Persuasive Systems Design and Self Determination Theory: Mapping System Features to Intervention Framework to Foster Motivation

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Abstract

To study the effects of a persuasive system on system users' behaviour, it is important to know what content was delivered via the system and how. This paper presents a mapping of Persuasive Systems Design (PSD) features and key elements for autonomous motivation, as presented in Self Determination Theory (SDT). These were used in an actual design of a Behavior Change Support System for micro-entrepreneurs' occupational health. The mapping shows how the theory guiding the intervention was realized through the persuasive system features. This exercise illustrates the need for specifying what feature of a system are built for which purpose so that it becomes easier to assess and evaluate how exactly a system has delivered the behavioural change and outcome.

Keywords

Behaviour Change Support Systems, Persuasive Systems Design, Self Determination Theory

1. Introduction

In order to study the effects of a persuasive system on system users' behaviour, it is important to know what content was delivered via the system and how. There are numerous approaches to behaviour change [1, 2]. While conceptual frameworks for behaviour change themselves may be well described for what they aim to achieve and how, what often remains with the persuasive technology as a delivery channel is the question of how does a technology channel deliver the desired intervention?

A "black box" phenomenon where an intervention is delivered using an information system but where the system is not described in detail [3] means that only a selection of the mechanisms at play in the delivery of a behaviour change intervention are known and explorable. With such a plethora of intervention techniques available, is it possible to use a

structured systems design approach in order to build a system where we can see how intervention content becomes a part of a system and how it is presented in the system features?

This paper discusses the amalgamation of the objectives of autonomy and appropriate motivation as they arise from Self Determination Theory (SDT) [4] and the process of selecting an effective set of persuasive system features as described in the Persuasive Systems Design (PSD) model [5]. SDT highlights the basic psychological needs of autonomy, competence and relatedness [4]. The fulfilment of these basic needs is discussed as the means for achieving the kind of intervention tone that can facilitate the type of motivation that would help system users achieve their behavioural goals [4]. While SDT informs the implementation of the intervention content, that is, the topics and materials for the problem domain together with selection of Behaviour Change Techniques (BCTs) used in the intervention, the persuasive software has to find concrete ways of operationalizing these in practice – which is where a systematized approach to developing information technology needs to be brought in and is done here in the form of the PSD model.

In this paper we investigate the following questions:

- How do system features affect motivation factors not only in terms of system use itself, but in order to start, carry on and commit to behaviour change?
- Do system features facilitate the kind of motivation that is conductive to behaviour change and sustaining new behaviours?

By presenting the mapping of behaviour change intervention requirements in tandem with the system feature selection from the PSD model we hope to contribute to both researchers and practitioners in showing how handling the principles and concepts arising from various theories and frameworks can come together in an evidence-led approach. Such an approach will, then, help produce persuasive systems that not only deliver intervention content in some manner but does it in a way where we can more easily trace the effects of the system through its exact features. We also expect to see how such a mapping exercise will illustrate, in a systematic fashion, where and how intervention-guiding theoretical principles and system development support each other and whether there are areas that require further attention – whether done as part of design iterations or post-hoc, as in the present study.

2. Background

Carefully constructed Behaviour Change Support Systems (BCSSs) have been shown to support behaviour change in a variety of domains such as physical exercise [6, 7] and dietary behavior [8]. However, it has also been acknowledged that a system, regardless of its quality or distinctive features, alone cannot achieve the behavioural results the system user is after: a degree of motivation is also needed so that the system user starts the utilization in the first place and keeps up with the wanted behaviour also in between using the system. The present paper explores the relationship between system features and motivational determinants.

A BCSS is an information system that persuades without coercion or deception [3] and as such, then, provides support that a person chooses to make use of in order to gain some behavioural goal, a change in his or her present behavioural patterns. To make such a choice a person has to have motivation, but as is known, motivation is not a simple on/off binary with volume control: according to [4, 9] research into motivation can identify six types of

motivational orientations that are dynamic rather than static, and that are not character traits. From early on the fields of persuasive technology and behavioural sciences have highlighted the role of motivation as one of the three key elements present in successful behaviour change: opportunity, capability and motivation. The three are discussed, for instance, by Fogg [10] and later form a significant part of the Behaviour Change Wheel (BCW) by Michie, et al. [2].

