A research framework for playful persuasion based on psychological needs and bodily interaction

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Abstract. This paper presents a research framework that relates interactive systems to behavioral change with psychological needs and bodily interaction as intermediating variables. The framework is being developed in a multidisciplinary research project that focuses on how to design intelligent play environments that promote physical and social activities. Here, the framework serves to generate design relevant research questions and to guide communication amongst group members.

Keywords: persuasive technology, play, user experience, bodily interaction, interactive systems, design, ambient intelligence, research through design

1 Introduction

This paper presents a research framework that relates interactive systems to behavioral change with psychological needs and bodily interaction as intermediating variables. Due to the potential of technology to help solve pressing societal problems, the design community is giving increased attention to the design of systems for behavioral and societal change. We believe that to design persuasive systems within the ambient intelligence paradigm (e.g., interactive systems encompassing products, services and environments), we need to address the full spectrum of human psychological needs as well as the rich bodily interactions people engage in while trying to fulfill them.

Our research framework is being developed in a research program entitled 'Intelligent Play Environments' (IPE). The IPE program deals with the design of playful interactive systems that stimulate physical and social activities. Such systems comprise intelligent software agents

embodied in physical play objects, which can sense and react to the human players. The systems should stimulate 'open-ended' play, a form of improvisational play that emerges by providing local interaction opportunities [1]. Thus, the design challenge in the IPE project lies in designing for open-ended play while at the same guiding players towards predefined behavioral patterns.

Interactive systems, such as the ones envisioned in IPE, are made possible by novel media technologies, wireless broadband communication and embedded intelligence; also referred to as "ambient intelligence" [2], "internet of things" [3] and "ubiquitous computing" [4]. In a sense many of our on-line activities (including work, play and communication) are already realized through interactive systems, as they can be carried out on a variety of platforms concurrently, such as on smartphones, dedicated game-systems and in-build car systems. Designing interactive systems is a complex activity, aligning hardware and software components with individual, situational and societal demands.

Interactive systems designed to stimulate behavioral change are called persuasive systems [5] based on the term *persuasive technology* coined by Fogg [6]. In the field of persuasive technology several strategies are presented that can change people's behavior by taking into account human computer interaction principles and human motivation. Behavioral change can take on many forms, such as changing a person's attitude, motivation or actually influencing a person's behavioral repertoire [7]. Another view on persuasive systems has its roots in the philosophy of technology. Due to the phenomenon of *technological mediation*, new technologies either allow for or restrict certain types of behavior [8]. For example, the technology of the microscope allows us to look into a visual micro-world while at the same time visually disconnecting us from our immediate environment.

A broad perspective on psychological needs and bodily interaction is needed to design persuasive systems within the ambient intelligence paradigm. In such a perspective, people fully engage (emotional, social, sensorial, etc.) with intelligent environments and systems of products rather than in a visual-cognitive manner only, which is often associated with traditional screen-based information systems. People share universal needs that drive behavior; relating to feelings of pleasure, intrinsic motivation and wellbeing [9]. Further, only those aspects of interactive systems that affect our sensorium, our bodily interface to

make sense of the environment [10], are essential when relating system features to human needs.

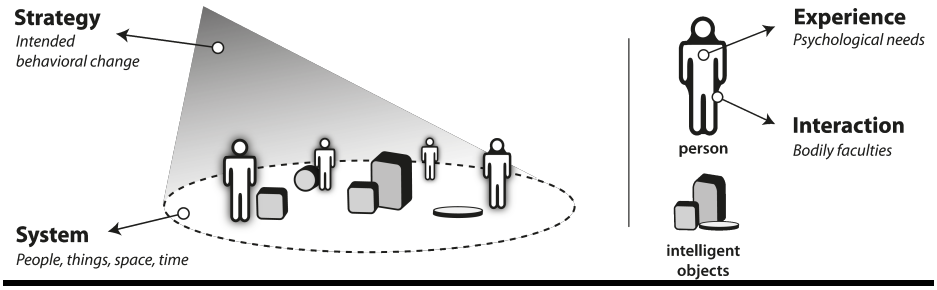
Our framework is being developed in a multidisciplinary research project focusing on how to design intelligent play environments that promote physical and social play. The framework serves to generate design relevant research questions and to guide communication amongst group members. This paper is set up as follows: First, each level of the framework is discussed with respect to the relevant literature and its value for the framework as a whole. Second, the issue of how to operationalize the framework in research will be discussed.

