

WHAT MAKES IT WORK? MAPPING EFFECTIVE GAME MECHANICS FOR HEALTH GAME USER RESEARCH

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ABSTRACT: Many research projects have assessed the possibility and effectiveness of implementing games as health interventions. Recent literature shows generally positive results in specific case studies. However we acknowledged that research projects in this field regularly seem to disregard the connection to possible effective game mechanics, design principles and behavior change theories to underpin such results. Evidently most of these studies were intended and designed solely as randomized controlled trials (rct's) to validate effectiveness of health interventions. We propose a theoretical framework to assess whether and on what grounds certain behavioral effects may be attributed to particular game mechanics and game play aspects. Our model is founded on the Elaboration Likelihood Model of Persuasion (ELM), which is quite appropriate to guide the evaluation structure for interventions that either aim at short term or long term attitude and behavior change. The scope of the research framework we have in mind is too extensive to elaborate here, since it stretches from gameplay principles & mechanics to psychological entertainment theories, to persuasive principles & behavioral theories and several UX-related evaluation methods as well. By means of an analysis of the working principles in the renowned game-based intervention Re-Mission we propose a small step towards such a framework. Since we consider the ELM an essential guiding model within our framework we need to clarify its working beforehand.

INTRODUCTION & BACKGROUND

Obviously in the field of health game intervention research some important steps are being made already. Clinical trials concerning health games sometimes indeed evaluate the use of socio-psychological theories on attitude and behavior change (Kharrazi, Shirong Lu, Gharghabi & Coleman, 2012), (Rahmani & Austin Boren, 2012), (Primack, Carroll et al 2012). However the interrelation with, or mapping to effective game design principles & mechanics is mostly neglected. Moreover there is little consensus about the required content and structure of a research (& development) framework that incorporates experimental validation as well as assessment, evaluation and possibly validation of effective game design principles.

Problems, opportunities & goals

The main goal of this paper is to present a conceptual framework for intervention and validation research. Similar to what Lim et al. (2013) already accomplished in the field of educational games, we believe our efforts will contribute to the development of an international knowledge base on assessment of effective game design principles in health game interventions. Please note: whenever I write 'we' in this text I refer to my colleagues at the professorship User Experience & User Centered Design. This paper can be partly understood as an extension of Braad, Folkerts & Jonker (2013), who explore an approach of monitoring design decisions and corresponding theories throughout the design & development cycle of game based health interventions, allowing evaluation results to be attributed to design decisions. The current paper however sketches an overall picture of the research framework our research group aims at, using the Elaboration Likelihood Model

(ELM) as a guiding principle. It demonstrates what the conceptual parts comprise of and how they are contingent upon the ELM. An expert review of Re-Mission from a particular perspective will illustrate the modus operandi of the framework and its various sections.

WHITE PAPER: HEALTH GAME USER RESEARCH MODEL

Our white paper outlines a conceptual framework for game effect studies in which gameplay experience and effects in terms of health interventions are related to the underlying design principles. Some essential principles will be explained afterwards with the description of a viable *expert evaluation* and *play test* of Re-Mission (Hopelab, 2004). Intended for optimizing patient behavioral participation in cancer treatment programs this game-based intervention is already extendedly tested by means of experimental validation research (Kato et al., 2008). Results show that playing Re-Mission improved *treatment adherence*, *self-efficacy* and *knowledge*. It did not affect *self-report of adherence*, *stress*, *control*, or *quality of life*. With that in mind we consider it significant to assess the mapping adequacy of motivational and persuasive behavior change principles to game design principles.

We set up an expert evaluation, using heuristics with which we aim to address just one category of possible effective game aspects here. Using heuristics is a deliberate choice, considering what Bernhaupt (2010) recommends about proper user experience research methods. She emphasizes the importance of selecting the appropriate method related to the development phase at hand: focus groups, interviews, informal play testing and questionnaires in the preproduction and prototype phase; heuristic evaluation, play testing, observation, (semi-structured) interviews, quantitative comparisons of gamers' behaviors, and questionnaires focusing on users' attitude and experiences in the implementation & testing phase. Before we carry out a playtest to assess the actual user experience it is essential to analyse the game in advance, to inspect whether it contains potential motivational and persuasive principles. We need a fitting checklist, or heuristics, to examine the game in expert evaluation. A list of heuristics consists of elements to systematically inspect effect related aspects like challenges, goals, rewards, visuals, excitement, storyline, characters, etc. (Wang, Shen, Ritterfeld 2009).

