was administered via Sony Mobile’s Lifelog platform (Sony Mobile Communications, 2016). This platform was selected because of access to data and the ability to provide a custom application related to the step challenge. (One of the researchers was employed at Sony Mobile at the time of the study.) Lifelog both records steps (and other user and usage information) and displays this in a graphical way for the user. An example is shown in Figure 1.

3.1 Determining Personality Type

Prior to beginning the step competition, the individual’s predisposition towards BIS- or BAS-activation was measured using Carver and White’s BIS/BAS scales (1994; 2013). This is a 24-item questionnaire, on which respondents report how much they agree or disagree with each statement (on a 1-4 scale). The responses were scored to indicate the strength of responses on the BAS-scale and the BIS-scale, in percentage terms. The difference between the two values (BAS-score minus BIS-score) gave a summary value which could be used to indicate higher BAS-activation (a positive value) or a higher BIS-activation (a negative value). An example of the implementation of the questionnaire is shown in Figure 1.

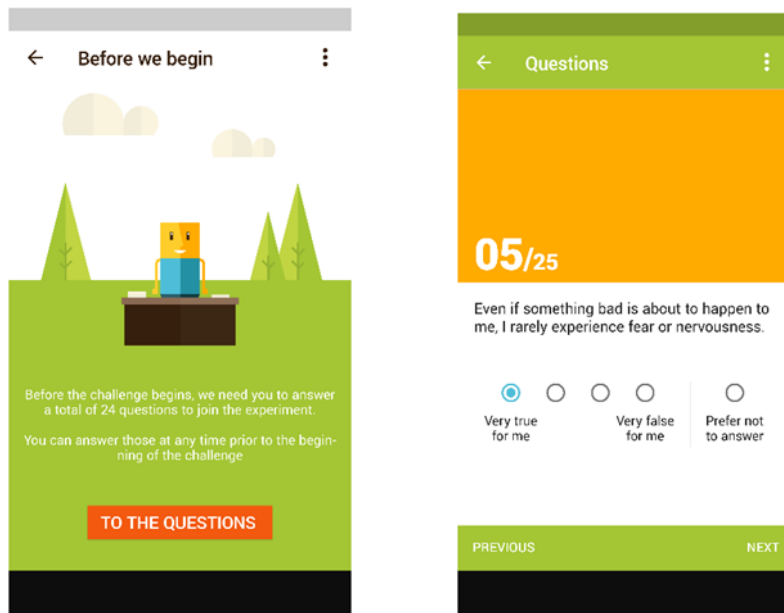


Figure 1. Screen shots from step challenge application.

3.2 Motivational Messages: Pep Talks

The content of the messages was based on Reinforcement Sensitivity Theory (Gray, 1991) to reflect the characteristics of BIS-activation and BAS-activation. The messages are presented in Appendix 1. Based on the underlying theory, it was assumed that BAS-dominant individuals would be more impulsive, demanding, reward-oriented, extroverted, risk-taking, socially comfortable and more easily become addicted (Carver & White, 1994; Jorm et al, 1998). The messages were more of the nature of a coach who pushes participants to excel and focuses on the competitive aspect of the challenge. Examples of messages targeted to more BAS-activated individuals were “This won't do, you'll have to pick it up. You need more steps today to beat your scores from yesterday!” or “Good, better than your step count yesterday! Let's keep at it for the best score so far!”

Those with a higher BIS-activation were assumed to be more sensitive to social punishment, cautious and resistant to something new, slightly frustrated, and possibly anxious, (Carver & White, 1994; Jorm et al, 1998). Messages for the BIS group were supportive, intending to incorporate a sense of competence, to be encouraging while at the same time lightly challenging, and to support social involvement in the creation of a "we" feeling. Examples of these were:

“You and your partner have taken more steps during the day together. Your cooperation is what makes the difference-WELL DONE!” and “You've walked less than yesterday's step count at this point of the day. Working towards doing more steps than yesterday is the goal but you do what you can and have time for.”

