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ePsychology: Designing Theory-Based Health Promotion Interventions

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Abstract

Persuasive technologies pervade much of our everyday lives today in areas from marketing to public health. In the latter case, persuasive technology represents a promising area of application. However, we know much too little about how to design effective interventions to support sustained behaviour change and improved well-being. The purpose of the present paper was to contribute in two ways. First, we want to contribute to current practice in designing such interventions. Second, we try to identify key research questions that could be a point of departure for a more detailed and comprehensive future research program. We do this by means of expressing 28 propositions. In sum, the propositions reflect that the construction of digital interventions should be seen as an iterative process which should take into account both content and design factors. However, we argue that intervention research and practical design experience is not just something that follows basic research at a polite distance, but rather is its inherent complement.

KEYWORDS: persuasive technology, ePsychology, cognitive-affective processing system, emotion regulation, ego depletion, health behaviour, behaviour change, systems design

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I. INTRODUCTION

On the basis of theoretical reasoning in the area of behaviour change and our practical experience, we herein express 28 propositions for designing ePsychology interventions. The concept of ePsychology interventions is established to distinguish between different types of digital interventions that we often find in persuasive technology. Thus, ePsychology interventions can be defined as interventions designed and based on psychological practice, theory, and research delivered through digital media. The propositions are expressed with the intention to help guide the future of ePsychology within the areas of health and well-being in two ways. First, the propositions may guide current practice of designing ePsychology. Second, by delineating areas of research that should be further refined by means of developing and testing more specific hypotheses, the propositions may represent fragments of what could be a more comprehensive future research program. The purpose of this research would be not only to provide a yes or no answer to the question of whether ePsychology interventions can be effective, but rather to reveal some of the causal mechanisms that could explain why they are effective or not.

A few reviews have managed to identify several sample, study, and intervention characteristics that moderated psychosocial and behavioural outcomes [Portnoy et al. 2008; Wantland et al. 2004], but this has not always been the case [Walters et al. 2006]. Consequently, we are interested in knowing how psychological theory and research related to behaviour change and maintenance can be utilized in designing interventions. In particular, interesting questions are: How can we design interventions not only to motivate users to initiate change, but to maintain change as well? Which psychological change predictors should and could be addressed by means of a psycho-educational approach? How important is it to provide additional just-in-time therapy and how can this be achieved? How can digital technologies be used to prevent ego depletion? How can ePsychology interventions support the making of implementation intentions and coping planning? How can digital technologies help detecting and preventing lapses and relapse? Of course, many other questions could be asked, but these are among those we address herein.

It is self evident that ePsychology should utilize insights from cutting edge psychology in order to maximize effect. However, many would say, and we tend to agree, that it is of equal importance to acknowledge that in order to be effective, ePsychology interventions must be able to reach the audience and hold the interest of the user over time. No doubt, the fact that the intervention is judged by the user to be effective in helping her to achieve her ultimate goals, may contribute considerably to this end. Nevertheless, we also need to capitalize on insights about how user interface and information technology influence upon both initial and continued use, and hence ultimate effect. Because we restrict ourselves to talk about the area of psychological change, more specifically to behaviour change and well-being, a focus will be on such questions as: How do you best establish a “therapeutic alliance” by means of digital technology? How do you maximize adherence to digital interventions (i.e., stickiness)? What characterizes successful information systems (ISs) in this area? How do different information architectures influence user perceptions? How can we enhance (perceived) individualization and personalization? How important is interactivity, and how can it be increased?

In Section I, we provide some comments and suggestions for the study and analysis of digital interventions in general, that would greatly help in advancing and accumulating knowledge. We do this throughout propositions 1-5 by encouraging the use of more rigorous evaluation designs, process studies, sophisticated analytical techniques, and protocols, and focus on identifying active intervention ingredients. In Section II (propositions 6-14), we provide some basic psychological insights that we suspect would enhance the use and effect of digital interventions in general. We would like to see future digital interventions to have a clearer structure and chronological order, and to intentionally try to prevent relapse and ego depletion. In Section III (propositions 15-22), we draw on insights from positive psychology and how it can help designers and researchers to develop interventions through a positive lens. Oftentimes, health behaviour change interventions tend to focus on negative aspects of behaviours, such as why smoking is bad for your health and what will happen to you if you do not stop smoking while ignoring the overall picture where smoking may in fact contribute to the smoker's social and emotional well-being. Thus, positive psychology can help to maintain and focus on general well-being and what is good. But all of this is vain, if we do not manage to reach and hold the interest of the audience over time. Thus, in Section IV (propositions 23-28) we advocate design with the intent of making an emotional impact, establishing a relationship with users, and explicitly encouraging and helping users to adhere to interventions among other things. Finally, we synthesize our comments and suggestions in Section V to provide a summary and overview of our propositions.

II. EPSYCHOLOGY INTERVENTIONS: EVALUATION AND RESEARCH

Proposition 1: More ePsychology interventions should be evaluated by means of long-term randomized controlled trials and should apply the intent-to-treat principle.

It is almost self-evident that digital and fully automated health behaviour and well-being interventions, as in contrast to face-to-face counseling, have the potential of reaching many people at low costs. But can they be effective tools in helping people to change successfully? Some may say that the jury is still out on that question. Nonetheless, there are some very promising indications that they indeed make a valuable contribution. A meta-analysis of 75 randomized controlled trials provided support for their effectiveness in changing knowledge, attitudes, and behaviour in the health promotion area [Portnoy et al. 2008]. More specific effects have been documented in for example promoting physical exercise [Hurling et al. 2006], weight management [Tate et al. 2001], smoking cessation [Walters et al. 2006], and alcohol reduction [Backer-Grøndahl and Kraft 2006]. Despite these initial and promising findings, there is an obvious need for studies which apply more rigorous evaluation designs [Walters et al. 2006]. More specifically, there is a need for digital interventions to be evaluated in long-term randomized controlled trials [see e.g., Brendryen and Kraft 2008].

In psychology and medicine alike, randomized controlled trials (RCT) are regarded as the definitive study design for proving causality. The main reason is that study participants are allocated by means of randomization to different interventions. Hence, any observed post-intervention differences between the treatment and control groups can be ascribed to the different interventions they have received or to random error. Consequently, RCTs are preferred as a standard for evaluating treatment efficacy because of their potential to maximize internal validity. Still, the tensions between internal and external validity need to be considered carefully by researchers [Del Boca and Darkes 2007a]. For example, *efficacy* studies employ a subset sample for analyses (e.g. 90percent treatment adherence) to test whether the intervention produces positive results under optimal or controlled conditions. This gives a high internal validity, however, post-randomization exclusions may severely inflate the probability for type I error [Lachin 2000] and possibly compromise between-groups equivalence and statistical power [Del Boca and Darkes 2007a]. Unfortunately, non-adherence to experimental protocols is the rule rather than the exception, which in most cases is solved by applying the intent-to-treat [ITT; Gross and Fogg 2004]. This implies that all participants are included in the analyses and non-adherence is treated as if the participant received the full experimental treatment. For example, in evaluating a smoking cessation intervention, all participants are included in the analyses and participants with missing values on smoking status are coded as smokers. Thus, applying the ITT principle provides the most conservative estimate of treatment effects and tests the *effectiveness* of an intervention, that is, whether the intervention produces positive results under more realistic real-world settings or greater extent of external validity.

Even the most extensive follow-up procedures and most elegant retention strategies cannot prevent attrition. Researchers should therefore pay attention to expected attrition rates and subgroup analyses, including analyses for treatment mediators and moderators. For example, are there any differences between eligible and ineligible participants? Do participants with missing values differ on important variables from the other participants? A survey of RCTs found that most studies provide inadequate descriptions and methods for handling missing data and deviations from randomization procedures [Hollis and Campbell 1999]. Thus, researchers who explicitly describe how they deal with missing values and deviations from randomization can enhance the quality of their research considerably.

Proposition 2: More digital interventions should utilize the inherent potential for studying active ingredients and the design process.

Tensions between internal and external validity are inevitable, but then again, the rigor of evaluating the efficacy or effectiveness of interventions has been greatly enhanced by the use of technology. Non-specific factors that may affect outcomes in real-life settings, such as variability in therapist behaviours across conditions, can now be controlled more strictly [Kazdin 1979]. Technology-based interventions help standardize and control extraneous variables as the contents, techniques, principles, format, dose, and so on, can be held constant [Carroll and Rounsaville 1990]. The "technology-model" of research can thus help ePsychology interventions in two important ways [ibid]. First, it allows us to study the active ingredients in interventions and the dimensions along which interventions may vary conceptually and operationally. Second, the technology model can help us to operationalize (either qualitatively or quantitatively) the process of intervention design. For example, how do you proceed to design a positive emotional user interface? What strategies can you employ to increase intervention compliance?

The "technology model" of research is very appealing and has several advantages over real-life studies. One advantage is that participants from all over the world can be recruited which allows researchers to study interventions along cultural dimensions and gives plenty of sample size. However, researchers should explicitly state

the recruitment strategy as any overreliance on any particular strategy is likely to introduce biases and make generalizability difficult [Del Boca and Darkes 2007b]. Several solutions have been chosen to recruit research participants. In many studies participants are recruited through a health Web site and/or by means of advertisements in online newspapers. Oftentimes, the control group either receives the intervention at a later time [waiting-list control, see Hester et al. 2005; Zetterqvist et al. 2003] or receives an alternative intervention like a paper format intervention [see e.g. Brendryen and Kraft 2008]. In some studies, all contact between the researchers and study participants are handled by means of electronic channels such that questionnaires are sent by e-mail or accessed on the Internet [for examples, see Zetterqvist et al. 2003; Brendryen and Kraft 2008]. In other studies, there are numerous in-person contact points between the researchers and the participants. For example, in a study of a Web-based weight management intervention, study participants met with a psychologist five times (app. 20 min. per visit) to measure progress and satisfaction with the intervention [Womble et al. 2004]. In another study, a research assistant e-mailed participants who did not log on to an Internet-based intervention addressing body image and weight concerns [Winzelberg et al. 2000]. Although attrition can sometimes be high and measures need to be taken to protect the internal validity of the RCT, in-person contact can potentially introduce human bias and offset the second major advantage of automated interventions and data collections [Eysenbach 2002]. Participants in computer-based studies generally report a preference for computer-based assessments which also tend to identify greater proportions of individuals reporting for instance hazardous sexual behaviours [i.e., they minimize response bias; Strecher 2007]. Given plenty enough sample size, statistical power, and depending on the statistical analysis plan, it is recommended to maintain accurate adherence records for evaluating differential treatment exposure rather than introducing in-person contact. Simple protocols should suffice in most cases to collect adherence data such as time spent on a Web site or task-completion which can easily be analyzed using Web server log file analysis software applications.