Considered from the perspective of behaviour change, motivation can significantly affect learning results: the more external the locus of causality, the more resentment and reluctance can be involved in the learning process and the thus poorer the results [4, 9]. Learning a new behaviour, requiring that right kind of motivation, should be no different and therefore the necessity to facilitate proper motivation with a degree of autonomy is important for persuasive systems. System features that facilitate the right tone, content, messages and style of interaction should, considering the theoretical implications of SDT, make a difference between fostering autonomy or pushing external control in a system user's motivational orientation.

2.1. Self Determination Theory: basic needs and motivation

Self-determination theory views motivation as stemming from basic psychological needs of autonomy, competence and relatedness [4, 11]. Autonomy means an experience of oneself as the source of activity and action, having the opportunity to express free will in a given activity. Competence refers to a person's experience of oneself as a genuine actor who is able to achieve the things they want, and who is able to make use of their own abilities. Relatedness refers to being understood and appreciated. Satisfaction of all three needs is essential for the balanced well-being and ability to change and grow. Furthermore, these basic needs are interconnected: for example, increase in perceived autonomy can lead to an increase in perceived competence [9, 12].

Essentially, seeing motivation stemming from these three psychological needs means that we pursue goals, domains, and relationships that foster and support this needs satisfaction [4]. Ryan and Deci [4] point out that motivation is not merely a question of how much motivation there is, i.e. the amount, but the type or orientation of that motivation – that motivation involves "the underlying attitudes and goals that give rise to action." (p. 54).

An SDT sub-theory, Organismic Integration Theory [11, 12] distinguishes three categories and within the categories six types of motivational orientation that essentially vary in the degree of autonomy as regards their regulation; these are intrinsic motivation, four types of extrinsic motivation, and amotivation. From the least autonomous to the most, the four types of extrinsic motivation are: externally regulated, interjected, identified, and integrated. Externally regulated and interjected tend to be considered the least autonomous types where the motivation for carrying out a task comes not only from some instrumental need to obtain an outcome, but the impetus for the task is external to the person carrying it out: a demand, deadline, order, expectation, guilt, or some other form of pressure is at work in these cases. Identified and integrated motivation, however, represent a state where a person is able to identify with the values involved in the activity or a task and even consider obtaining the goal as a part of his or her identity [9, 12, 13]. The level of autonomy for the identified and integrated orientations can be high, as in intrinsic motivation, but at the core the motivation still is towards obtaining a goal, not doing and activity for the sake of itself. The latter is the definition for intrinsic motivation [11, 4]. The state of amotivation describes a situation where a person has not obtained or identified any reason at all for completing a task or doing an activity, effectively

not quite knowing why he or she is doing it at all [11, 4, 12]. The more autonomous the motivation, the more likely that a person will be capable of making behavioural changes and maintaining new behaviours [9].

As regards intrinsic motivation, the Cognitive Evaluation Theory [14, 15] explains how context and environment can affect intrinsic motivation either by facilitating or decreasing it. However, according to Ryan and Deci [12] most of what we do in everyday life is not intrinsically motivated and we can assume that for many people lifestyle changes are not motivated by the innate joy in pursuing a new diet or exercise regime but by the results that can be gained by such changes. Thus, it is necessary to consider factors and environments that facilitate identified and integrated regulation as well as intrinsic motivation. Ryan and Deci [12] have found evidence to support an assumption that identified and integrated regulation, like intrinsic motivation, are supported by fostering and facilitating the three basic needs as described in the SDT [12].

2.2. Persuasive Systems Design Model

The Persuasive Systems Design (PSD) model presents a means for analysis, design and development of persuasive information systems [5]. The model presents founding postulates for persuasive systems, steps for analysing the context of the system (intent, event, strategies), and selection and design of system features [5]. In the present case, this context analysis of who is persuading whom and why, knowledge of the target group and their behaviours, and understanding of possible delivery strategies was used as the basis of selecting core system features from the four main support categories presented by the PSD model. These categories are Primary Task Support (including persuasive software features such as Reduction, Self-monitoring and Rehearsal), Dialogue Support (e.g. Praise, Reminders and Suggestion), System Credibility Support (e.g. Trustworthiness, Real-world feel and Surface credibility), and Social Support (e.g. Social comparison). For more details on the PSD model, see Oinas-Kukkonen and Harjumaa [5].

3. Case: Behaviour change support system for micro-entrepreneur health

The BCSS discussed in the present paper is a mobile app developed for a defined target audience of micro-entrepreneurs. A micro-enterprise has fewer than ten employees, and quite typically a micro-entrepreneur works alone. In terms of health behaviour, long working hours is a characteristic of micro-entrepreneurs: more than half (55%) of those who work alone and a third (35%) of those who have employees report working 48 hours or more per week [16]. Heavy workloads together with other factors such as financial insecurity are known to be significant stressors [17].