3.3 Participants

Users were recruited from employees at two locations of Sony Mobile: Sweden and Brazil. Although approximately 100 users volunteered to participate, our sample contains 43 users. (See Table 1.) Users were filtered out for a number of reasons including not having a clear BIS/BAS dominance score due to unanswered questions or lack of activity in the competition itself (more than 2 competition days with zero steps captured). The two groups (BIS-dominant and BAS-dominant) were fairly evenly represented in the sample with 21 BAS-dominant and 22 BIS-dominant participants. The majority of the participants were male and from Brazil, as shown in Table 1.

	Female	Male
Brazil	6	23
Sweden	1	13

Table 1. Country and Gender of Step Challenge Participants.

3.4 The Experiment: Step Challenge

Participants first had to download the application. This was an Android application, created specifically for this study to work with Sony's Lifelog platform. Then participants were asked to respond to the questionnaire. They provided some demographic details (name, etc.) in the first question and then answered the 24-items of the BIS/BAS scale. A partner from the same location was randomly assigned. Partners did not have to have the same BIS/BAS orientation because all behaviour measures and pep talk messages were at the individual level.

The experiment lasted for eight days during which the steps taken by the participants and the use of the step challenge application were automatically recorded. The application presented pep talks, implemented via pop-up messages (constructed from the BIS/BAS theory as described above) to participants three times a day for four days

each. This allowed a comparison of days with pep talks versus days without pep talks.

At any time during the competition the participants could check their status in terms of number of steps and in comparison to the other teams. At the conclusion they were told their team's final position in the challenge and given an exit questionnaire. This questionnaire asked about the participant's attitude regarding the pep talks and the competition in general.

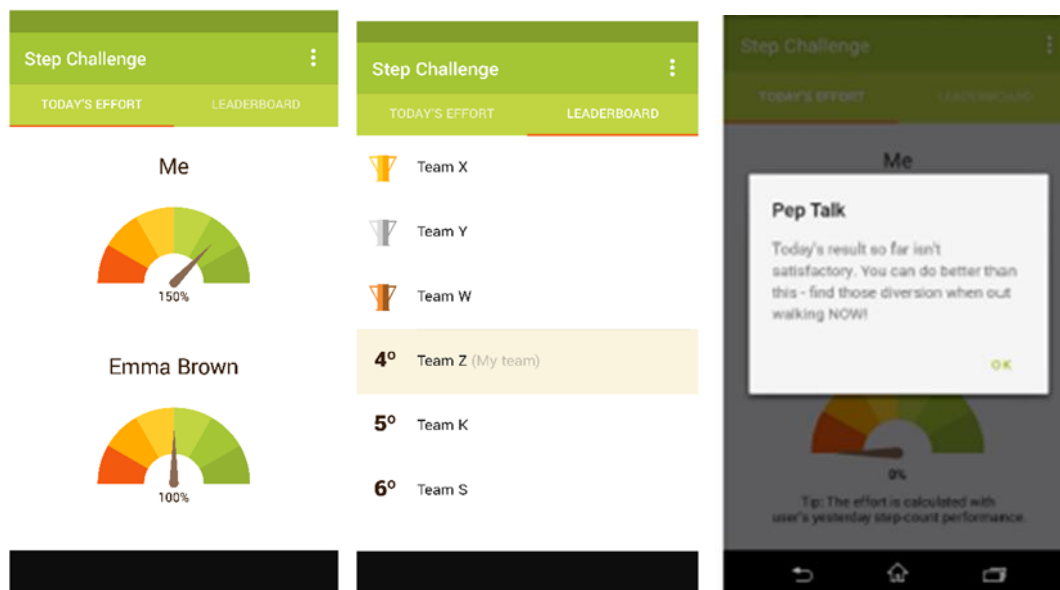


Figure 2. Status and pep talk screen shots from step challenge application.