We have emphasized some of the advantages of the technology model of research; but this does not mean the model is without challenges. For example, the most stringent way to perform experiments involve the application of the double-blind procedure which entails that neither the participants nor the researchers know who belongs to the control group and the experimental group. Obviously, in the technology model of research double-blind procedures cannot be conducted because the participants always know what kind of treatment they receive [Eysenbach 2002]. For example, if you take part in a study of a digital smoking cessation program, you obviously know you are in a digital intervention. The impossibility of carrying out double-blind procedures can be partly amended by separating researchers, intervention designers, and analysts to produce effective blinding of staff and delaying information about assignment to experimental conditions and what other conditions that are a part of the study until study termination. The latter strategy represents a problem with informed consent and may not always be ethically viable. A possible solution to this dilemma might be to inform participants that they will not be fully informed about treatment assignment and existing conditions before the end of the study. However, researchers ought to be cautious tampering with informed consents as participants frequently fail to fully understand the information presented [Griffin et al. 2006].

Proposition 3: More studies of ePsychology interventions should employ dynamic modeling.

Dynamic modeling is one way of representing a constantly changing reality and all of the parts and interactions between the parts in a complex system. Reality (or change) is never static but is dynamic in nature and usually takes considerable time. For example, a considerable number of people who quit smoking are at the risk of relapse for more than a year after they have stopped smoking [Hughes et al. 2008]. During this process of smoking cessation, the quitter experiences different types of psychological processes [Rothman 2004a]. Hence, a variety of predictors will be influential along the change attempt and determine if it will become a successful quit attempt or not on a long-term basis. The importance of predictors of successful change is rarely constant over time and there are many factors that may promote relapse into daily smoking. Consequently, the process of smoking cessation is extremely complex, and small initial changes along the course may cause different developmental trajectories in the process of smoking cessation.

The complexity of the human mind and behaviour may seem overwhelming and unpredictable. It is not always obvious that the state of a human being is composed of certain interconnected phenomena. However, if we think of the human mind and body as processes, we can specify the structure of such processes and deduce the manner in which these processes generate change [Huckfeldt et al. 1982]. In other words, by applying dynamical modeling researchers can represent processes of change by enabling the analysis of a process through time. There are many examples of how dynamic models have been applied successfully in psychological areas such as motivational flow [Guastello et al. 1999], alcohol relapse [Witkiewitz and Marlatt 2007], approach-avoidance conflicts [Abraham et al. 1990], and the cognitive-affective processing system [Shoda et al. 2002] to mention just a few. We believe that dynamic modeling can not only test the theoretical underpinnings of a model, but perhaps more importantly, it can help determine the state of the individual in a change process more accurately; thereby, we can deliver interventions that are more effective overall. In addition, one of the reasons why dynamic modeling is a good prospect for these

purposes is because of its potential to provide a better fit for the data than more conventional analyses such as, for example, multiple linear regression. Next, we briefly describe dynamic modeling more closely, and then we will give an example of how dynamic modeling can be applied to interventions.

Dynamic modeling is not a statistical technique but is one strategy for obtaining values for structural parameters within a dynamic model is to estimate the parameters statistically. To do so, researchers must develop and formalize dynamic models. Model development and formalization follows basically two steps. In step one, researchers ask the question: "What does reality consist of?" Construction of a model begins with a portrait or still image of reality at one point in time. This includes all possible variables which may have an influence on reality. Then, guided by theory, the number of variables should be reduced to a manageable amount and initial formalization of the model should make a manageable set of observable system states. In step two, researchers ask the question: "How does this reality change by the logic of the variables specified in the model?" Now the researcher must make explicit statements and assumptions regarding the structure of temporal interdependence. Nevertheless, because our observations always occur in *discrete* time (i.e., often significantly separated in time), and because *difference equations* offers greater possibilities for modeling observed behaviour with simpler mathematical models, it is most often appropriate to develop models as a series of discrete and equally spaced time representations [Huckfeldt et al. 1982].

What happens conceptually can be illustrated as follows: The designer or researcher specifies one specific form of a difference equation such as the *recursive* form where each term in the sequence is defined as a function of the preceding term. Then he or she aims at solving the difference equation which in the case of a recursive form means to obtain a closed-form solution (i.e., non-recursive function). Thus far, the designer or researcher knows the values of the structural parameters at any point in time; however, interpretation of the system state is more than obtaining a closed-form solution. For a substantive interpretation the designer or researcher should look at the stability of the system state. One such measure of stability is *equilibrium* which is essentially a measure of the level of the process. A difference equation sequence can be said to be in equilibrium if the sequence remains stable or constant over time, but this does not mean that equilibrium entails an absence of change in an individual's behaviour. There are many ways a person can quit smoking, just as there are many processes that can thwart a person's attempt at successfully quitting smoking. And by knowing when a problem occurs and where the problem lies in the system, we can hopefully intervene and deliver therapy that can help tip the scale in favor of a successful change attempt.

Dynamic models may help us to understand a process and learn essentially all there is to learn, including what causes one process to break down and be replaced by another (i.e. *synchronic* change within a fixed dynamic structure). In other words, it can inform us about the existing structure, but it cannot inform us about what new structure will emerge. Thus, a new model will need to be specified and formalized. The process of moving from one dynamic structure to another (i.e. *diachronic* change) requires different methodologies and is not discussed here. Developing formal models for theory-based processes such as control processes [Carver and Scheier 2002] is very relevant to persuasive technology and has both practical and scientific implications and applications. An example taken from couple therapy can illustrate the practical application and importance of dynamic modeling.

In the case of marital or couple therapy, a system could collect data about each couple member's emotional state by assessing positive and negative affect. Clearly, this can be done in several ways, but let us assume that these data are sampled through a mobile application several times during the day over a prolonged period of time (e.g. 14 days). After this period, the amount of observed data can let us reliably estimate several parameters in a model where we assume that emotional state plays a pivotal role in the couple relationship. Based on theory and previous research, we attempt to specify a model that contains the parameters necessary to convey the emotional state of each couple member. Gottman and coworkers [1999] have done this in case of marital conflict which includes two terms as follows:

$$\text{Wife}_{t+1} = a + r_1 W_t + I_{HW}(H_t) \quad (1)$$

$$\text{Husband}_{t+1} = b + r_1 H_t + I_{WH}(W_t) \quad (2)$$

The parameters a and b are constant terms which are the natural uninfluenced steady emotional states. The uninfluenced state is the average level of positive minus negative affect when we control for the spouse's emotional state that a person brings to the interaction. The r s is the influence of the immediate past on a person and the I s are the influence of the spouse on the person (e.g. husband's influence on his wife at time t). These equations can be adjusted as more data are observed if necessary, but they can also be used to detect when a couple member is in a negative emotional state. In such a case, the system could react by including tasks or exercises on the daily Web sites that aim at down-regulating negative affect or up-regulating positive affect, but which were originally not included.

New parameters may also be estimated and included such as negativity detectors [Gottman et al. 1999]. Such a detector may serve as an indicator of lapse or relapse and should consequently trigger an appropriate intervention. A good example of one such negativity detector is the husband wearing a wristwatch that measures his pulse [Gottman and Silver 1999]. The wristwatch could transmit data back to the system, and once data are fed into the system, the emotional state of the husband can be estimated immediately. And if the parameter including the pulse variable exceeds a certain threshold, usually more than 100 beats per minute, it can automatically trigger a beeping in the wristwatch which signals that the husband should take a time-out. Furthermore, if the husband's pulse does not return to less than 100 beats per minute within a short time span or keeps elevating, the system could initiate a mobile phone call that includes guided stress-reduction instructions or encouraging to go slow. In fact, the phone call itself may be an effective intervention by disrupting the marital conflict before it escalates.

Proposition 4: More studies of ePsychology interventions should provide more in-depth descriptions of system components and characteristics that may have contributed to (the lack of) success.

None of the aforementioned reviews discussed in depth what differentiated successful interventions from unsuccessful interventions. This lack of reporting may have been caused by the fact that there was little or nothing to report. The fact that most published articles provide only insufficient descriptions and reporting of the actual interventions [Hurling et al. 2006 represents one of few exceptions] may contribute to a lack of accumulated knowledge with regard to predictors of intervention efficacy [Walters et al. 2006].

Although the technology model diminishes problems with treatment integrity and discriminability, it is nevertheless, desirable to develop a protocol for descriptions and operationalizations of the design process, implementation and intervention [for example of one such protocol, see Oinas-Kukkonen and Harjuma, in this issue]. Few studies and reviews [but see Portnoy et al. 2008] discuss in depth what differentiates successful interventions from unsuccessful interventions and scientific journals contribute to this end by not allowing researchers to submit intervention protocols or enough space for extended articles. Thus, the design and practice of evidence-based interventions suffer from poor scientific quality products. However, it is worth to notice a few exceptions. The *Journal of Medical Internet Research* recently published an online article which describes the design and implementation of a weight maintenance intervention [Stevens et al. 2008] and has accepted an extended article with enough space to include a description of a highly successful smoking cessation intervention [Brendryen, Drozd and Kraft 2008]. Moreover, the journal *Addiction* is now asking authors to submit intervention protocols which will be made available online in a supplementary archive and linked to the online version of the published paper.

Proposition 5: Randomized controlled trials, dynamical modeling, and just-in-time therapy: More studies should focus on mechanisms of action.

The apparent lack of intervention protocols may be related to the fact that most digital health behaviour interventions seem to be constructed in an atheoretical manner. In other words, there has been little explicit use and reporting of the theoretical underpinnings of interventions [Walters et al. 2006]. As previously mentioned, insufficient reporting of intervention protocols may contribute to the lack of knowledge with regard to predictors of intervention efficacy. A first start for interventions could be to anchor the therapeutic intervention ingredient on specific assumptions about what causes the problem and how the therapy works. This kind of reasoning should be done in all interventions, digital and in-person alike. Good examples of this kind of approach exist. For example, in a digital stress management intervention described by Zetterqvist et al. [2003], in a study of smoking cessation by Brendryen et al. [2008], and in a study of an alcohol intervention [Walters et al. 2007].