Dual pathway model: long term & short term effects

Before we construct an explanatory set of heuristics for our expert evaluation we need to clarify the structure of our ELM-guided dual pathway model, which is based on the premise that interventions have difficulty to sustain intended behavior change. Immediate and short term effects generally seem easier to attain, while long term effects seem rather difficult to achieve, as Petty, Barden & Wheeler (2009) explain accurately. The main distinction in our model is based on the condition that certain types of interventions require long term behavior change effects (stop smoking, eat more healthy, maintain physical exercise, adherence to drug intake), while other types call for immediate and short term effects (distract from painful treatment, prepare for distressful treatment, rehabilitation exercise).

Our entire research and assessment concept is based on the *Elaboration Likelihood Model of Persuasion* from Petty & Cacioppo (1986), a dual process theory of how attitudes are formed and changed. It is based on two assumptions: people want to have correct beliefs; and people do not have the motivation or ability to carefully assess everything. According to Petty & Cacioppo persuasion happens along two channels: firstly the **central route** (long term effects): people logically and consciously scrutinize the arguments they are presented with, the results of their scrutiny determines the direction of the persuasion, this requires motivation and the ability to think carefully about the issues at hand; and secondly the **peripheral route** (short term effects): people rely on the use of heuristics (in the rule of

thumb or educated guess-way), and surface-level cues to validate persuasive arguments they are presented with; the cues typically have little to do with the persuasive message itself, and are premised on existing familiarity and positive attitudes; we are drawn into it by fancy graphics, attractive people, people we like; this route requires less motivation and less (conscious) attention.

Especially in health intervention design and evaluation it is crucial to understand what exactly triggers higher motivation for elaboration, thus encouraging patients to take the central route, in order to attain sustained changes in believe and attitude. Strong attitudes are more durable, guide thinking and, perhaps most important, strong attitudes guide behavior (Petty, Barden & Wheeler 2009). Playing Re-Mission for the first time patients could just play along for the sake of aesthetics and fun. But by way of recognizing personal relevance in the presented issues, which possibly arouse their ‘need for cognition’ (Thompson & Haddock, 2012), they could be tempted to choose the central route. Otherwise it might suffice to let them merely travel the peripheral route, to prevent or evade reflections and counter arguments on persuasive or motivational messages.

CONSTRUCTING A SET OF HEURISTICS

In order to construct a valid set of heuristics for initial expert evaluation, firstly we have to determine and classify the target effects of the intervention. The game goals of Re-Mission are clearly stated in the research results of Kato et al (2008). According to the authors the game content was engineered to address behavioral issues, identified in literature reviews and preproduction targeting studies as crucial for optimal patient participation in cancer treatment. In their experimental study a control group played a commercial game, while the experimental group played the same game plus the intervention game Re-Mission for at least one hour per week during three months. Results show that *Treatment adherence, self-efficacy and knowledge about cancer (treatment)* improved significantly. Playing the game did not affect *self-report measures of adherence, stress, perceived control over health, or quality of life*.

Our expert evaluation aims to assess which game characteristics caused the successful and the less successful results. The proper route in our dual pathway model is determined by the targeted health behavior aspects, which can evidently be classified under long term change: the patients’ stance towards their own *perceived control over health* is clearly supposed to last longer than just till the end of a game play session. This implies that our heuristics have to assess whether the gameplay invites the player to take the central route, which is represented by the left part of the matrices below (fig. 1, 2, & 3).

Figure 1 Health Game User Research Matrix: effective gameplay principles/entertainment

Long term effects Theory/principle	Description / implementation	Short term effects Theory/principle	Description / implementation
<i>Central route (ELM) (high elaboration, rational, meta-reflective)</i>	<i>Medium to long term attitude, affective & cognitive change.</i>	<i>Peripheral route ELM) (low elaboration, affective, superficial, impulsive)</i>	<i>Short to medium term attitude & affective change</i>
Challenge, Flow. Rules, goals (concrete, achievable, rewarding)	Game challenges balanced in complexity, gradually increasing. Render reflection	Challenge, Flow. Rules, goals: concrete, achievable, rewarding	Game challenges balanced in complexity, gradually increasing. Stimulate flow
Fun (hard, serious) Immersion: sensory, challenge based, imaginative	Hard fun: goals, obstacles, strategy. Frustration, fiero, relief. Serious fun: rhythm, repetition, collection; excitement, Zen focus	Fun (easy, people) Immersion: sensory, challenge based, imaginative	Easy fun: exploration, fantasy, creativity. Curiosity, surprise. People fun: communication, cooperation, competition;

Next to that we need them to evaluate how and to what extend certain aspects of the categories *design & gameplay principles* (fig.1), *persuasive principles* (fig.2) and *behavioral principles* (fig.3) were implemented with exactly this intention. Do they provide personal relevancy, do they stimulate reflection on persuasive messages, and do they provide sufficient freedom of space and time to think them over carefully?