4.0 Results

One of the primary aims of the study was to determine if there were differences in behaviour between the users we identified as BIS-dominant and those we identified as BAS-dominant. We measured two behaviours: steps and engagement with the application.

The median number of steps was 4644 per day. Both BIS and BAS-dominant users took more steps during the competition than they did before the competition. To more clearly measure the impact of the competition, we needed to determine whether the participants took more steps during the competition period than during their

baseline measure. We used four non-zero step days prior to the competition for comparison.

We found that all users increased their step counts during the competition; this was significant for the entire group as well as the BIS and BAS subgroups. We expected the BAS group to have higher relative step counts than the BIS group, but this was not found.

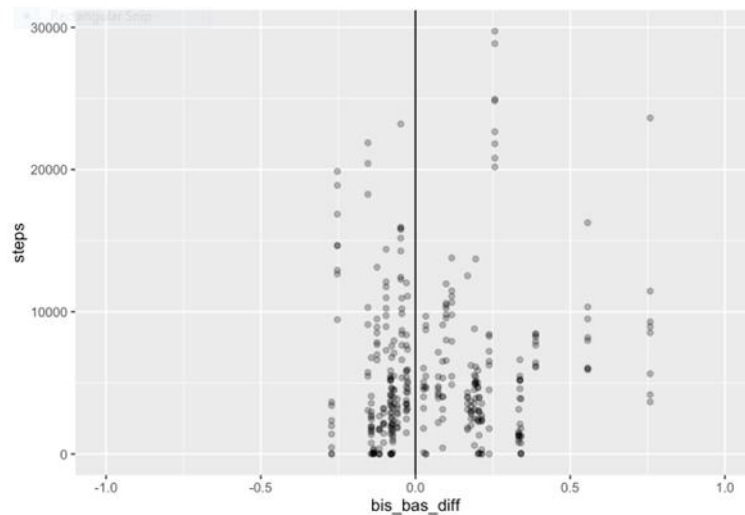


Figure 3. Plot of daily steps versus BIS/BAS score. (Scores between 0.0 and 1.0 reflect dominance of BAS-activation and scores between 0.0 and -1.0 reflect BIS-activation.)

We expected to see that the participants would walk more on days they received the pep talks, but this was not found in the data. This was particularly true of the BIS-dominant participants. The data indicated they were walking less on the days with pep talks.

We found that the median user visited the application slightly more than two times per day (minimum 0, maximum 31). The total visits per person ranged from 8 to 154, with a median of 17 (mean 24.58). No significant difference was found between the BIS- and BAS-dominant groups in terms of overall engagement with the application.

In general, we found that users did engage more with the application on the days they received pep talks. When we looked at differences between the two groups, BIS-dominant users did engage more with the app when receiving pep talks. BAS-dominant users did not.

During the study the groups were broken down further, and a portion of the BAS-dominant users received BIS-type pep talks and a portion of the BIS-dominant users received BAS-type pep talks. However, no significant differences were found between the groups in terms of steps or engagement.

After the competition the users were given a final questionnaire with two questions regarding their perception of the pep talks. These were:

- What's your general impression of the pep talk messages? (4-point scale of positive to negative)
- What part of the pep talks did you feel gave you the most value? Was it the factual information or the stimulating phrases to keep at it?

About half of the users thought the pep talks were positive and the other half thought they were negative (19 vs 20). The majority said it was the factual information that was more valuable.

Some differences were found when comparing the BIS and BAS groups. BIS-dominant users in general were not so happy with getting any type of pep talk (12 negative vs 6 positive). BIS-dominant users that got mismatched pep talks (pep talks that were in the BAS-dominant style) were all negative (4 out of 4). BAS-dominant users were mixed about the pep talks, and their results were the same regardless of whether the pep talks matched or did not match their BAS-dominant characteristics. Thus it appears that BIS-dominant users are sensitive to pep talks/feedback and they are specifically negative to pushy BAS-type pep talk messages. BAS-dominant users are mixed about pep talks, half like them and half don't but they don't seem to care what type of feedback it is.