In some of these studies, one has tried to identify *why* the intervention worked. In the alcohol intervention that Walters et al. [2007] evaluated, a central premise was that alcohol consumption is influenced by normative perceptions, in this case as both descriptive norms (i.e., how much you drink compared to relevant others) and injunctive norms (i.e., how much experts advice to drink). The effect of the intervention was shown to be mediated through changes in perceived norms about drinking. Similarly, in the smoking cessation intervention studied by Brendryen and Kraft [2008], a central objective of the intervention was to strengthen self-efficacy among quitters. Indeed, the effect of the intervention was found to be partially mediated through higher self-efficacy beliefs in those who received the Web-based intervention. In these examples, the therapeutic ingredients in the interventions were based on theory and testifies that something was changed along the way. But the questions remain: when, how, and with what? To the best of our knowledge, no studies of digital interventions have been conducted to examine what happens during the change process even though the technology model of research enables investigators to study exactly these processes or mechanisms of action through which change is accomplished. Studies of process are important in health interventions because behavioural and psychotherapy interventions are complex and involves process effects that may impact during the course of the change process and impact on the developmental trajectory of the change process. Therefore, deconstructing and modeling interventions should be an equal priority

for study as efficacy or effect studies. Among questions that need to be addressed are, for example: How does the therapeutic alliance evolve over the course of the intervention? Or, how does the intervention impact on coping planning?

From a practical point of perspective, studies of process relate closely to dynamic modeling, just-in-time therapy, and individualization. Digital interventions allow an enormous amount of user-data to be stored and any computer-based assessments can be easily administered. Thus, individualizing and delivering regular or just-in-time therapy should be based on the whereabouts of the user in a process. For example, a user walks down the street approaching, knowingly or unknowingly, his or her favorite pub which may for instance elicit an impulse to drink. The user's mobile phone which has enabled the global positioning system (GPS) may determine the time, speed, direction, and location of the user, and as he or she approaches the pub, the mobile phone rings with instructions to e.g. make an implementation intention. As another example, a user logs on to receive his or her daily or weekly treatment and engages in a dialogue which quickly assesses the user's affective state. By modeling user behaviour, the system should be able to determine the system state and provide substantive interpretation of the stability in the system. Given local instability in the affect variable, the system detects the instability and extract a therapeutic component intended to up-regulate positive emotions or down-regulate negative emotions. The system should also be able to detect more global instability. For example, in the case of increased negative affect, it may spill over and decrease the level of self-efficacy and motivation which would then require more extensive therapy.

An alternative option could be using sophisticated methods for collecting data to establish a baseline and have between-session assessments to model behaviour at discrete points in time. These methods are originally designed for research purposes but can, nevertheless, be incorporated as an integral part of the intervention. Serious consideration should also be devoted to the re-design of these methods so that they are not perceived for what they are (i.e., research instruments) when the intervention is used for purposes of treatment-only. We briefly consider five different methods for capturing real-world data that can provide a unique and rich set of user-data to personalize, individualize, and tailor interventions.

The two first methods are an interactive voice response (IVR) that allows a computer to detect voice and touch tones in telephones and short message services (SMS) that allows interchange of short messages between mobile telephone devices. Both IVR and SMS have been applied successfully to collect data previously [for examples, see Perrine et al. 1995; Collins et al. 2003]; however, a call center needs to be established and maintained which drive costs. Thus, IVR and SMS may not always be viable for financial reasons. The third and fourth method are the experience sampling method [ESM; Scollon et al. 2003] and ecological momentary assessment [EMA; Shiffman et al. 2008], which are two quite similar methods. They involve repeated sampling of subject's current behaviours and experiences in real-time and in user's natural environment. Both techniques minimize recall bias and maximize ecological validity in situations where we cannot always make assessments, and both help us understand processes and the dynamics of behaviour in real-world settings. ESM and EMA can utilize several sampling techniques such as event-related sampling or random time sampling. If certain events are of main interest such as conflicts in the couple relationship, users can be asked to record any episodes of conflicts as they occur naturally and complete an assessment that could include what the conflict was about, what caused the conflict, what emotions were felt during the conflict, etc.. If the main interest lies in characterizing a representative sample of user's experiences such as recording a typical day, random prompts to complete an assessment may be more appropriate. ESM and EMA have been applied successfully to the study of social anxiety [Kashdan and Steger 2006], negative emotions [Moberly and Watkins 2008], and the smoking cessation process [Shiffman et al. 1996]. The fifth method is the day reconstruction method [DRM; Kahneman et al. 2004]. It combines features of time-budget measurement and ESM to assess how people spend their time and how they experience their activities and settings of their lives. Users are asked to reconstruct the preceding day by completing a structured self-administered questionnaire. By employing techniques from cognitive science, DRM is constructed to reduce retrospective reporting biases [Belli 1998; Robinson and Clore 2002], and usually gives a more complete coverage of the day than ESM or EMA. The DRM has been applied to the reporting of affective experiences [Schwarz et al., in press] among other things.

Combining such sophisticated methods for capturing data with modern technology can produce a rich and unique set of data for each individual. These data can be used to model behaviour and to develop and formalize models with a good fit of data. By knowing the "state of the individual," digital interventions should be able not only to deliver just-in-time therapy but appropriate and effective therapeutic components.

III: EPSYCHOLOGY INTERVENTIONS: BASIC INSIGHTS FROM THE PSYCHOLOGY OF BEHAVIOUR CHANGE

Proposition 6: The structure of digital health interventions should reflect the psychological chronology of the change process.

We have seen described earlier that people who quit smoking are at substantial risk of relapse for more than one year after quitting. Also, we have discussed how the magnitude and nature of the relapse forces vary considerably along the timeline of the change attempt. Hence, quitting smoking or any other change process has a certain psychological chronology. This chronology is characterized by the fact that different psychological processes have varying importance throughout the change process [Rothman 2004a]. In fact, many self- and behavioural-change processes reflect to some extent a generic core of psychological processes. Albeit, each type of change has a unique psychological make up, many changes also seem to share some core characteristics as far as the psychological chronology of the change is concerned. Thus, over different types of changes some psychological processes, that is, predictors of successful goal attainment, seem to be more important relatively early in the change sequence, while other processes or predictors seem to be more important later in the change sequence. This is exactly what is reflected in many of the change and phase models of behavioural change that have been proposed in social and health psychology during the past few decades [for overview see Sutton 2005], and this insight allows us to model the psychological chronology of the core ingredients of successful behavioural change.

In essence, personalized, interactive, digital media makes tailoring and individualization possible, that is, by providing information relevant to the phase of the change process that the individual user is in. Individualization can be achieved by designing an intervention that reflects the psychological chronology of the change timeline, but also by including feedback systems to ensure individualization of the intervention. By collecting information throughout the change process, individualization is made possible which means that the amount of information, help and support that the user receives can be reduced and be more focused to the specific needs of the user. In other words, one can capitalize on the principle of reduction [Fogg 2003]. Reduction makes target behaviours easier to achieve by breaking a complex activity into more manageable steps, and providing only task-relevant pieces of information. For example, complex goals may be broken down into specific sub goals or behaviours that may foster successful goal attainment. Additionally, and perhaps more importantly, the reduction implies that the information the user needs during the change process is broken down into chunks that are presented to the user at the relevant time, stage, phase or even situation in the change process. This will increase the user's perceived utility of the intervention, a key factor for the use of any kind of media or communication channel [Zhang 2007]. Also, since the content appears relevant and useful to the user, the likelihood of elaborated information processing will be increased.

Having modeled the psychological chronology of the change process that the user goes through, a natural next step is to lead the user through a predetermined sequence of intervention components step by step. To some extent, this resembles the idea behind what has been called tunneling [Fogg 2003].

Proposition 7: More ePsychology interventions should be tunneled.

Many digital Internet health behaviour interventions are designed as ordinary Web sites using, for example, hierarchical information architecture. Consequently, these health interventions have a Web site structure, but no or little therapeutic structure. Oftentimes, participants are only encouraged to log on as often as possible or with certain intervals while there is an apparent lack of prompts to do so (i.e. e-mails, SMS, or other). Furthermore, the intervention itself has no overall storyline or narrative in terms of issues, subjects, tasks, etc. that follow the participant over numerous days or throughout the intervention. Many of these interventions seem to be flawed by participants making minimal use of the service available to them. For example, in a study of a Internet weight loss intervention, participants logged on to the Web site 18 times on average during the first 16 weeks of the intervention [daily log on was advised; Womble et al. 2004]

Systems or interventions designed as Web sites allow the user, after log on, to go look for the information that is most relevant or sought after. In this way the intervention resembles a library which means that the information that is most necessary and useful to the user is not made explicitly available according to individual needs and timing of the change process [see Strecher 2007]. As a result, this type of a self-help intervention *de facto* resembles a help-yourself intervention. An alternative strategy would be to design a structured intervention, i.e. a system with a fixed sequence; a tunnel that the user is guided through. He or she is not introduced to a Web-based help-yourself library of information but is instead led by hand through the change process. The user enters the tunnel when he or she initiates the change attempt [for examples, see Brendryen and Kraft 2008; Winzelberg et al. 2000]. Tunneling and reduction presumably makes it easier for the user to successfully go through a change process since the user is led through a predetermined change sequence and receives the most appropriate information, support and therapy at

the right time. However, one may expect that some users will be annoyed by a tunneled system because it takes away user control. By entering the tunnel they give away a certain level of self-determination in that information and activities are presented to her in a predetermined sequence. According to Self-Determination Theory, three psychological needs motivate the self to initiate behaviour; the need for competence, the need for autonomy and the need for relatedness. The need for autonomy refers to the need to actively participate in determining own behaviour. It includes the need to experience one's actions as result of autonomous choice without external interference [Deci and Ryan 2002]. In essence, a tunneled and structured system may reduce the feeling of autonomy and self-determination on behalf of the user. It may thus be at odds with the need to experience choice when the user decides what to do, when and how to do it [Zhang 2007]. Since increased levels of self-determination are assumed to be linked to increased levels of engagement, performance and active information processing [Reeve 2005], one should be aware of possible negative consequences of a tunneled and structured system which possibly decreases the level of user autonomy.