2 A four-leveled framework

Our research framework relates interactive systems to behavioral change with psychological needs and bodily interaction as intermediating variables. The first level describes the behavioral change the designers intend to achieve; the second level describes the experienced psychological needs that can drive the intended behavior; the third level describes the bodily interactions that fulfill these psychological needs, and lastly, the fourth level describes features of interactive systems that afford the bodily interactions. These levels bear resemblance to the levels proposed by Ward et al. [11] aimed at connecting product attributes to human values in four intermediate steps to establish powerful 'brands' (e.g., functional attributes, functional benefits, emotional benefits and human values). The levels of the framework are represented in Table 1 and described in more detail below.

Table 1. The four levels of the research framework ordered top-down (from Transformation to System level). The two examples show how similar transformations can be realized applying different ways of addressing psychological needs (experience level), based on different bodily interactions (interaction level) and different systems (system level). Below it, the research framework is visualized.

Level name	Focus	Aspects	Example1	Example2
Transformation	"What is the intended behavioral change?"	Attitudes, motivations, behavior, etc.	Seduce people to jump up and down for a specific period.	Seduce people to jump up and down for a specific period.
Experience	"Which psychological needs support behavioral change?"	Autonomy, stimulation, connectedness, progression, etc.	Need for self-expression	Need for discovery
Interaction	"How do bodily interactions fulfill psychological needs?"	Thinking, feeling, sensing, doing, etc.	Touching the floor with one's feet elicits musical sounds.	Jumping upwards allows one to see just one piece of a puzzle at a time.
System	"How does the interactive system afford bodily interaction?"	People, things, space, time, context, etc.	Dancing on a musical staircase.	Peaking trough a heightened show box.



To further illustrate the four levels of the framework we use the example of a car cabin. When viewing the cabin of a car as the interactive system, the system comprises chairs, a steering wheel, dashboard, air-conditioning and possibly other people. One can

imagine how our bodies are involved. The chair is pressing against our backs; the steering wheel can be grasped and manipulated by our hands; the dashboard can be seen and heard; our skins feel the air-conditioning while our minds give meaning to this cabin based on previous encounters.

This bodily involvement can be experienced subjectively. The chair feels soft and supportive, the dashboard looks colourful and clean, rotating the steering wheel feels responsive and smooth, and hitting the pedal while hearing the feedback of the engine results in a feeling of power. In this example, the chair supports the need for comfort while the steering wheel supports the need for competence. Together, these different experiences combine into a unified whole affecting our behaviour. Depending on whether the need for comfort and competence is more dominant in the overall experience, the car cabin can either promote a relaxed or a sporty driving style respectively.

2.1 Transformation

The transformation-level deals with the designers' intended behavioral change. Thus, for the IPE project this entails stimulating physical and social play. Specifying a behavioral target will guide the construction of the interactive system, shaping the design activity as described by the 'design with intent' approach [12]. Setting a behavioral target involves specifying the desired behavior, the context in which it takes place and the timeframe in which the behavior is sustained [13]. For example, one can imagine that one aims to increase social interaction - captured by the amount of conversation - to occur during a play activity lasting for about ten minutes but also surpassing the play activity itself, sustained for several months in one's everyday live.

The value of the transformation-level of the framework lies in guiding interactive system design as well as in providing a means for assessment, monitoring and system adaptation. Assessments may have different forms, ranging from behavioral observations (using sensor technologies) or by interviewing people about their own attitudes and behaviors. For the IPE project this can entail monitoring physical play by measuring physical movement through low-resolution cameras for instance. Further, if behavioral targets can be translated into decisional algorithms, it would become possible to embed them in the interactive

system, thus creating intelligent systems that can respond to users adequately based on sensor data. In the IPE project we intend to empirically explore the feasibility and potential of this approach.

2.2 Experience

The experience-level deals with the psychological needs that intrinsically motivate people and foster their development. Some of these well-described needs are the need for autonomy, competence, social relatedness, health and hedonic stimulation [9]. In a recent study, the first three needs of this list were found to be the most satisfying ones [14]. Further, Laschke and Hassenzahl advocate a *gamification* approach that makes novel behaviors intrinsically rewarding by connecting them to psychological needs rather than by providing extrinsic rewards. [15]. See Korhonen et al [16] for an extensive list of playful experiences that intrinsically motivate play. For example, the playful experiences of *expression* may relate to the need for autonomy while the experiences of *competition* and *fellowship* may both relate to the need for social connectedness.