In order to address the health consequences arising from the micro-entrepreneurial lifestyle in a manner that would bring support to the target group with as little disruption as possible, a mobile app was developed. The goal of the app was to offer lifestyle and health behavioural support and guidance leading to better ability to work and recovery from work [18]. The app provides content for micro-entrepreneurs to become motivated about behaviour change and to achieve optimal or manageable levels of stress, effective work hours, recovery from work each day, sufficient and good quality sleep, regular meal plans and healthier diet, and physical

exercise (both for sedentary work and for those in physically strenuous work) [18]. The intervention's psychological approach was based on SDT, given the promise this theory approach has shown so far [18, 19, 20].

4. Defining behaviour change techniques

In our case, the context analysis done as presented in the PSD model, supported by literature reviews and focus group sessions, directed the development to select a mobile application as the delivery method, as well as indicated that interaction bursts should be kept simple, short and not too frequent on any day. The types of work done by micro-entrepreneurs varies significantly from work that is done from home on the computer to running bed and breakfasts to long-haul lorry driving. Therefore, the content and their delivery could not be designed for any single use case. The context analysis and other end-user research done in the project also produced a small number of end-user personae which were drawn together in the project to help developers and content providers visualize some core characteristics that micro-entrepreneurs might have in common as well as to remember how different from each other they might be. The defined system features are presented in a following section of this paper.

In content development, expertise with the problem domain (entrepreneurship and occupational health) and SDT were brought together in drafting what the mobile app would deliver. The teams gathered evidence on effective BCTs based on previous meta-analyses and reviews and reflected upon them in the light of the motivation-facilitating targets from SDT. Brought together with the feature analysis from the PSD model, the content work was used in the design of how the system features were developed.

In addition to SDT and evidence of effective BCTs, the teams considered the operationalization possibilities identified by Silva et al. [21]. They focused on the development, implementation and evaluation of theory-based interventions with SDT as an example. The review summarised some key elements in interventions that support the three basic needs as defined in the SDT: autonomy, competence and relatedness. The degree of need-supportiveness is an important factor in an SDT-based 'motivational climate' [21]. Table 1 summarises the review findings by Silva et al. [21] on how the basic psychological needs have been operationalized so far.

Table 1
Summary of key elements for the support of basic psychological needs [21].

Autonomy	Relevance	An intervention provides clear and meaningful rationale for any activities and facilitates self-endorsement.
	Respect	An individual's perspective, feelings, and agenda are important and are acknowledged as such.
	Choice	Individuals are encouraged to follow their own interests and they are also provided with options whenever possible.
	Avoidance of control	No coercive, authoritarian or guilt-inducing language or methods are used.
Competence	Clarity of expectations	With the individual, together, realistic goals are set and there is discussion over what to expect and what not to expect from the behavioural outcomes.
	Optimal challenge	Goals and strategies are tailored to the individuals' skills, aiming at optimal challenge.
	Feedback	Informational feedback is offered, and it is clear and relevant (e.g. on progress on goals). The feedback is non-judgmental.
	Skills-training	There is a possibility for instrumental and practical skills-training with guidance and support.
Relatedness	Empathy	The intervention provider genuinely attempts to see the situation from the individual's perspective.
	Affection	The intervention provider displays genuine concern and also appreciation towards the person involved.
	Attunement	The intervention provider pays careful attention to the individual and collects knowledge about the person.
	Dedication of resources	The intervention provider volunteers time, effort and energy to the situation and on the individual.
	Dependability	The intervention provider is available at a time of need and the individual can trust that the provider can be reached when necessary.

Viewing key elements in Silva et al. [21] that are connected to SDT alongside the BCT taxonomy by Michie et al. (2009) it becomes clear that SDT alone is not enough to provide a clear-cut basis for choosing a specific BCT to be used in an intervention. A given BCT can, in fact, be either in line with SDT or quite contrary to it, depending on how it has been implemented (for example, is the ethos supporting autonomous motivation or is it controlling). It is possible to direct a person, for example, to goal setting in a more or less authoritarian manner, or by using incentives or even threats and still provide support for autonomy [21, 22]. It is for this reason highly important to give ample attention to how the BCTs are implemented and whether the system stays true to the goals of supporting SDT principles.