On the other side, research seems to indicate that user control as in a non-tunneled system may result in user deviations from important information, instructions, and tasks which lowers user performance [for overview see Strecher 2007]. Particularly, people with lower levels of knowledge, skills and resources seem to suffer when the content that an intervention actually delivers to the user depends significantly on user choices and control [see Strecher 2007]. Additionally, it seems to be important to take into account autonomy and self-determination related to specific decisions made by the user. For example, one should include program components and content that strongly underscores that the decision to change and to take part in the intervention is fully self-determined by the user. In this way the user invites the system as a helper and supporter in her change attempt. Additionally, deflated levels of perceived individual control over system structure in a tunneled design, may be leveled out by increasing the feeling of personalization and individualization of the system components in terms of contents, graphical interface, features, personalized feedback, and more. This seems important since increased personalization seem to increase system adherence [number of visits and time per visit to system; see Wantland, et al. 2004].

Proposition 8: ePsychology interventions should reflect that when people initiate a behavioural change, relapse is often the rule rather than the exception.

Large numbers of people try hard to lose weight, change their drinking habits, quit smoking, control their gambling, stop taking illegal drugs, take up regular exercise, adhere to their medication, and more. Some of those who try to change actually succeed. Nevertheless, if you try to change yourself in one of those areas, the odds of success are generally not on your side. On the contrary [for overview see Brandon et al. 2007], depending on the area of change, the methods used, and a number of other factors, relapse rates typically varies between 50 and 95 percent [for an overview over the concept of relapse see Brandon et al. 2007]. For example, if you quit smoking without the use of any behavioural support or medicines, the probability that you are still smoke free a year later is about 3 to 7 percent [Hughes et al. 2004]. Likewise, if you try to lose weight, the probability of one year of sustained weight loss is less than 5 percent [Albert et al. 2002]. We also know that large proportions of people with serious medical conditions fail to adhere to their treatment regimens, including taking their drugs as prescribed [for review see O'Donahue and Levensky 2006]. In sum, when people try to change their health behaviours, relapse appears to be the rule rather than the exception.

Relapse may imply that after a short period of successful initial change, you return to your full-blown pattern of the old habit. It seems obvious that in some cases people actually choose to go back to their old habit as a result of comparing the new versus the old behaviour [West 2006]. In these cases, we are not actually talking about relapse, because people take up the old habit due to a change in motivation; in many ways this resembles the same process as when we establish brand new habits. We denote this as a "deliberative relapse" which really is a form of self-conscious choice [West 2006]. It is likely that a vast majority of those who try to change make such a deliberative choice to start smoking or drinking alcohol again rather than relapsing in a more traditional sense of changes in long-term outcome expectancies.

Many of those who try to stop smoking, drink less, or lose weight, invest great efforts trying to resist temptations that could initiate the snowball effect and make the way for a full-blown relapse. In other words, they try to mobilize willpower, or stated differently, they try to successfully self-regulate. Hence, it is pretty obvious that the process of relapse begins prior to the first slip or behavioural violation [see Marlatt 1985; Brandon et al. 2007]. While making a change attempt requires, among other things, motivation, change maintenance requires self-regulation, that is "operations performed by the self to alter its own habitual or unwanted responses to achieve a conscious or non-conscious goal" [Vohs and Schmeichel 2003]. This should be taken into account when developing ePsychology interventions by including psycho-educative components where the difference between a slip and a full-blown relapse is explained so the user can be prepared when experiencing a slip, combined with a system for just-in-time therapy by SMS or IVR when a slip is detected. Hence, the system could help the user prevent that a slip snowballs into a full-blown relapse.

Proposition 9: ePsychology interventions should be constructed to prevent ego depletion.

The inability to maintain a desired and newly established behaviour most often represents a self-regulation failure, i.e. an inability to exert self-control and thus acting out an impulse that runs counter to the person's values or long-term goals [Baumeister et al. 1994]. In other words, self-control is a necessary means to enable us to override undesirable thoughts, feelings, and responses to avoid temptation [Webb and Sheeran 2003].

Temptations often come in the form of impulses. Some people are more prone than others to act on their impulses. For example, smokers have been identified to be more impulsive than non-smokers [see Brandon et al. 2007]. Impulses and consequent actions are of course not always problematic as in the case of the impulse to drink a glass of water when you are thirsty. The impulses that are problematic are those that imply that living them out will be at odds with our personal long-term goals or standards. For example, the urge of having a cigarette may ruin your quit attempt and your highly valued long-term goal of a smoke-free life or the impulse of having a chocolate bar may be at odds with your long-term goal of losing weight. In such situations, successful self-regulation involves taking control of your actions and emotions, in order to ensure that you do "what is good for you" long-term instead of "what is good" right now. Since relapse is so prevalent in behavioural change, this is oftentimes obviously not what happens.

Successful self-regulation is a multifaceted process. This means that, unfortunately, many factors can contribute to a failure in self-regulation [for overview see Baumeister and Heatherton 1996]. One major account of self-regulation failure is an inadequacy in self-regulatory strength. This implies that you are not able to mobilize psychologically what it takes to override unwanted thoughts, feelings, or impulses [Baumeister and Heatherton 1996]. According to this resource-depletion model of self-regulation, a person has a limited amount of generalized self-regulatory resources at any time [Baumeister and Heatherton 1996]. Accordingly, an initial act which requires self-regulatory resources may be followed by a period of vulnerability, i.e., when self-regulatory resources are needed but depleted. Thus, if one, in this period of ego depletion, is exposed to a situation which requires effective self-regulation, then a failure in self-regulation is likely to happen because you are temporarily depleted of those resources [for overview see Vohs and Schmeichel 2003].

People can become temporarily depleted or fatigued of self-regulatory resources, for example, when they try to resist temptations, control their emotions, or try not to act automatically upon their impulses [Vohs and Heatherton 2000]. For example, if a few days into a smoking cessation attempt, you experience a problematic job situation, you may need to use self-regulatory resources to both cope with the resulting negative emotions and try to improve your performance. If you simultaneously or shortly after, are exposed to a temptation to smoke, then you are probably at risk for relapse because your self-regulatory capacities may be temporarily depleted.

On the one hand, preventing ego depletion in ePsychology interventions could be done by implementing psycho-educative components informing the user of the importance of healthy nutrition, rest, and sleep. This is because self-regulation failure is more likely when a person is fatigued and have low levels of glucose [Muraven and Baumeister 2000]. On the other hand, positive mood or emotion is known to counteract ego depletion as well [Tice et al. 2007]. Thus, components that instill positive affect like a funny film clip or a happy song could be used as just-in-time therapy when experiencing ego depletion.

Proposition 10: ePsychology interventions should address factors that cause slow oscillations in relapse proneness.

In order to understand the process of relapse, there seems to be a need for identifying the chronology of relapse risk forces, i.e., how the strength of the various relapse forces wax and wane throughout a change attempt. On the basis of much existing research it is likely that relapse proneness is both multifaceted and follows a certain chronology. Hence, behavioural change interventions should be designed accordingly.

More specifically, we know that some relapse forces and risk factors may manifest themselves in slow oscillations in relapse proneness over time [see Piasecki et al. 2002]. Rothman [2004a] has suggested that the decision criteria that lead people to initiate a behavioural change are different from those that cause them to maintain the change. For example, prior to quitting, people who decide to stop smoking may initially have been motivated by the long-term, probabilistic positive consequences of quitting. In contrast, when they actually stop smoking, their motivation to stay smoke-free the first days and weeks, may be more influenced by the short-term, certain and unpleasant consequences they experience. Moreover, in the first days and weeks post-quit, their decisional balance (along with their self-efficacy and other variables) may vary considerably. These types of oscillations may influence the chances for a successful outcome. One framework, among many, that may provide an explanation on what causes these slow oscillations in relapse proneness is the cognitive-affective processes system [CAPS; Metcalfe and Mischel 1993]. In the CAPS model, the "know" is thought to be specialized for thinking and it can be characterized by words

like *cognitive, complex, reflective, slow, develop late, attenuated by stress and self-control*. Most psychologically oriented change interventions appear to address such cognitive processes. Because of that, we could say that they have contained components which have a psycho-educational approach. This implies that they try to educate people who change about what to expect and how to handle difficult times. For example, you learn from self-help books to identify a goal structure, and what the consequences of successful behavioural change are likely to be in the future (i.e. "what is good for you"); your self-efficacy is boosted by persuasion (i.e. "you can do it") or by means of progress reports, etc. You may also learn how to intervene on your thoughts, feelings, and actions.

Proposition 11: ePsychology interventions should help people make implementation intentions.

An important characteristic of digital interventions appear to be their potential to prevent ego depletion in users. An equally important characteristic would be the ability to offset the consequences of ego depletion if and when it occurs. Webb and Sheeran [2003] have shown that the formation of implementation intentions may help serve both needs. Implementation intentions are subordinate to goal intentions [Gollwizer 1999]. Thus, while a goal intention may be that "I will lose weight," an implementation intention is a statement of the form: "As soon as situation *y* occurs, I will initiate goal-directed behaviour *x*." By specifying the coping response, before the situation arises, one assumably passes control of behaviour to specified cues (e.g. feeling an urge to eat a chocolate bar) to the environment. Time, place, and situation thus become cues that automatically activate the relevant coping response. The idea is that this probably implies that the need for cognitive control is circumvented, a process called "strategic automatization" [Webb and Sheeran 2003].

Additionally, when the user experiences temptations, i.e., close-call situations in which the user is brought to the brink of relapse, the occurrence of relapse seem to be influenced by the users coping responses. In this respect, the use of both cognitive and behavioural coping strategies seem to effectively prevent relapse in such situations [for overview see Shiffman et al. 1996], which is why behaviour change interventions typically aim to prepare people by improving their coping resources. It seems reasonable to expect that although interventions which improve the users coping resources in general may be justified, intervention elements like a reminder of coping strategies by SMS or IVR supporting adequate coping in close call situations would seem particularly promising.

Proposition 12: ePsychology interventions should help people make coping plans.

Sniehotta and colleagues [2005] separate between two versions of implementation intentions, namely action plans and coping plans. *Action plans* refers to when, where, and how to act in accordance with one's goal intention, thus action plans are similar to Gollwizer's definition of implementation intentions, while *coping plans* relate to barriers in that they focus on strategies that will ensure that you will act on your goal-intentions even when you are faced with obstacles like in high-risk situations. Coping plans do not necessarily reflect goal-directed behaviours. Rather, they may represent behavioural or cognitive coping responses that reflect interactions between the individual and the environment. For example, a coping plan could be that "If I am tempted to have a cigarette, I will call the 24-hour craving line immediately" [for an example, see the smoking cessation intervention Happy Ending described by Brendryen et al. 2008]. Hence, coping plans address how to prevent that one reacts to environmental or psychological cues in an unwanted way [Sniehotta et al. 2005]. This seems to make coping plans extremely valuable, because an impulse to act in a way that may ruin your long-term goal may occur in many different physical, social, and psychological situations; at home, at work, when attending a party, or when being frustrated, grumpy, stressed, etc. Consequently, it appears to be difficult for the user to make specific implementation intentions regarding how to act in all combinations of locations, situations, and moods. In contrast, it seems more appropriate that the user form one or a few implementation intentions to cover all situations and moods.