5.0 Discussion

The results of this exploratory study were less conclusive than we had hoped. The discussion therefore explores some of the potential reasons why we found few differences between the groups and minimal impact of the personalised pep talks.

There are a number of possible reasons that we observed very little difference between the two user groups in terms of behaviour. The small number of participants and the limited time period of data collection may have contributed to the lack of significant differences between the groups. One possible explanation is that the instrument used did not accurately differentiate between the two motivation types. While not without limitations, the instrument has been tested in many environments, and found to be a valid technique (Jorm et al, 1998). Thus while the overall scales may be appropriate, it may be that our method of identifying the dominant activation style (BIS/BAS) as a binary variable was too simplistic and did not reflect the relative strength or weakness of each personality trait for the individual participants (since in fact most individuals display some of both types). And as can be seen on the scatter plot shown in Figure 3 above, our users were tightly clumped around the centre, particularly on the BIS side, so we may have had two groups of users who were not vastly different from each other in terms of motivational styles, which is possible since the participants were mostly males working in similar technology-related roles. Another explanation may be that the particular pep talk texts used were not strongly enough related to the different motivation types, or were not perceived as significantly different by the participants.

We can describe the personalisation used in this experiment in terms of Fan and Poole's (2006) three dimensions of personalisation (what, who, how). On the first dimension, there was a fixed set of information available to the users (effort/steps, position on leader board) but these were personalised in that they displayed the individual's team results. The pep talks were personalised based on the BIS/BAS level and the comparison of the individual's steps with the previous day. This personalisation illustrates the second dimension: the personalisation was based on the BIS/BAS-activation score and steps. Regarding the third dimension, the personalisation was dynamic in that it changed according to the behaviour of the user in terms of number of steps taken (compared to the day before). The selection of which pep-talk message to display was autonomously determined by the application, and thus implicit from the user's perspective.

It may be that users should have more control of the personalisation. This has relevance not only for how personalisation of the application is done but also for how

the motivational cues are achieved. Research (Fan and Poole, 2006) has suggested that people react differently to systems that they perceive are explicitly controlled by humans versus systems that respond autonomously (implicit personalisation). If users had been given the option to control whether or not they received pep talks, and what type, and how often, we may have seen greater differences between the groups.

The post-challenge questions regarding the pep talks give us some insight into our participants' responses (or lack thereof) to the pep talks. While the BAS-dominant participants were evenly split between positive and negative impressions of the pep talks, the BIS-dominant participants overall had a more negative impression of the pep talks, and those who received BAS-type pep talks were particularly critical. Therefore it appears that the use of pep talks in general may not be an appropriate means of motivating BIS-dominant participants, and when such motivation cues are used, care should be taken to see that they are written in a style that is not offensive to BIS-dominant participants.

6.0 Conclusions

The issue of how to design technology to support motivated behaviour in a way that enables the user to achieve effective performance (and without experiencing undue stress) is especially relevant in applications related to health behaviour (Szalma, 2014). While we were able to develop a real world application that users found pleasant to use, and that resulted in a measurable change in behaviour while using the application, we did not see the expected impact of the personalisation of pep talks based on motivation type.

This exploratory study was based on a small sample of only 43 participants, primarily male, from two locations of a single organization. The study was conducted over a short time period of only eight days. As such we cannot make statements regarding the long-term impact of this intervention. The personalisation was based on only one personality trait (BIS/BAS-activation) and the accuracy of the pep-talk texts in targeting BIS/BAS activation was not tested before this study.