With regard to the question of BCTs implementation, let us present some reflections upon three BCTs that have been suggested to be effective by previous meta-analyses: 1) self-monitoring [23], 2) feedback [19, 23], and 3) offering instructions and information (see Webb et al., 2010). [19]

First, self-monitoring refers to the individual's methods of monitoring or recording their own behaviour during the change process [23]. It has been suggested that self-monitoring can help in strengthening the individual's sense of competence by advancing their self-management skills [24]. In addition, a meta-regression has showed that interventions utilising self-monitoring combined with for example, setting goals for oneself and reviewing the goals were significantly more effective when compared to other interventions [23]. This result might point

to the direction that in order for self-monitoring also to support a person's need for autonomy, it would appear necessary to also support self-reflection [25]. In this manner the person would have a chance to perceive how the monitored behaviour is relevant to their specific goals. In practice the app aims at offering self-reflection cues in connection with user input – for example in tasks where user goes through his or her typical food choices in a day.

Second, the BCT referred to as feedback includes someone else monitoring the individual's behaviour and giving feedback on the performance or its outcomes [23]. An important factor regarding feedback is that its mode and style of delivery must match the system user's competence and need for relatedness. In the support for competence the feedback should be informative and non-judgmental, and in the support for relatedness it is important to pay attention to empathy, affection, and appreciation [21]. There is previous knowledge on what empathy and affection look like in face to face preventive health care settings: emotional support can be given for example, through normalising that is, assuring that the individuals' health related concerns are normal [26] or the professional sharing their own experiences [27]. However, these research results cannot be easily implemented as such to a mobile application. Out of the above-mentioned two approaches identified in actual face to face interaction in preventive health care encounters, a mobile application cannot share its own experiences, which leaves the option of normalising as a means of supporting the system user.

Third, offering instruction and information as one BCT goes well with SDT: they should help in competence support. Furthermore, providing clarity to the cause relations between behaviour and is consequences can support a person's sense of autonomy – provided that the information focuses on relevant issues [21].

As presented, these BCTs can be implemented in such a way that they are in line with the SDT. Still, from the perspective of SDT there can be concerns as regards the balance between effective physiological outcomes and a person's psychological well-being [21]. For example, a highly effective outcome in terms of weight loss can have detrimental effects on a person's psychological well-being should the weight-loss behaviour become obsessive (ibid.). A further consideration from SDT's viewpoint is to accept also "no change" as a positive outcome of an intervention when a person, after reflection and consideration, decides not to pursue behaviour change.

Against this theoretical background and the requirements on the form of the content that arise from it, a persuasive system developer need to understand the aims of each BCT in the content of the system, for example why user must always be given free choice in initiating any activities, or why rewards may not be a good approach. Working together with subject-matter experts in the area of the background theory, the persuasive system experts can negotiate any potential pitfalls in how persuasive system features are presented in a system.

5. Defining persuasive software features

In practice the overall design of the intervention in the project was done between three teams working each on their own particular area of expertise. There was the software development team with the development expertise and also (more importantly even) the expertise in developing and researching persuasive systems. Another team came from social psychology with the expertise on SDT and BCTs. The third team had the expertise on the particular problem domain (entrepreneurship and occupational health) and working closely with the social

psychology team, provided domain-specific content for the system. The process of development was iterative and while the mapping described in this paper did not take place as a part of the development and design effort, at each turn the decisions for how the system features would be delivered were informed by the intervention content. For example, in order to emphasize the three basic needs of autonomy, competence and relatedness, the SDT would not encourage competition or rewards as a means to facilitate autonomous motivation, and as such, competition inducing features were left out of the system. The mapping presented in this paper is, then, a *post-hoc* summary and recapitulation of the outcomes of the iterative persuasive systems design process.

The mapping is done here between the PSD model's software features and postulates and the key component techniques of supporting motivation, as listed by Silva et al. [21]. Going with the review by Silva et al. [21] we focused in this analysis on the three main aspects, the basic psychological needs, of the SDT to place them with matching feature categories in the PSD model. The practical examples and analysis by Silva et al. [21] provided the characterisation of how each psychological need can be supported in practice. During the development process the context analysis part of the PSD model already identified a number of feasible persuasive features, and the simultaneously on-going iterative assessment of content and BCT selection sharpened the focus to a final selection. In this analysis we have assessed the system feature selection against needs supportive key component techniques in Silva et al. [21] in order to formally describe the grounds for defining the software features.