In an all-inclusive expert evaluation we would start off with a set of heuristics that covers assessment of effective game play principles and game mechanics related to entertainment. What types of fun does it offer, what motivates players, is the challenge-skills ratio properly balanced, does it stimulate in- or extrinsic motivation, which types of immersion or transportation in the story world does it stimulate, are the game mechanics accurately arranged to guide players through the central route? Since we demonstrate just a segment of our concept here, we pick just one category of our model to extract a set of heuristics from, namely the persuasive principles (fig.2), particularly those of narrative persuasion.

Figure 2 Health Game User Research Matrix: Persuasive Principles

<i>Central route (ELM)</i>	<i>Medium to long term change.</i>	<i>Peripheral route (ELM)</i>	<i>Short to medium term change</i>
Narrative persuasion: narrative transportation, identification, perspective	Persuasive technique conceived to stimulate (meta-) reflection	Narrative persuasion: narrative transportation, identification, perspective	Persuasive technique conceived to avoid (meta-)reflection
Procedural rhetorics: arguments by goals & rules: stimulate (meta-) reflection	E.g. allow bad behavior, suppress good. Choices & actions lead to paradox.		
Persuasive technology:	mechanics to stimulate tunneling, tailoring, suggestion, self-monitoring, conditioning	Persuasive technology:	mechanics to stimulate reduction, tunneling, suggestion, tailoring, conditioning
Tools of Influence	Behavior is based on fixed action patterns Reciprocity, commitment and consistency, scarcity, authority	Tools of Influence	Behavior is based on fixed action patterns Social Proof, reciprocity, authority, liking

Heuristics to assess narrative persuasion

One way to motivate players and to guide their attention to *relevant issues* - conditional for the central route - is to arouse **narrative transportation** (Carpenter & Green 2012). Transportation into a narrative world refers to cognitive, emotional, and imagery engagement in a story. Individuals who are transported into stories are more likely to change their attitudes and beliefs in the direction suggested by the story.

So our first heuristic would be: “(How) does the story of Re-Mission aims at transporting the player into the game world?” Non-narrative game play principles & game mechanics could cause a somewhat similar tactical immersion (Adams, 2004), but we deliberately disregard this for now. We consider a set of sub-heuristics as well, which addresses narratological aspects like actors, actions, events, plot, fabula, narrator and focalization (Bal, 1997). De Graaf, Hoeken, Sanders & Beentjes (2011) focus on the dimension of **identification with story characters**. They demonstrate that *perspective* - through whose viewpoint do you perceive story events and characters’ thoughts and feelings - actually influenced identification and story consistency of attitudes. However, game stories are not only able to render different types of immersion, like strategic, tactical, spatial and temporal immersion (Ryan, 2001; Adams, 2004), in order to *suppress* reflection and counter

arguments. By way of intentionally manipulated narrative aspects it is feasible to arouse a *reflective* mental state in players as well, in which they are provoked to think about the represented events in the game, thus taking the central route of the ELM. Techniques to set off signification processes which force players to reflect upon the narrative events are: *breaking the fourth wall & deconstruction* (Frasca, 2001), *narrative complexity* (non-linear, non-chronological, as opposed to classical narration), *deviations* or *surprising plot twists*. So the first of the two following heuristics would be: “In what way the story of Re-Mission provokes identification with a character, and how does it cause the player to experience the story events and thoughts from the desired perspective?” The second one of this pair of heuristics has to assess whether and in what way the story stimulates (meta)reflection: “Is Re-Missions’ story likely to stimulate a reflective mental state in players?” Of course a subset would have to assess the possible directions and topics of (meta)reflection, to examine whether the behavior change message is likely to be treated and adapted as intended. For now we limit ourselves to just these persuasive narrative heuristics. In an extensive expert review our set of heuristics additionally needs to assess the existence and nature of procedural rhetorics, the tools of persuasive technology and the principles of influence (fig. 2. left part). Next to that they need to examine a possible effectuation of behavioral theories (fig.3): which gameplay principles arouse self-regulatory & self-reflective processes, stimulate transition to a next stage in behavior change or improve perceived control over behavior?