The value of the experience-level for the framework is to create behavioral change through intrinsic motivation and generate design requirements at the same time. Given the predefined behavioral target, people can be motivated differently to attain it. With respect to the IPE, one player might be stimulated into physical activity because others do it as well (need for social connectedness) while another player might feel motivated because of the individual challenge that lies in the activity (need for personal growth). Different requirements are needed when designing for each psychological need. For example, designing for social connectedness requires interconnecting each player and allowing communication and interaction between them, while designing for individual challenge entails providing feedback on individual performance over time.

2.3 Interaction

The interaction-level describes the manner in which bodily interactions are able to fulfill psychological needs. Our bodies can be viewed as our

interface with the environment through our senses, feelings, thoughts and movements [10]. Bodily faculties and psychological needs are deeply intertwined: Humans are endowed with a hedonic system in the brain supporting human functioning [17, 18]. This hedonic system connects many bodily areas to cognitive processing, allowing us to experience (dis)pleasure in many different ways and directing our behavior to optimize wellbeing. A previously conducted qualitative study found that experiences related to psychological needs, involved multiple bodily faculties with a prominence of two or three specific ones [19].

The value of the interaction-level for the framework lies within guiding the design of the interactive system based upon our 'bodily interface'. This opens up the design space to allow for full-body environmental interaction. Different modes of bodily interaction uniquely shape a design. Norman distinguishes between visceral, behavioral and reflective design [20]. With IPE, the type of bodily interaction pursued in a design should fit with the psychological needs addressed to motivate the players. For example, play that is tuned to need for challenge may be more cognition-based (reflective) while play that is tuned to the need for fantasy may be more sensory-based (visceral).

2.4 System

The system-level describes the components of interactive systems. System design is a new focus in the design community influenced by the merging of products, services and environments. These systems consist of many 'nodes' with non-collocated inputs and outputs that are socially and culturally situated hereby making such systems inherently complex and unpredictable [21]. With respect to IPE, the system contains tangible and intangible play objects, the players whom can be either virtually of physically present, the spatial configuration of players and objects, and the rules and procedures that may evolve over time.

The value of the system-level for the framework lies within the ability to focus on the components of interactive systems that have human significance, allowing designers to shape the interactive system without the need to first specify a technological paradigm. Due to the

inherent complexity of these interactive systems, designing them requires an experiential approach and assessment of these systems call for qualitative and ethnographic research methods [22]. Thus, the IPE project will follow a research through design approach that will generate experiential knowledge at each design iteration, informing the framework and guiding successive iterations.

3 Discussion

Although we are too early in the process to have evaluated the framework empirically, we can highlight how we envision the four levels to be operationalized in research. For example, we plan to investigate the relationships between the four levels, (a: transformation-experience) 'which psychological needs are most influential in stimulating physical and social play?'; (b: experience-interaction) 'how can bodily interactions fulfill these psychological needs?' and (c: interaction-system) 'how can we construct interactive systems that afford the appropriate bodily interactions?' The insights gained can be assessed in relation to using the framework as an evaluation tool, in which the framework is used bottom-up (flowing from system to transformation) or top-down, as a design-generation tool (flowing from transformation to system).

It is further of importance to acknowledge in the framework differences between individuals (such as gender and age) and differences over time. Given differences in strength and levels of endurance it would be unrealistic to expect identical behavioral patterns for younger and older players. Further, for some players, the need for vitality may be dominant to feel engaged while for other players this might be the need for competence, requiring different types of bodily interaction (that may well be afforded by the same interactive system). Also, the dominant psychological need that creates engagement for an individual player may change over time since people develop skills and knowledge while playing. Additionally, depending on a user's mood and short term energy level (e.g., physical fatigue or mental fatigue after having concentrated for a long time) dominance of psychological needs may vary, affecting the type of interactions people would be willing to engage in.

The research can inform both the fields of persuasive system design and of user experience (UX), in which UX is defined as "the experience(s) derived from encountering systems" where encountering involves actual usage but also passive confrontations [23]. New insights in persuasive systems can be gained when exploring the power of psychological needs to affect behavior in playful applications. Knowledge on UX can be strengthened as well. For example, how are psychological needs experienced emotionally and how do different bodily interactions (as afforded in a design) fulfill them?

4 Conclusion

In this paper, we have proposed a research framework that relates interactive systems to behavioral change with psychological needs and bodily interaction as intermediating variables. When used in an iterative design process, the framework guides the successive design iterations and is tested empirically at the same time. We will investigate the research framework as a tool for design generation (guiding technology development), design evaluation (translated into decisional algorithms) and multidisciplinary communication. As one of the tools for these investigations we are currently testing a preliminary self-report software tool for assessing and analyzing the results. The tool is based on elements of this framework. We envision it to be used in combination with other methods and tools, including camera observations of behavior.

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