Proposition 13: ePsychology interventions should offer instant, just-in-time therapy in order to prevent relapse due to sudden spikes in relapse proneness.

It appears important to take into consideration that profiles of relapse proneness often vary considerably across time, situations and persons [see for example Piasecki et al. 1998; Muraven et al. 2005]. Focusing the dynamics and consequences of sudden spikes in symptomatology and relapse proneness may provide important insight about successful change. In the CAPS framework such sudden spikes are conceptualized as being part of the "go system" [Metcalfe and Mischel 1993]. Sudden spikes in relapse proneness can be considered as parts of the emotional system, specialized for rapid emotional responding on the basis of situational (originating from outside or inside the individual) triggers. Such "hot spots" can be characterized by such words as emotional, go, simple, reflexive, fast, develops early, accentuated by stress, and stimulus control [Metcalfe and Mischel 1993].

These peaks in relapse proneness seem to be difficult to predict. They may occur suddenly and in many cases they disappear after a relatively short period of time. But coping with them cannot wait until you have gotten home and consulted your self-help material or until next week when you have your next group therapy class. The peak in symptoms is a close call situation that must be dealt with as soon as possible; i.e. relevant help and support should

be available whenever and wherever you need it. Thus, more effective digital interventions are likely to offer support or therapy which is available just before, during, and after a peak in relapse proneness. Consequently, portable devices such as mobile phones are likely to be effective tools for relapse prevention and therapy [see the role the mobile phone plays in the smoking cessation intervention Happy Ending described by Brendryen, et al. 2008]. Future research should focus how portable devices can be best deployed in different areas of health behaviour change where relapse is a major problem.

Proposition 14: The just-in-time therapy that digital interventions offer should help individuals tackle the experience of negative affect.

The next question which arises is: What kind of treatment should be available at the close call situation? Generally, it seems reasonable that the content of the treatment should reflect what the users experience psychologically during a peak in relapse proneness. It has been reported that daily changes in self-efficacy and outcome expectations may predict lapses the next day, at least in the area of smoking cessation [Gwaltney et al. 2005]. Nonetheless, it may seem more important to point to the fact that a considerable amount of research has testified to the important role that negative affect seems to play in relapse [for research on smoking and dieting see for example Brandon et al. 2007; Kenford et al. 2002; Shiffman and Waters 2004]. It seems reasonable to expect this to be the case in a number of different behavioural domains.

As a corollary, it seems pertinent to consider negative affect to be both a proximal predictor of relapse and a mediator and/or index of the processes that yield relapse vulnerability [see for example Piasecki et al. 2002; Kenford et al., 2002]. Thus, in addition to its own unique contribution, negative affect seem to mediate and moderate the impact of a number of both pharmacological and non-pharmacological events and processes upon relapse proneness. A number of explanations which may possibly account for the causal mechanisms which may underlie the relationship between negative affect and relapse proneness have been offered [for overview see Shiffman and Waters 2004]. Although further research into these specific mechanisms is welcomed, it seems that we know enough to suggest that more effective behavioural change interventions probably should include some elements that can effectively help individuals manage the experience of negative affect – whenever and wherever negative affect is experienced simultaneously with an urge to relapse. Such a component is built into the smoking cessation intervention Happy Ending that has proven very effective in clinical trials [see Brendryen and Kraft 2008; Brendryen et al. 2008].

One possible mechanism is that negative affect either signals and/or is a mediator or moderator of ego depletion. Whatever the causal mechanisms are, a dose of positive affect could apparently be prescribed as the best medicine [in addition to sleep, rest, and a portion of glucose; see for example Tice et al. 2007; Fredrickson and Levenson 1998; Gailliot and Baumeister 2007].

IV: EPSYCHOLOGY: EFFECTIVE EMOTION REGULATION AND POSITIVE PSYCHOLOGY

Proposition 15: ePsychology interventions should provide support for effective affect regulation.

There is good reason to expect that people who are striving to change important aspects of their lives, will benefit from positive psychology [Seligman and Csikszentmihalyi 2000] interventions. It is likely that interventions that instill positive affect will both increase the likelihood that the change attempt itself will be successful and give the user a better life during the change process. Therefore, interventions should capitalize on what we know about *affect regulation* (we use the term to subsume the management of subjective feeling states in general). The reason is that affective states influence subsequent behaviour, experience, and cognition [Bless and Forgas 2000]. So, one function of affect regulation is to limit the residual impact of lingering emotions and moods on subsequent behaviour and experience. Feelings most certainly provide important information to a person and serve to direct subsequent thought and behaviour in mostly adaptive ways.

Affect regulation refers primarily to the modulation of feeling states, mostly in terms of the valence of those states, although people seek to regulate energy level as well [Thayer 2001]. Some researchers in the stress and coping tradition have primarily emphasized the down regulation of negative affect [Bushman 2002] while other researchers have focused the up-regulation of positive affect [Fredrickson 2000]. Affect regulation adapts to daily life and influences health in a positive way. Additionally, people regulate their affect level in order to achieve another superordinate goal: to maintain a global sense of subjective well-being (SWB). SWB has two affective components at its core, both of which are considered as aggregates or averages over relatively long time periods [Diener and Seligman 2002]. These two components are average levels of positive affect (PA) and negative affect (NA). Consequently, people may influence their SWB by regulating the two major affective states, PA and NA. ePsychology interventions thus have to aim at helping people to minimize NA and/or maximize PA. This can be

done in two ways. The intensity of the affective state may be influenced downward for NA and upward for PA, and/or the duration of the affective state may be influenced.

Future digital health and well-being interventions should include intervention elements that are based on a number of affect regulation strategies. These specific strategies would probably reflect one of four general classes of affect regulatory strategies: those strategies that are either behavioural or cognitive, and are focused on changing the situation or the emotion [Larsen 2000]. Most likely, interventions should aim at influencing both NA and PA. However, negative life events have a stronger impact on subjective feelings than do positive events [Baumeister et al. 2001] and NA is two-to-three times stronger than PA [Larsen 2000]. Additionally, change reactions and consequences like ego depletion and relapse are often paired with the experience of NA. Still, the increase in PA is also an important goal of digital interventions, since people in their daily lives often try to induce or maintain PA [Larsen 2000].

Proposition 16: ePsychology interventions should utilize recent insights from applied positive psychology.

Positive psychology is the science of optimal human functioning, a field focusing on positive subjective experiences, positive individual traits and positive institutions that can improve quality of life [Seligman and Csikszentmihalyi 2000]. Positive psychology aims to broaden the focus of clinical psychology beyond suffering and its direct alleviation. To focus on a person's ambitions, positive life experiences, and strengths of character might buffer against disorder and contribute to psychological resilience.

One theory that aims to describe the connection between positive emotions, meaning and coping is the broaden-and-build theory of positive emotions, developed by Fredrickson [1998; 2001]. This theory describes how positive emotions broaden people's thought-action repertoires. Fredrickson [1998] demonstrated that positive emotion induced in the laboratory after a time-pressured speech preparation task where the participants believed their speech would be videotaped and evaluated caused negative emotion to dissipate more rapidly than when neutral or negative emotions was induced. Furthermore, Tugade and Fredrickson [2004] found that positive emotions undo the cardiovascular aftereffects of negative emotions like increased heart rate, increased blood pressure, and increased vasoconstriction. It has been speculated that there exists an upward spiraling effect of positive emotion and broadened thinking; individuals who experience positive emotions are more likely to find meaning in negative events, and this meaning-making, in turn, leads to greater positive emotions. Fredrickson, et al. [2003] claims that positive emotions can momentarily broaden people's modes of thinking, which can improve ways of coping with a stressful experience. With repeated experiences of positive emotions over time, a style of such broad-minded coping might even become habitual and thereby build resilience against adversity.

During the last decade, we have witnessed the development of several positive psychology interventions that have shown promising results in terms of increasing and sustaining positive emotion and engagement, as well as meaning in life. We believe different types of health behaviour change interventions might be facilitated by applying different aspects of positive psychology. For example, nurturing social relationships and increasing engagement and flow would probably appeal to a broader audience of users than meditation and mindfulness. Thus individualization and adjustment according to the domain of the health behaviour intervention should be taken into account to fit the best activities from positive psychology to the individual user and domain of the intervention. Several of the interventions conducted in the field of applied positive psychology has been tested online [see e.g. Seligman, Rashid and Parks 2006]; thus, elements from applied positive psychology seems promising to implement in ePsychology interventions.

Proposition 17: ePsychology interventions should provide strategies to enhance optimistic thinking.

When people meet difficulties in life, they experience a wide range of emotions ranging from excitement and eagerness to anger and anxiety. The balance between positive and negative emotions facing adversity is related to people's degree of pessimism or optimism. Optimists experience less distress than pessimists, because they use different cognitive coping strategies. Optimists tend to attribute failures to external, variable and specific explanations, while persons with a pessimistic attributional style give failures internal, stable and global explanations [Seligman 1991]. Optimism is found to be negatively related to the use of denial and to distancing oneself from the problem, which are strategies that are related to pessimism [Carver and Scheier 2003]. Furthermore, optimism is related to problem-focused coping, use of positive reframing, and a tendency to accept the reality of a situation in uncontrollable situations. Such effective coping strategies are important to succeed in health behaviour change, thus optimism should be addressed in digital interventions.