The design of the content modules in the system applied a taxonomy of behaviour change techniques. When placed on top of the context analysis-based PSD feature selection, we can see the commonalities and also where a system feature might not be conductive to the intervention goals. Tables 2-5 illustrate PSD categories and the basic psychological needs, listing in the table cells which individual PSD features would appear to offer the right kind of support for each psychological need. The specific needs support component, as listed by Silva et al. [21], is presented with the system features in brackets. The column on the right offers a description of how the feature has been implemented in the app.

Of the system features categorized under Primary task support in the PSD model, Reduction, Self-monitoring and Rehearsal were selected to the system (see Table 2). Reduction refers to simplification of large or complex tasks to smaller units that are easier to perceive or carry out [5]. The system in question has split an overall goal of healthier lifestyle and a goal of recovery from work into parts that earlier research had identified to be problematic for micro-entrepreneurs, such as sleep or diet. From there on the tasks and exercises focus on some specific element for any given topic, such as simply taking time in a day to contemplate one's own thinking. Cutting up a large task into smaller, more manageable, elements means each part can be perceived more immediately relevant.

Table 2

Primary task support features and basic needs support

Autonomy	Competence	Relatedness	Persuasive software feature description
Reduction [Relevance]	Reduction [Clarity of expectations; Optimal challenge]		Reduction of larger tasks into smaller, more manageable parts happens in the app as an overall concept. The overall goal for a user of the system can be very significant: a lifestyle change. The app segments overall lifestyle items into smaller categories such as sleep or diet. From there on the tasks and exercises focus on some specific element for any given topic, such as simply taking time in a day to contemplate one's own thinking.
	Self-monitoring [Feedback]		The system offers users a number of tools for self-monitoring. These include a pedometer, monitoring daily rhythm for sleep, work and free time, and questionnaire-based tools for the key factors in well-being, stress levels, and quality of recovery from work. Feedback on activities (tasks) where user provides input in the system generally result in a suggestion for reflection.
	Rehearsal [Skills training]		The tools offered by the app include a way to practice forming a healthy plate of food, planning your meals and meal times for a day, and reminder for breaking sedentary work patterns.

Self-monitoring as a feature allows users to track their own behaviour, performance or status [5]. In terms of competence support, this feature is a means for providing relevant feedback to the user. As part of the overall user experience design the characteristics of clarity and non-judgmental tone [21] were taken into account. Rehearsal means that a system user can practice some specific behaviour safely away from an actual situation so that the skill would be more complete by the time he or she encounters the given situation in a real setting [5]. The app offered simple "tools" for the users where to make meal plans and work out how to fill a plate of dinner in accordance with the current nutritional recommendations. The activities are well in line with the skills training technique for competence support [21].

Direct matches from Primary task support features to relatedness support were not identified, unless one wishes to include the tone of the app. However, the tone is something that was included and built into all interaction in the app and therefore it is listed under more general user experience items later on in this paper.

Autonomy support in the app's Dialogue support features was found in Reminders, Suggestion, and Praise (see Table 3). Reminders in the system involved tasks that the user was able to postpone, and tasks that were designed to run over a short number of days which then required the user to fill in his or her responses. Reminders are associated with relevance as a means of supporting autonomy in that they help the user focus on a set task and also form an idea of what is going to be happening with the app in the near future. In the same vein the system feature also works in providing clarity of expectation and optimal challenge in support of competence. The latter is realised in the way a user is able to choose which tasks and what type of tasks (immediate or ones that are done over time) to take on. Users also have control over the timing of the tasks. Reminders also offer the user choice (autonomy support) as they

are always open for the user to decide whether to use one or whether to follow the reminder when it comes.

Table 3
Dialogue support features and basic needs support

Autonomy	Competence	Relatedness	Persuasive software feature description
Reminders *[Relevance; Choice]*	Reminders *[Clarity of expectation; Optimal challenge]*		Some exercises in the app take time. The system will remind the user as regards timed exercises. These exercises have been set by the user. There are also reminders for the user to fill in any regular questionnaires that are there to offer self-monitoring content. User control over when and how many tasks and what type of tasks they take on allow the users to maintain a feasible affort with the app.
Suggestion *[Relevance; Respect]*	Suggestion *[Clarity of expectation; Optimal challenge; Feedback]*	Suggestion *[Attunement]*	Based on the initial user questionnaire, users are given a suggestion regarding which topic (sleep, diet, stress, etc.) to start with. Naturally the user can choose not to follow the suggestion and pick any of the other topics as well (or none at all), but the suggestion states that it is based on the responses given by the user. Suggestions tailored to a user's particular responses also show attunement. Additionally, each topic module offers relevant suggestions (content related suggestion). Finally, the app includes suggestions that help with getting the most out of the app itself. For example, when user has viewed most (9 out of 11) of the videos available in the app, the app gives a suggestion that there are just a few more and would the user like to view one or more straight away.
Praise *[Respect]*	Praise *[Feedback]*	Praise *[Affection]*	Completing exercises, going through the informative content, and using the system regularly give the user feedback in the form of praise ("well done!").