Nevertheless, this study serves as a pilot upon which we can build larger-scale studies. To extend this work, a larger sample (with participants from a broader, more diverse group) would be needed. Different types of motivational cues could be examined. The timing and amount of feedback could be varied, as well as whether the level and type of personalisation is determined by the application or directed by the user. The experiment should be conducted over a longer time period, and behaviours (in this case step counts in particular) should be measured over months or even years. It would be useful to study the different outcomes when participants compete individually versus with partners or in larger teams. In this step challenge participants' steps were compared to their own performance as well as the performance of others. Evaluation of performance when no comparison is provided, or when the participant is compared only to his or her own results, could provide additional clues as to how best to motivate behaviour change.

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Appendix: Pep Talk Texts

BAS-Dominant Texts		
#	More steps than yesterday	Fewer steps than yesterday
1	Hi and welcome to the competition! Here's your first of many pep talks. I will show up three times a day, at 08:00, 11:00 and 17:00, during the coming four days. So, on with your shoes and get out to take as many steps as you can manage!	
2	Ok, you've been at it for a couple of hours. Keep at it, time for you and your team partner to work your way up the leaderboard!	
3	Finally we're at the end of the afternoon and you can work up even more steps now when the work day is close to an end.	
4	Here we are again, all powered up at the beginning of a new day. The steps you take today will really make a difference!	
5	You have walked more than yesterday's step count at this point of the day. Take a walk after lunch to increase your metabolism.	You have walked less than yesterday's step count at this point of the day. Take a walk after lunch to increase your metabolism.
6	Great work today, but we know you can do even better! Go go go!	This won't do, you'll have to pick it up. You need more steps today to beat your score from yesterday!
7	Good morning contestants! Today's the great diversion day. Take as many diversions as you can today when out walking to increase the amount of steps even further!	
8	Good, better than your step count yesterday! Let's keep at it for the best score so far!	Today's result so far isn't satisfactory. You can do better than this - find those diversion when out walking NOW!
9	You've walked more than yesterday's step count at this point of the day. Take the long way around to your car, bike or train now on your way home.	You've walked less than yesterday's step count at this point of the day. Take the long way around to your car, bike or train now on your way home.
10	Good morning! Today's the last day of the pep talks. Time to make sure there's a prize waiting for you at the end and to show your competitors who's the boss!	
11	Super! Better than yesterday, but let's work even harder now for that chance at the prize pool!	Ouch, you need to work more at this to increase your bonus and have a chance at the prizes at the end.

	BIS-dominant texts	
#	More steps than yesterday	Fewer steps than yesterday
1	Hi and welcome! Here's your first pep talk. I will show up three times a day, at 08:00, 11:00 and 17:00 over the next four days.	
2	IF > 1000: Well done! You've done more than a <u>thousand steps already today!</u>	IF < 1000: I see you haven't done that many steps today yet, <u>but there's still plenty of time.</u>
3	You and your partner have taken a great sum of steps during the day together. Your cooperation is what makes the difference - WELL DONE!	
4	Another day with new steps to take. You and your partner are on the go!	
5	You've done more than yesterday's step at this point of the day. Keep at it!	You've done less than yesterday's step count at this point of the day. Keep at it!
6	Good, you've done better than yesterday at this point of the day. Keep at it, your hard work is what makes the difference.	You haven't yet matched yesterday's step count, but that's ok! You know that you're working on it!
7	Good morning! You're doing well and today you're going to do a lot of steps. Work it!	
8	You've walked more than yesterday's step count] at this point of the day. Working towards doing more steps than yesterday is demanding but you do what you can and have time for.	You've walked less than yesterday's step count at this point of the day. Working towards doing more steps than yesterday is demanding but you do what you can and have time for.
9	Last message of the day. I hope you're feeling ok with today's effort, because no matter what, your work is worth a reward, so give yourself a treat.	
10	New day, new energy, new steps to take!	
11	It's almost lunch. If you want you can always take a walk afterwards to increase the metabolism.	
12	This is your last pep talk. You've taken a lot of steps these four days. Keep fighting, you're awesome!	