One way to address optimism in digital interventions could be to include tasks from cognitive behavioural therapy (CBT) which focuses on turning negative and pessimistic thought patterns into more positive and optimistic thinking. Because CBT is a highly structured form of therapy it seems suitable for implementation in digital interventions. In CBT, the user learns to recognize and identify automatic negative thoughts and then dispute these negative thoughts to find alternative explanations. One example of CBT used in digital interventions is MoodGym, which is an intervention with five modules addressing depression [Christensen et al. 2004]. The process of identifying and disputing negative thoughts used in CBT can be rather demanding on the user; thus, we suggest an alternative in the form of positive psychology to address optimism in digital interventions. Several studies have shown that optimism can be cultivated and enhanced through writing exercises focusing more on positive aspects of one's future life. One such writing exercise described by Lyubomirsky [2007] is to keep a goals and sub-goals diary. By focusing on goals and learning how to divide them into sub-goals and by that make goals easier to obtain, one's feeling of mastery is enhanced, which again will help in seeing the future and one's abilities in a more optimistic light. Another exercise is to enhance optimism by writing about one's best possible future self [King 2001; Sheldon and Lyubomirsky 2006]. In the best possible self exercise, one imagines and writes about the best possible future for oneself in several life domains. This exercise helps the user to see the big picture of his or her goals and dreams and by that, contribute to a more optimistic way of thinking.

Proposition 18: ePsychology interventions should help people experience and express gratitude to prevent hedonic adaptation and increase well-being.

Gratitude is defined by Robert Emmons as "a felt sense of wonder, thankfulness and appreciation of life" [Emmons and Shelton 2002]. Research on gratitude has recently started to detect the multiple benefits of experiencing and expressing gratitude. Grateful thinking bolsters self-worth and self-esteem, which is important in a change process. It can also strengthen social bonds by expressing thankfulness to other people. Furthermore, gratitude promotes savoring of positive experiences and helps people cope with stress and trauma. Hedonic adaptation refers to people's remarkable capacity to quickly adjust to new circumstances. Adaptation to positive life circumstances is the reason why the effect of happy events tends to be shorter than we expect [see e.g., Lyubomirsky 2007]. It is plausible that gratitude can counteract the effects of hedonic adaptation by preventing people taking the good things in life for granted.

Several studies have focused on the effect of gratitude interventions. Emmons and McCullough [2003] found that participants randomly assigned to a gratitude intervention where they wrote about things in life they felt grateful for, showed more positive affect and less negative effect compared to control participants. Seligman et al. [2006] tested several Internet interventions in order to develop positive psychotherapy (PPT). One of the exercises was "Three Good Things" which is similar to the gratitude exercises by Sheldon and Lyubomirsky [2006] and Emmons and McCullough [2003]. Participants were asked to write every day for one week about three good things that happened to them that day and why they happened. This exercise was included in a random-assignment placebo-controlled study, where positive psychology exercises delivered by Web-relieved depressive symptoms for at least six months compared with placebo interventions, the effects of which lasted less than a week. Other exercises to instill gratitude that could be included in digital interventions are writing a gratitude letter, e-mail, or sending a SMS to someone or expressing gratitude directly to someone in-person or by phone,.

Proposition 19: ePsychology interventions should help the users to increase engagement and flow experiences in their daily life.

Duckworth, Steen, and Seligman [2005] divide happiness into three distinct areas: the pleasant life, the engaged life, and the meaningful life. Pleasure and engagement can be seen as distinct routes to happiness and well-being, and we believe that both routes should be addressed in digital interventions. The engaged life pursues engagement, involvement, and absorption in work, intimate relations, and leisure activities [Csikszentmihalyi 1990]. When people are so engaged in an activity that they lose track of time and place and are completely absorbed in the activity, they have reached a psychological state called *flow*. When people experience flow, they report feeling strong and efficacious, at the peak of their abilities, alert and in control. When in flow, they are totally immersed in the activity; they are fully concentrated and unaware of themselves. To reach flow, one has to establish a balance between skills and challenges. If the challenges of the activity overwhelm your level of skills and expertise, you will feel anxious and frustrated, and if the activity is not challenging enough you will feel bored [Csikszentmihalyi 1990]. Thus, to reach and maintain flow in our lives, we continually have to test ourselves in increasingly challenging activities. Digital interventions can provide the user with knowledge of what flow is and how they can increase flow in their lives by doing activities that are challenging and intrinsically motivating. In addition to educative information about flow, we think that some kind of instrumental support should be included in digital interventions. In the following, we suggest two types of exercises that could be included in digital interventions. Both exercises provide ways to identify activities that can create flow and give support for increasing the time doing engaging activities in daily life.

Many people are rather passive in their leisure time. Passivity and lack of interest and engagement lead to more negative emotions, and Csikzentmihalyi and LeFevre [1989] actually pinpoint that people can improve their quality of life with a more conscious and active use of leisure time. When people are engaging in pleasant activities, they are more likely to have positive thoughts about themselves and their own lives. Pleasant activities can also enhance social support as they often are done together with friends and family. Doing more pleasant activities in one's daily life will most likely enhance the level of positive emotions as well as engagement and self-efficacy through mastery experiences. CBT provides exercises with instrumental support like lists of activities and planning strategies to make time for such activities. We believe exercises from CBT that prompts the users to engage in more pleasant activities in their daily lives can easily be adopted in digital interventions to increase both engagement and pleasure.

Another kind of exercise that could help people increase flow and engagement in their lives finds its base in Seligman et al.'s [2006] work on development of positive psychotherapy to address depression. In one of the exercises tested in PPT, participants got feedback about their highest strengths after completing the "Values in Strengths" questionnaire. After the feedback the participants were told to use a different strength in a new way every day. This exercise seems to increase engagement and flow by identifying people's greatest talents and strengths and then help them to find opportunities to use these strengths more.

Proposition 20: ePsychology interventions should include education and instrumental support for nurturing social relationships.

The third dimension of Seligman's definition of happiness is the meaningful life [Duckworth, Steen, and Seligman 2005]. This dimension involves the pursuit of meaning through using one's signature strengths and talents to belong to and serve something that is bigger than the self. Family, community, religion, and politics are examples of such positive institutions. Interaction with others is an important route to experiencing positive emotions. Social contact and having close and supportive relationships with friends and family is considered meaningful and a source for experiencing positive emotions for most people. A study on the role of intimacy and social support in health outcomes concluded that the health-promoting benefits of intimacy most likely occur because intimate relationships are likely to engender higher levels of social support [Reis and Franks 1994]. Thus, strategies to strengthen bonds to others and learning to achieve intimacy in one's close relationships should be included in digital health interventions.

Several intervention studies focusing on how one can strengthen relationships by doing kind acts, expressing gratitude, and learning how to forgive, have been conducted in the field of positive psychology. In a study by Otake et al. [2006], participants were asked to report the number of kind actions they performed per day. The results from this study suggested that a one-week intervention that simply asked people to count kindnesses is able to increase people's subjective happiness. Counting acts of kindness probably leads to a focus on altruism such that the participants actually increase the number of kind acts they are doing. Being nice to other people by doing kind acts will strengthen the bond to the receiver and might also inspire the receiver to do more kind acts and reciprocate.

To enhance social relationships, digital interventions could include practical exercises like the one described by Otake and colleagues. Other exercises that could facilitate the feeling of belonging, support and intimacy could be to draw a map of your social network to become more aware of close and more distant relations, instructions to call friends and relatives more often, to give someone a compliment, do a pleasant activity with a friend and so on. We will also suggest that social support and active-constructive responding should be addressed in digital interventions. Giving and receiving social support in adverse times of life is one of the most important functions of a social bond. Social support can consist of emotional, instrumental or informational support. Emotional support could, for instance, be to talk over a problem with a friend, provide encouragement, or positive feedback. Instrumental support refers to the various types of tangible help that others may provide like help with childcare or provision of transportation. Informational support refers to the help that others may offer by providing information or advice. Active-constructive responding implies that one reacts in a visibly positive and enthusiastic way to good news from someone else [Peterson 2006; Seligman et al. 2006]. Research into couples and intimate relationships suggests that supporting partners when good things happen is as important in building a relationship as supporting when bad things happen [Lyubomirsky 2007]. Both social support and active-constructive response should be addressed in digital interventions through psycho-educational components in combination with concrete exercises. This can be done by using dialogue systems [see Bickmore 2003] that can initiate for instance role plays that the user does together with a partner at home.

We have already outlined some strategies and exercises focusing on how to experience and express more gratitude in one's life. Similar techniques can be used to learn how to forgive if a person has been hurt or offended. When people are being hurt, wronged, or attacked by another person, the most typical reactions are to reciprocate with equal harm, to avoid the other person or to seek revenge. Meanwhile, forgiveness involves suppressing or reducing one's motivation for revenge and avoidance and replacing those negative feelings with more positive attitudes, feelings, and behaviour. Forgiveness does not necessarily involve the reestablishment of the relationship with the

transgressor, but it involves a shift in thinking such that the desire for revenge decreases and the desire to do the transgressor good increases. People who are forgiving in relationships are more capable of reestablishing closeness and are more likely to be happier, healthier, more agreeable, and honest. Forgiving allows a person to avoid bitterness and to move on [Lyubomirsky 2007]. Digital interventions could support forgiveness by educating the user on the benefits of forgiveness. Digital interventions could also benefit from providing interactive writing exercises where one practices empathy by writing the offenders forgiveness letter to oneself where the user takes the transgressors role and finds alternative explanations for the event that has offended him. A similar exercise could be to write a forgiveness letter to the offender. Practicing empathy could also be done by using a conversational dialogue system suited for role play. By doing these kind of exercises the user can decrease negative emotions, and replace them with more positive emotions, and he might also improve his relationships with others.

Generally, sites which incorporate the use of a chat room are perceived to provide increased social support scores [Wantland et al. 2004]. However, this is not a unanimous finding. In some studies, users who participate actively in online discussion groups report only a moderate social support from the group [see Winzelberg et al. 2000].

Proposition 21: ePsychology health interventions should include components teaching and supporting meditation and mindfulness.

Mounting evidence suggests that meditation and mindfulness has multiple positive effects on happiness and positive emotions, stress, cognitive abilities, and physical health [Shapiro et al. 2002]. Meditation comprises a family of techniques that goes by different names and categories. The core ingredient in both mindfulness and meditation is the cultivation of attention. Mindfulness has been defined as a state in which one is “attentive to and aware of what is taking place in the present” [Brown and Ryan 2003]. Mindfulness captures a quality of consciousness that is characterized by clarity and vividness of current experience. Mindfulness is intentionally paying attention to what is happening in the present moment with an orientation of acceptance and curiosity and marked by non-evaluative observation. If the person notices that attention has wandered from this orientation, he gently reorients the mind back to a more open state of awareness [Kabat-Zinn 1990].