Suggestion as a system feature provides relevance and respect in terms of autonomy support. Relevance comes from the suggestion timing: it is by specification a tip that is given to the user at an appropriate moment. In the case system the suggestions follow some user input (completing a task, responding to a questionnaire). Respect is present in suggestions not only in the overall tone (common to all parts) but in that regardless of the user's response, the suggestion will not start to push or embarrass the user towards the target behaviour even when their responses show less than ideal behaviour. Like relevance, clarity of expectation is a part of providing suggestions. Linking the suggestions to user input helps maintain a match between user's current state of behaviour and what actions can be recommended, thus providing optimal challenge level. Furthermore, being linked to user input, suggestions provide users with relevant feedback.

Praise is essentially positive feedback on achieved milestones or goals [5]. In the case application Praise provides autonomy support in the form of respect (as acknowledgement of the user's agenda and goals), competence support in the form of feedback (reaching a goal, completing a task), and relatedness support in the form of affection. The latter is difficult to

achieve with a computerized system but the nature of a praise message in a system is such that it targets a specific achievement and in that sense is not just a general message but tied closely to that specific thing that the user has done.

Table 4
Credibility support features and basic needs support

Autonomy	Competence	Relatedness	Persuasive software feature description
		Trustworthiness *[Dependability; Attunement]*	The content provided throughout the app is evidence-based.
		Real-world feel *[Dependability]*	The source of the app is known and can be contacted.
		Surface credibility *[Dedication of resources]*	Clean, neutral but visually pleasing, calm look and feel, and simple user interface design are intended as means of fostering trust and sense of professionalism so that users can easily feel that they are using a professionally created system both in terms of its content and its technical implementation.

Good user experience design generally immediately yields some Credibility support features (see Table 4), such as Surface credibility. A clean, usable interface and structure help users perceive a system as competent and that the developers have put a good effort into producing the system [5]. While such a design necessarily has to be a goal of any system, a persuasive system should pay conscious effort on achieving good user experience in order not to reduce the persuasiveness of a system. Good surface credibility helps provide relatedness support. Real world feel means that the users can see who is behind the system [5]. With the present case app, the organizations behind it were easily traceable to official organization websites with further information and contact opportunities, thus offering dependability as a means of relatedness support. Trustworthiness in the system was related to the real-world feel and the opportunity to look into the organization behind the system. In addition to dependability, trustworthiness (knowing that the content provided is honest and genuine) provides a system with attunement as a means of relatedness support. All the information in the app and in the accompanying websites shows the system's focus on the target group.

As a Social support feature (see Table 5) the app had Social comparison, which means that users can see some of their performance compared to a group of people similar to themselves [5]. The feature provides the user with feedback by showing their response levels in comparison to averaged level on the same readings from the reference group (the other micro-entrepreneurs using the system), thus offering competence support. The feature also provides attunement as a means of supporting need for relatedness by giving the said comparison to "people like me". The system also offered the users four proto-personae of micro-entrepreneurs that illustrated many of the common characteristics in this otherwise heterogenous group of people. The system users were able to read about each persona and what their work life would typically be like, giving the users an opportunity to see that they do have a reference group and that the system is intended for them to use (attunement).

Table 5
Social support features and basic needs support

Autonomy	Competence	Relatedness	Persuasive software feature description
	Social comparison *[Feedback]*	Social comparison *[Attunement]*	The system collects information about its users through questionnaires. The information is returned to the users in generalised format so that the user can see his or her own situation compared to the rest of his or her reference group. For example, when user responds to a stress level query, the response graph is shown together with the average response from the rest of the reference group.
			System shows "people like you" personae as a way of identifying with the rest of the target group.

6. Mapping with persuasion postulates

The identified motivation supporting SDT elements [21] have been mapped to the seven founding postulates of the PSD model [5] in Tables 6 and 7. In our case the description explains both how the system adheres to the postulates in general (even when a motivation element has not been identified), and where the postulates and their realisation coincides with the motivation elements.