Figure 3 Health Game User Research Matrix: Behavioral Principles

<i>Central route (ELM)</i>	<i>Medium to long term attitude, affective & cognitive change.</i>	<i>Peripheral route (ELM)</i>	<i>Short to medium term attitude & affective change</i>
Social Cognitive Theory	Stimulate (meta-)cognitive processes, symbolization, self-regulatory & self-reflective processes		
Self-Determination Theory	Stimulate intrinsic motivation (predicts initial and continued performance)	Self-Determination Theory	Stimulate extrinsic motivation: relies on external rewards and punishments
Theory of reasoned action/planned behavior	Inclination to behavior change depends on attitude towards new behavior & perception judgment of others, and on perceived control over behavior	Theory of reasoned action/planned behavior	Stimulate the perception that new behavior is easy to perform.
Transtheoretical Model of behavior change	Control and stimulate transition to next stage in behavior change process: stimulate user to think about (and reflect upon) making the move	Protection motivation theory	Control person’s perception towards threat severity, and perception towards protective behavior (self-efficacy).

The next step would be to perform the actual expert review, in which we sort out whether and how the mechanisms of narrative persuasion function in Re-Mission. While exploring the bodies of young cancer patients, players control the nanobot *Roxxi*, who gets directions from an amusing minibot. Game play includes destroying cancer cells and managing common treatment-related adverse effects such as bacterial infections, nausea, and constipation by using medication as ammunition and relaxation techniques to reduce stress. With our first heuristic we try to assess the relevant narrative aspects by describing: (how) the story of Re-Mission aims at transporting the player into the game world. As a player you take off choosing the first patient: John Davies, whose Patient History is displayed initially. You see a map of his body, and the location of *Roxxi*, just before you go in to meet minibot *Smitty*, who welcomes you just as you’ve stepped into *Roxxi*’s shoes. You

seem to be in a blood vessel, which is looking quite huge to you now, as a big cave of maybe 10 meters in diameter. The aesthetically pleasing environment makes you feel at ease, while the minibot as a humorous narrator explains John's condition and your first mission, which begins after a short training in moving and shooting. We could easily conclude quite soon that the terms of our first heuristic are achieved adequately, since the narrative aspects, like characters & narrator as well as the story setting, seem to be fittingly constructed to draw you in, and engage you in the story world.

With our next heuristic in line we would be able to assess narrative aspects like identification with a game character and the perspective of the player. Since our space is limited here we have to move on, beyond our third heuristic as well - which assesses how the story provokes a certain reflective mental state in players - to the next step in our process.

The results of our initial expert review will produce a list of assumptions on how players will experience the examined narrative aspects. To assess whether our assumptions hold any ground we set up a proper play test, for which we transfer relevant heuristics in a game experience questionnaire. The play test itself can either be executed in a lab situation or in medical treatment settings, where players can be carefully observed during the test (possibly using the thinking aloud method) and surveyed afterwards, using our game experience questionnaire. Results of this play test could finally lead to adjustment of specific narrative aspects in order to attain target effects not only more efficiently, i.e. improve patients' *perceived control over health*, but more sustained as well.

CONCLUSIONS AND DISCUSSION

The aim of this paper was two sided: to clarify our research and assessment concept by sketching the outlines and foundation of the entire model as we envision it, and to explain the working of it through the creation and application of heuristics for an expert evaluation. However we were only able to make a small step in assessing the effectiveness of narrative persuasion principles in Re-Mission. Evidently an all-encompassing test suite requires heuristics extracted from the other categories of our model as well. After carefully designed validation studies (TBA) we expect our model will provide a framework of fundamental game design principles & mechanics and behavior change models & theories, aimed at the assessment of health game interventions. Systematic selection and implementation of the appropriate principles along with fitting research and evaluation methods is guided by the assumption that short term and long term attitude & behavior change both require different approaches. We consider it the strength of our concept that it is purposefully constructed on this premise, founded on the empirically validated ELM. Both routes thereof guide the selection of proper game design and behavior principles to use in expert evaluation, user play tests and other relevant research methods.

Our next step is to produce empirical evidence through small research projects, to begin with using our framework to assess the effectiveness of game play principles and game mechanics in health games designed by our students. For now we are the first to admit that our model is flawed from a certain perspective: some essential theories are validated in a range of media and intervention types, but hardly in games for health. We'd like to establish more substantial research projects on health game interventions as well, in order to validate our model. This paper might be recognized as a call for (international, clinical) partners for joint research projects, in order to produce a validated research model and knowledge base on effective game mechanics and behavioral principles. Obviously we aim to share the results from future research, in order to guide scholars in this field, and to help designers of health interventions to build even better, more effective games that incite sustained health related behavior change.

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