Central practices in mindfulness that could be included in digital interventions are body scanning, mindfulness of breathing, and sitting meditation. Body scanning is a technique where it is important to maintain “awareness in every moment, a detached witnessing of your breath and your body, region by region, as you scan from your feet to the top of your head” [Kabat-Zinn 1990]. During the practice of body scanning, one takes an observing role toward oneself and primarily recognizes all sensations in the body and secondarily external events, emotions, and cognitions that may arise while observing the body. Instructions for body scanning, meditation and breathing exercises could easily be provided through instructions on mp3 files or video in digital interventions.

Proposition 22: ePsychology interventions should provide instrumental support for savoring positive experiences.

Savoring is defined as any thoughts or behaviours capable of generating, intensifying, and prolonging enjoyment. People who regularly and frequently savor positive experiences are happier and more satisfied with life in general, more optimistic, and less depressed [Peterson 2006]. Savoring can be thought of as having a past, present, and future. You can savor the past through reminiscing, the future through the anticipation of things to come, or enjoy just being in the present.

One effective strategy for savoring is to share positive events with others. It is often easier to savor when you do something together, and you can also reminisce together about the event later on. A digital intervention could provide instrumental support by making it more convenient for the user to plan events with friends and family by sending out invitations via text messages, e-mails or via Microsoft Network (MSN) or Facebook. Another effective savoring method is to build memories of positive events. This can be done by taking photographs or video recordings from the event, but one can also just store mental images. By using images whether they are mental images or actual images helps one to focus more clearly on the event which again will reinforce the associated positive emotions. A digital intervention could support making a savoring album online and allow the user to share the album with invited friends. A third strategy for savoring is celebrating good news. Sharing successes and accomplishments with others is associated with increasing well-being and positive emotions. Instrumental support for planning a celebration with friends and family could be provided in a digital intervention. The user should also be encouraged to be proud of what he or she has accomplished. Thus, the user should get instructions and encouragement on positive self talk (e.g. “tell yourself how hard you have worked for this to happen, and imagine how impressed others are by what you have done”).

V. EPSYCHOLOGY INTERVENTIONS: REACHING AND HOLDING THE AUDIENCE

Why do people initiate, continue, stop, or avoid using digital health interventions? What needs do users want to fulfill, how are those needs interrelated; what are people's goal-oriented commitments that drive use? How can our understanding of these questions guide us in designing desirable technology that people really want to use? Asking these questions is to take a motivational perspective on technology design issues [Zhang 2007]. How we answer them will have direct implications on how we design such interventions.

Let us take only two examples. If you are to write a newspaper story on alcohol, you may search Web sites that can offer libraries with this kind of information as Wikipedia does (i.e. enormous matrices or hierarchical structures of information and a lot of user choices). However, if you are concerned about your alcohol habits and really want help and support to change them, your need is totally different. Consequently, this should be reflected in how the intervention is designed. Let us mention but one possible consequence. It may be that in the latter case, you may be less concerned with giving away the autonomy that Web sites often offer in terms of navigation freedom and more motivated to receive credible and empathetic advice as part of a structured system. It is easy to agree with Zhang [2007] in that: "It is crucial that we understand technology use behaviour and eventually feed this understanding into technology design".

Proposition 23: ePsychology interventions should be designed with the explicit purpose of holding the interest of the user.

It takes time to change one's habits or personal characteristics and in order to be effective, digital interventions should be able to hold the interest of the user over time. Empirical studies have demonstrated this to be a potential serious shortcoming in digital health interventions [see e.g. Lenert et al. 2003; Matano et al. 2007]. So what keeps users coming back to an intervention? One could think of at least two main reasons. First, users have a primary need that is sought satisfied by initially starting up the intervention. This need is fuelled by the fact that the intervention is seen as a useful tool to help reach a valued personal goal. The motivation for both initial and continued use may hence be the expected utility of use. Most probably, continued use is heavily influenced by experienced utility which fuel expected future utility. So in order to ensure long-term use, digital interventions should be constructed to optimize subjective expected utility, i.e. to be judged by the users to help them to achieve their goals that motivated initial use of the intervention in the first place. This could probably be induced by offering the user relevant, individually tailored material and feedback, which has been shown to increase system use [Wantland et al. 2004]. Also, incorporating interactive and continuous self-monitoring and feedback systems are likely to increase system use.

Media choices are affected by both individual needs for information and stimulation [Rayburn 1996]. To better understand continued use of digital health interventions, research should consider additional motives to instrumental use, i.e., motives other than the expected completion of the initially intentional goals. Specifically, what are the experiential reinforces for continued use? To what extent do latent gratifications motivate continued or increased use? Consequently, it seems important to address more broadly the psychological, social, and cultural needs that contribute to media choice and use. In other words, one has to search for the correlations between observed gratifications and the psychological origins of the satisfied need. One must fully recognize that both affective and cognitive states influence media usage. In this context, it seems important to take into account that the initially sought-after gratifications may be different from the gratifications that are actually received [Rayburn 1996]. For example, there is every reason to expect that digital interventions must fulfill user's expectations that use will provide entertainment and relaxation [Ferguson and Perse 2000]. We would also like to add positive affect to this.

Other strategies to address the challenge on adherence could be embedding motivational components into the system, offering incentives for completing the intervention, including steps or levels in the system which requires a certain level of adherence to for example unlock previously unavailable system features as is common in gaming. However, there is a need for further research into these and other possibilities to increase adherence.

Proposition 24: Implementation intention formation should be used in the service of regular system adherence.

In addition to help serve the attainment of behavioural change, the formation of relevant implementation intentions could prove to increase the usage of the system itself. A goal intention related to system use would specify the behaviour one wants to perform or the goal one wants to achieve and could have the format "I intend to follow this intervention." An implementation intention, on the other hand, would specify the exact response that one will initiate to ensure that the goal is attained. Implementation intentions come in two forms [Sniehotta et al. 2005]. Action planning is the process of linking goal-directed behaviours to certain environmental cues by specifying when, where, and how to act [Gollwitzer 1999]. These cues can trigger the initiation of action without conscious intent. Engaging in planning enables individuals to make strategic use of environmental cues and act successfully without the

requirement of investing self-regulatory resources. In relation to system use, the system itself could contain features that help the user make action plans in terms of for example specifying how, when, and where the user will attend the system the following day: "If it is 6 p.m. tomorrow, I will sit down in my study and visit my Web-based alcohol program."

The second type of implementation intentions are coping plans [Snihotta et al. 2005], which creates a mental link between expected risk situations and adequate coping responses. By foreordaining how to best escape unwanted influences on behaviour, individuals can act on their intentions even in situations where barriers and obstacles constrain intended actions or evoke contra-intentional behaviour. In this way coping planning can protect good intentions from distractions because a concrete coping procedure is at hand when the risk situation is entered. Sheeran and coworkers [2007] evaluated an intervention which utilized implementation intentions that may seem relevant for the usage of most information systems. The intervention aimed to increase attendance at scheduled initial appointments for psychotherapy. Related to usage of an information system, the intervention itself could help the user to make a coping plan, such as for example: "If I start thinking about not visiting the program on a daily basis, I will ignore those thoughts and tell myself that it really helps me attain my personal goals."

Additionally, designers of ePsychology interventions should consider using prompting to increase adherence. For example, in the Happy Ending and Balance interventions, SMS prompts are sent to the user if he/she has not daily visited the Web sites of the intervention. It is also possible to make use of context-based prompts, i.e., messages that are given to the user in a predetermined physical situation [for examples of context-based prompts see Vurgun, Philipose, and Pavel 2007]. It is also possible to consider context-based prompts that are connected to the GPS functionality of a mobile unit. Particular therapeutic functionalities of the ePsychology intervention could be triggered by the geographic location of the user (e.g. when approaching the favorite bar, liquor store, home alcohol cabinet, or similar situations).

Proposition 25: ePsychology interventions must be constructed to establish a good therapist-client relationship.

In digital therapy, the information system can be seen to represent a counselor, expert, advisor, consultant, supporter, friend, and/or therapist. Extensive research indicates that the quality of the therapist-client alliance is predictive of treatment success [Weinberger 1996]. Behaviour change is facilitated when the client feels personally accepted and valued. Thus therapist empathy is crucial in providing the conditions necessary for a successful change to take place [Miller and Rollnick 2002].

Empathy will ensure that the clients feel that the therapist is genuinely invested in them and their well-being, understand the difficulties they are facing, and can be trusted to dedicate psychological and emotional resources that the individuals can draw on for support. More specifically, the therapist-client alliance is based on three factors: First, a mutual understanding of the goals that one pursues as part of the change process; Second, a mutual understanding of the tasks and responsibilities of the two parties; And third, a linkage between the therapist and client that is based on mutual trust and confidence.

It is particularly important that the client is informed and prepared. He or she should know what the main character of the intervention will be, the modus of communication, the structure of the information system, and what he/she is expected to do, etc. [Weinberger 1996]. Also, the purpose of the main therapeutic ingredients should be explained to the client. By doing this, the therapy is made more understandable for the client, and he/she may act as an active problem solver and partner in the therapeutic process. The clients are thus helped to develop clear and realistic expectations about what the behavioural change intervention will imply and can do for them. This implies that the client gets an overview of the main structure of the intervention and/or system and its change elements. For example, clients should be helped to formulate realistically achievable goals, and be encouraged to believe that they are capable of engaging in the appropriate tasks and efforts leading to goal pursuit. Clients should be informed about how the information system will support these achievements, and how they will receive help, support, and feedback throughout the change process.

Proposition 26: ePsychology interventions should be constructed according to what constitutes a successful information system.

There is an apparent need to more systematically approach digital intervention in the health and well-being domain as information systems. To this end, the Information Systems success model [DeLone and McLean 1992] may offer a promising point of departure. According to this perspective, six categories of characteristics should be assessed to determine the success of an information system: 1) system quality; 2) information quality; 3) use/intention to use; 4) user satisfaction; 5) individual impact; and 6) organizational impact. The system's quality refers to the technical accuracy and efficiency from which the information system produces the information, and is generally assessed by

means of for example response times, reliability, and usability measures. *Information quality* refers to the system's ability to successfully convey the intended meaning (i.e. semantics). Measures of information quality assess the perceived quality of contents, accuracy, timeliness, relevance, etc. The last four categories, that is, use and intention to use, user satisfaction, individual and organizational impact, reflect the effect that the information has on the user. These categories can be assessed, for instance, by measuring the amount of time spent on a Web site, user satisfaction ratings regarding confusing or clear instructions, perceived instrumental support in decision-making, such as help to identify positive outcome expectancies, and responsiveness or actual behavioural change. More recently, the IS model has been revised and updated to include service quality which assesses the perceived support for end users [DeLone and McLean 2003]. Which of these dimensions are deemed most important depends upon the level of analysis. But nevertheless, research on digital interventions should address these issues more thoroughly to inform future design as this will also have consequences for the process of designing persuasive information systems in terms of content and functionality [Oinas-Kukkonen and Harjumaa, in this issue]. A very simple example serves to shed light on why it is important to study digital interventions as information systems: assuming that the information quality is poor in that it requires an extensive vocabulary by users, then it should not come as a surprise that the intention to use and actual use of a digital intervention will most likely drop below acceptable levels. But what constitutes good information quality quantitatively and qualitatively remains vague in many cases.