Information technology affects its users at all times [5]. (See Table 6.) One simply has to think of the frustration levels when the internet is down even for a few moments. Therefore, the attention to the system's tone and overall communication style was important so that the user would not feel pushed or judged at any time – not only when completing a task but also when simply browsing around.

The second postulate, people like their views about the world to be organized and consistent [5], ultimately refers to the concept of cognitive dissonance [28], assuming that new information that contradicts information obtained (learned and accepted) earlier will cause a state of cognitive dissonance which we naturally wish to disperse. In order for behaviour change to take place, old habits, information and beliefs may have to be contradicted by new information, but by doing it with gentleness that provides needs support may help in making the new information easier to accept. The case system illustrates relevance, respect and choice throughout its design in order to support autonomy, offers relevant feedback in order to provide support for competence, and shows attunement and empathy in its overall demeanour in support of need for relatedness.

Table 6

PSD postulates #1-#4 and basic needs support (based on Oinas-Kukkonen and Harjumaa [5], and Silva et al. [21])

Autonomy	Competence	Relatedness	Postulate and its description in the case system
Avoidance of control			**Information technology is never neutral.** Careful attention was paid to the language and overall information design in order to avoid authoritative or coercive tone whether the content was general informative content or task content.
Relevance; Respect; Choice	*Feedback*	*Attunement; Empathy*	**People like their views about the world to be organized and consistent.** The system offers relevant and tailored content at a pace the user is prepared to advance, allowing the user time and space to reflect on the new information and suggestion. The informational content and the feedback may introduce new ways of thinking or ask the user to change the way he or she may have been doing things so far, but it is throughout given in an open and friendly way. Showing that the system has been specifically designed for the target user group highlights its relevance and the relevance of the information even when it goes against the system user's existing knowledge or thought patterns.
Relevance	*Feedback*		**Direct and indirect routes are key persuasion strategies.** The system has enabled the use of direct route in its content design and in the design of the delivery: Informative content in the system is offered as text and in video/audio format, and the user can always return to these sections of the app to repeat them or return to them if they have postponed reading/listening to them. Tasks often involve reflection on existing behaviours as regards a give topic. Tasks can be completed immediately, timed for later, or returned to at any time.
	Optimal challenge		**Persuasion is often incremental.** Reduction in the system design allows users to focus on one part at a time. Tasks in each module, such as sleep or diet, have been designed in accordance with the Transtheoretical model to offer challenge from early stages of stage through to maintenance phase – in accordance with the user's own position in his or her behaviour change process.

The system was designed to have various options and opportunities for the user to reflect on the new information and skills. This shows overall as providing relevance and feedback.

Table 7

PSD postulates #5-#7 and basic needs support (based on Oinas-Kukkonen and Harjumaa, [5]and Silva et al., [21])

Autonomy	Competence	Relatedness	Postulate and its description in the case system
Relevance Respect		*Attunement*	**Persuasion through persuasive systems should always be open.** The system is openly developed for the target users and is advertised as such, highlighting how users are all part of a defined group. It is also clear from all the materials that the system is developed for the purpose of improving the described lifestyle elements, and that the intention of the system is to improve the user's ability to recover from work.
Choice		*Attunement*	**Persuasive systems should aim at unobtrusiveness.** Identifying typical work patterns and what micro-entrepreneurs' workdays can consist of, it was necessary to design a system that only takes a few minutes of the user's time at any time, and which does not require interaction and attention for more than a few times a day.
Relevance	*Clarity of expectation*		**Persuasive systems should aim at being both useful and easy to use.** Overall user experience design aimed at good usability and user experience hygiene.
Choice; Respect; Avoidance of control		*Dependability*	**Re: Navigation.** Throughout the app the user can leave at any time without having to complete a module or a task. User can also access the various modules and exercises at any time.
Respect; Choice; Avoidance of control	*Clarity of expectations; Optimal challenge Avoidance of control; Respect*	*Affection*	**Re: Tone and language use.** Persuasive systems must not be coercive and so the app allows user to choose all activities and tasks freely throughout. Only initial introduction has to be followed to get started with the app. The content in the app aims at a natural, friendly tone without health-care or technology jargon. The system is also clear about its intended target users, showing that it has been tailored for the needs of that group. Language has been designed to be supportive and encouraging with an overall tone of letting the user think what they want for themselves in terms of health. No "should" or "must" in the language.
Relevance	*Feedback*		**Re: Content design.** Informative content offered in all modules and in the feedback.

Incrementality was implemented in the structuring of user tasks at each problem domain. The users could choose from ones that were relevant to early stages of change through to maintenance stage, leaning on the Transtheoretical model of change [29]. While borrowing from this theory, the task features were still constructed with the same SDT guided principles as the rest of the system.

Openness of persuasion was largely achieved through the Real-world feel feature providing attunement in support of need for relatedness (see Table 7). Also the informative content and explanations of tasks are part of the openness and transparency of the app and thus support relevance and respect.

The system was designed to be unobtrusive by following feedback from entrepreneurs during early design phases and building all features so that users would not be overwhelmed with the need to interact with the system: on the whole the tasks did not require the users to handle their phones for extended periods of time but were more in the nature of reflecting and observing.

Persuasive systems being useful and easy to use can, as a postulate, contain a mighty vat of elements. The present analysis highlights a few that have been identified to be important in terms of operationalizing the principles of SDT in an intervention [21]. Overall users were always given the option to back out or interrupt what they were doing and return to it later. This was important to show also in the interface design for navigation so that actions like moving back were always available and clear. As mentioned earlier on, the general tone of the application was constructed carefully, and the system offered relevant informational content throughout.

7. Discussion and conclusion

In the present case the system features were selected on the basis of a context analysis. The problem domain (micro-entrepreneurs and their work recovery) was reviewed alongside the SDT and consequently the taxonomy of behaviour change techniques [23] in order to find feasible ways of delivering the health intervention. The implementation of the system features incorporated the identified principles of the content delivery in a manner feasible in the technological solution. The review by Silva et al. [21] identified that all reviewed theory-based studies targeted all three of the SDT constructs, but the number of techniques targeting those constructs varied. In a similar vein, in the present case of BCSS development the formatting of the content aimed at offering something to satisfy each SDT category, but by no means aimed at using every possible technique for all of them. As in so many things, less can be more, and it is generally not a good design principle to overwhelm a system user.

Some considered system features were off limits because they were not feasible in the context. For example, building a cooperation feature for a user group very dispersed geographically and more importantly in terms of their field of work would not have been very feasible: different work hours, different sets of problematic areas, etc. would have made the feature heavy to implement and not likely to be highly used. Some features were discounted on theoretical basis: competition and rewards do not sit well with SDT and their use was ruled out entirely. The development of persuasive systems is, then, a question of balancing between feasible and sensible: not all that can be developed should be developed.

The psychological need area that in the mapping remains with the fewest matches is the need for relatedness. This category lists empathy, affection, attunement, dedication of resources, and dependability as the key components for providing the said support. While it may be possible to argue the building a complete system with evidence-based content and carefully constructed content that is tailored for a specified target group is a major dedication of resources, it would require further end-user research to determine if this is how the system

user would perceive the situation. Or, indeed, is pre-programmed house style for content and dialog language genuine affection and does it portray the empathy that is needed? These elements, no doubt, are there in the construction of the system, its goals and its contents, but the key question is whether they come across in a way that the user can perceive them? The support for relatedness by means of technology is an important one: if the requirement is to one day provide tailored help and support for large groups of people by means of technology, the technology needs to cover all three basic needs at a sufficient level. In the present case we can see that effort was made to show the user how the system was built for their needs and with their problems in mind, and how the system was trustworthy and dependable. Affection can be found in provision of praise by the system when a system user has completed a task. An interesting point for further development would be the incorporation of more affection and empathy in an active format, not only in the overall tone of the system.

Overall, we can see how the selected system features and known needs support components can support each other. The PSD model offers a framework for matching a general feature selection to a specific situation and theory guided handling of the health behaviour content which can then guide also the way these features are produced and implemented in the system. The present paper offers a simple feature matching in one application with the intention of showing that persuasive systems can be perceived as a composition of layers, and as in so much design, form follows function. Features for delivery take some of their form from what they are intended for, in this case support for basic psychological needs. The selection of features takes its form from what those features are needed for, indicated by the context analysis.

This paper presented *post-hoc* theory and feature mapping that took place during an iterative design and development process. As such the work remains largely conceptual. Further research on this topic would benefit from other similar analysis of application of theory requirements on system features so that possible patterns form across theories could be observed. An example could be an analysis of a system where the content is built on the basis of Transtheoretical model and the process of system feature selection would illustrate the building of incremental behaviour change in a persuasive system. As is, the present analysis provides support in making the system developer's toolbox more robust and versatile across theoretical approaches that guide persuasive systems design.

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