Proposition 27: ePsychology interventions should be constructed to produce an emotional impact.

Can digital interventions be designed so that they are easy to use and understand and also have an emotional impact? According to Norman [2003], emotional design is dependent on a balance between three levels of design: the visceral level; the behavioural level; and the reflective level. The visceral level is dominated by the physical features: the look and feel, the use of images, sounds, colors, etc. Information processing at this level is considered to be automatic because we are attracted to objects that are simple, symmetrical, harmonious, balanced, and proportional from an evolutionary perspective. At the behavioural level, one is concerned with how the use of the product (i.e. outside explicit awareness) is perceived by the user in terms of, for example, functionality, comprehensibility, user friendliness, and the physical perception of the intervention. At this level it is considered of primary importance that the program provides feedback to the user to ensure an understanding of what is going on. The reflective level is related to the user's construction of the meaning of the information system use. Particularly important features are program and user identity congruency, the experience of personal touch, and mastery of program use. We know much too little today about how digital health interventions could capitalize on emotional design. But we know enough to suggest that emotional design is likely to contribute to initial and continued use, as well as effect of digital interventions. For example, increased interactivity seems to improve the emotional quality of the product [Norman 2003].

Proposition 28: ePsychology interventions should be constructed to increase interactivity.

A number of studies have shown that interactivity plays an important role for user engagement. For example, results from two studies suggest that Internet weight loss interventions are likely to be most effective when they require participants to keep daily records of their food intake and physical activity, and the intervention provide feedback on their performance [Tate et al. 2001; 2003]. To the extent that interactivity can increase user involvement, it must be considered a critical characteristic of a digital intervention. Most often change involves a considerable effort and involvement by the user. Although the intervention will contain information, tasks, and advice, successful change depends on the active involvement and participation of the individual [Baumeister et al. 1994; Baumeister and Heatherton 1996]. On the one hand, this involves that the user comply with recommendations in terms of following the intervention closely; reading, thinking, doing, etc. as advised in the intervention. On the other hand, active involvement is necessary for effective self-monitoring to take place, selection of situations to be effective, appropriate handling of impulses to be initiated, etc. Specifically, for such change elements that are based on user input (feedback, progress reports, relapse prevention, etc.) to work appropriately, it is necessary that the user adheres to and actively takes part in the intervention.

As discussed previously, many changes require long-term maintenance in order to be successful. Furthermore, individuals must be able to gauge their progress against some frame of reference, which might include their own change plans, the behavioural progress of others who are in a similar situation to themselves, or regimens from trustworthy sources. In other words, efforts to change are likely to be successful when individuals receive timely monitoring and feedback on their progress [Carver and Scheier 1981]. With such feedback, individuals can be motivated by their own achievements. They can modify their strategies and gauge the proximity of their goals. Research indicates that changes are much more likely to occur when interventions include a significant feedback component [Brug et al. 1998].

The effectiveness of feedback can be enhanced in three ways [for a more detailed description of these principles, see Brug et al. 1999]. First, the system should pay attention to motivators and reinforces that are personally relevant to the user. Second, the system should make use of personalized self-evaluation and self-assessment techniques. Third, the system should stimulate the user to actively participate. For example, the user could be prompted to provide data about motivation, progress, etc. on numerous occasions before and throughout the intervention. On the basis on these collected user data, the system could provide three kinds of feedback; personal, normative, and ipsative [Brug et al. 1999]. The personal feedback provided to the user is based on his/her individual responses. For example, these types of feedback include the pointing out of the individual's risk status. The normative feedback is information of how an individual compares with others, for example, how the user's risk status compares with others. Finally, ipsative feedback is provided by representing information which compares the user's current and prior states. One example is that the user receives information of the development of the individual's risk appraisal over time but also information on achievements, money saved, increased life expectancy, etc. Hurling and colleagues [2006] have provided empirical data which demonstrate the importance of interactivity in digital health behaviour interventions. They showed that more interactive systems were judged by the user to be more engaging (increased user retention), created higher expectations for behaviour change, greater satisfaction with motivation, and improved self-perception related to behavioural change.

V. SYNTHESIZING THE KNOWLEDGE: A NEW GENERATION OF EPSYCHOLOGY INTERVENTIONS

Our hope is that the growing knowledge in the area of ePsychology results in a new generation of programs for behavioural change with higher efficacy than traditional programs. In the table following, we have tried to summarize and synthesize the proposals addressing strategies from the health behaviour change literature and giving examples of strategies and therapies that could be used in digital interventions to address each proposition.

Proposition	Short explanation	Examples of strategy/ therapy
Psychological chronology	The structure of the program is based on knowledge from psychological research about the specific health behaviour change process.	Dynamic modeling Tunneled design
Tunneled program	Architecture/design of the program. Therapy is presented step-by-step.	Establish therapeutic structure Principle of reduction
Relapse is the rule rather than the exception	Relapse rates typically vary between 50 and 95%. While making a change attempt requires motivation, change maintenance requires self-regulation.	Self-regulation therapy (e.g. coping plans to tackle temptations)
Ego depletion	Willpower as a strength-resource model; We become more prone to a lapse when experiencing negative affect, or are tired, i.e. ego depleted.	Just-in-time therapy (e.g. instilling positive affect) Psycho-educative components
Prepare for slow oscillations in relapse proneness	Relapse proneness is most likely both multifaceted and follows a certain chronology. Some relapse risk factors manifest themselves in slow oscillations in relapse proneness over time.	Psycho-educative components addressing cognitive strategies and processes
Implementation intentions	Plann in advance when, where, and how one will complete a goal.	Instrumental support for planning (e.g. using a calendar function or SMS)
Coping plans	Prepare for possible barriers that could hinder goal engagement and attainment by making specific coping plans.	Instrumental support on making coping plans
Just-in-time therapy –sudden spikes in relapse proneness	Sudden spikes in relapse proneness can be considered as parts of the "hot emotional system," specialized for rapid emotional responding on the basis of situational triggers.	Just–in-time therapy that helps the user focuses on the cognitive aspects of the situation
Just-in-time therapy - negative affect	Regulate emotion.	Up-regulating affect by IVR (e.g. music, story, stress–regulation)

As aforementioned, a possible disadvantage with digital interventions may be high attrition rates. We have suggested including positive psychology components in digital interventions to lower attrition rates, because this will probably make the intervention feel more self-relevant, and the user will also experience more positive emotions during the change attempt. The user is also more prone to relapse when experiencing negative affect. Thus, including components that help the user effectively regulate emotions is likely to prevent relapse. Moreover, it is likely that interventions that manage to instill positive affect will increase the success rate of the change attempt, as well as increasing well-being during and after the change process. In the table following, we have summarized the propositions addressing concrete techniques from the positive psychology literature that could be utilized in digital interventions. We have also provided examples on how these techniques could be presented in a digital program.

Table 2. Strategies from Positive Psychology

Proposition	Short explanation	Examples of strategy/ therapy
Optimistic thinking	Optimists cope better when facing adversity than pessimists.	Writing a story about ones best possible future life Digital goal/sub-goal diary
Gratitude	Gratitude increases well-being by bolstering self-worth, strengthening social bonds and preventing hedonic adaptation.	Instrumental support on reflecting over positive experiences (e.g writing down three good things that happened or writing a gratitude letter)
Engagement / flow	Flow is reached when one is so engaged in an activity that one loses track of time and place, and becomes completely absorbed in the activity.	Instrumental support for doing more pleasant and engaging activities in one's daily life (e.g. a calendar for planning)
Social relationships	Giving and receiving social support in adverse times is one of the most important functions of a social relationship.	Chat forums Psycho-educative components; improving communication skills Instrumental support for making contact (e.g. via SMS)
Meditation / mindfulness	Meditation and mindfulness has positive effects on happiness, positive emotions, stress, cognitive abilities, and physical health.	Instructions using IVR, mp3, slide shows, and similar
Savoring positive experiences	Savor thoughts or behaviours capable of generating, intensifying, and prolonging enjoyment.	Psycho-educational components (e.g. visualization) Digital photo album

An extensive amount of cognitive and emotional processes are involved in any health behaviour change attempt; thus, digital interventions that aim to help users quit smoking, reduce alcohol consumption, eat healthy, etc. should be extensive and provide the right therapy at the right time. The new generation of ePsychology interventions should take into account both cognitive processes involving self-regulation and emotional processes to prevent ego depletion and relapse. Furthermore, the new generation of digital interventions should be evaluated rigorously in long-term randomized controlled trials to gather more knowledge on what makes digital therapy programs effective.

VI. CONCLUSIONS

We know much too little about how to design effective digital interventions to support sustained behaviour change and improved well-being. What we know is that cutting edge psychological theory and research is likely to represent a rich source of relevant knowledge. We have used this source to express 28 propositions that relate to the content and design of digital interventions. The list of propositions is by no means considered to be exhaustive or final. The propositions may help assist current design of digital interventions. They do, however, also represent research questions that should be further developed and addressed to help establish a theoretical basis for the construction of digital interventions.

Researchers are often said not to be too concerned with "if things work in practice." Oftentimes, we think it is more interesting to discuss "if things work in theory." This was also, at least to some extent, the point of departure of the present paper. It primarily discussed how and why digital interventions designed to support self-regulation in the

service of behaviour change should work in theory. This endeavor was clearly inspired by the famous social psychologist Kurt Lewin's [1951] saying that "there is nothing as practical as a good theory." It is less well known that Lewin [1951] also expressed that the best way to understand a psychological phenomenon is to try and change it. Hence, intervention research and practical design experience is not just something that follows basic research at a polite distance, but rather is its inherent complement [Rothman 2004].

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Editor's Note: The following reference list contains hyperlinks to World Wide Web pages. Readers who have the ability to access the Web directly from their word processor or are reading the paper on the Web, can gain direct access to these linked references. Readers are warned, however, that:

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