HopeLab's Approach to *Re-Mission*

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Introduction

HopeLab's overarching institutional objective is to enhance the physical health and psychological well-being of young people with chronic diseases. *Re-Mission* (www.re-mission.net), a video game for young people with cancer, was created with that outcome in mind. In the game, players pilot Roxxi the nanobot through the bodies of teenaged cancer patients to investigate symptoms, destroy cancer cells, eradicate bacteria, stop metastases, and manage treatment side effects. The design of *Re-Mission*, and the evaluation of its effects, offers a model for those working in the games and health arena. In the following missive, we summarize results from a randomized controlled trial measuring *Re-Mission*'s impact on patient behavior and provide a short overview of the development process used to create the game.

Summative Research to Define Impact

Prior to public release of *Re-Mission*, we conducted a cycle of summative research to evaluate the game's clinical impact. This impact study was designed by a team of cancer epidemiologists, health psychologists, cancer biologists, and oncology physicians and nurses, and was modeled on standard evaluation of new medical therapies, using many of the same measurement instruments and research design features. Randomized controlled trials (RCT) are considered the "gold standard" for evaluating the causal effects of an intervention because participants are allocated at random to receive either an intervention or a comparison control condition (thereby equalizing the effects of potential confounding factors). Examples

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of RCT features used in the *Re-Mission* impact study included randomization of participants to play either *Re-Mission* or a control video game and the use of standardized outcome measurements, including validated questionnaires (e.g., to assess cancer-related knowledge) and clinically significant behavioral adherence measures (e.g., blood assays, electronic pill-cap monitors).

The study enrolled 375 cancer patients aged 13 to 29 years old at 34 clinical sites in the United States, Canada, and Australia. Results of the two-year trial showed 70 percent faster acquisition of cancer-related knowledge and a three-fold greater rate of increase in cancer-specific self-efficacy in patients who played *Re-Mission*. Results also indicated that those patients who received *Re-Mission* adhered more completely to their prescribed medication regimens than did those in the control group. Electronic pill-cap monitors documented a 16 percent increase in antibiotic doses taken (remediating about half of the total non-adherence rate), and blood chemotherapy metabolite levels were 41 percent higher among *Re-Mission* players (see Kato et al. 2008 for a full description of the trial methods and results).

Surprisingly, even those patients who played *Re-Mission* less than one hour per week showed improvements in medication adherence, improvements that were similar in magnitude to those of individuals who finished the entire 20-level game. Further analyses of the data suggested that *Re-Mission* game play led to faster acquisition of cancer knowledge in players, but this alone did not seem to cause the improvements we observed in treatment adherence behavior. A key driver of improved health behaviors seemed to be that playing *Re-Mission* increased young cancer patients' feelings of self-efficacy, or beliefs in their own ability to control and cope with the disease.

Goal: Achieving Game-Based Behavioral Change

Much of Hopelab's recent research has focused on understanding the specific psychological pathways by which *Re-Mission* impacts health-related behavior in adolescents, with the aim of identifying a generalizable recipe for game-based behavioral change. *Re-Mission*'s behavior-change components were originally engineered using a cognitive-behavioral approach, but recent observations suggest that non-cognitive processes might also play a key role. The *Re-Mission* Outcomes Study described above suggested that *changes in self-efficacy* were more strongly associated with changes in behavior than were changes in knowledge. In addition, there was no relationship between the duration of game play (i.e., information exposure) and the magnitude of behavior change (e.g., medication adherence), implying that short amounts of game play can induce rapid qualitative change in players' conceptions of themselves or their disease, ultimately leading to behavior change. In this sense, *Re-Mission* may function much like a commercial—re-branding health-supportive behavior by linking it to a desired self or lifestyle.

Next Steps

With increasing focus on emotional and motivational aspects of game play, HopeLab has begun a systematic review of the entire *Re-Mission* play experience aimed at optimizing behavioral impact in future releases of the game. The *Re-Mission* Deconstruction Study has analyzed more than 400 hours of real-time play experiences, as 33 adolescents and young adults (55 percent cancer patients) played the 20 game levels. Results confirmed that the basic concept of blasting cancer cells provided players with a sense of agency and power: "It feels like you have control over your own destiny," in the words of one patient. Players also expressed a visceral sense of "revenge" while destroying cancer and its side effects. These results further underscore the key role of emotional and motivational processes, particularly for players who come to the game experience with a well-established schema arranging the self in opposition to a mortal health threat. The extent to which playing *Re-Mission* can help "move" behavioral concepts such as symptom reporting and medication adherence away from "part of cancer" and toward "me and my weapons against cancer" might explain why even relatively brief game play experiences can have significant effects on subsequent behavior over the course of several months.

Our Design Process: Rationally Engineered Game Play

As medical science has come to understand the biological mechanisms underlying disease, new medicines are increasingly developed using a "rational drug design" strategy. In this process the molecular basis for illness is first identified, and then an array of candidate drug molecules are designed to block or correct that process. Those candidate drugs are tested in "pre-clinical models" and iteratively refined to maximize their impact on biomarkers (the molecular

parameters marking the disease process). Iteration occurs prior to full-scale testing for the abatement of disease signs and symptoms. We believed this methodology could be applied to the design of video games, and we adapted the approach to the design of game-play scenarios within *Re-Mission*.

The following list outlines six of the core principles in our design process:

1. Choose a target health outcome;
2. Identify its key behavioral mediators;
3. Define the psychological determinants of behavior;
4. Capture that perceptual field in the game-play scenario (e.g., Your Mission for Roxxi: Discover and battle residual cancer cells still lurking inside the body of a patient in remisson);
5. Live out contingencies in the virtual world instead of real life (e.g., IF the patient skips chemotherapy doses, THEN Roxxi's chemo-concentrating blaster misfires every third shot—cancer cells survive and become drug resistant);
6. Always have fun (Behavior = Knowledge × Motivation—changing knowledge is important, but changing motivation and emotions also provides big opportunities for increasing positive behavior; fun is a powerful motivator).

These six core principles are embedded in the final *Re-Mission* game design. For example, several *Re-Mission* game levels portray in-game patients battling leukemia, a high-prevalence pediatric cancer which requires significant and prolonged self-administered treatment regimes (Principle 1). If these prescribed regimes are not strictly adhered to, patients' survival is put at risk (Principle 2). Many adolescent cancer patients hold a faulty belief: "I'm cured—I went into remission a year ago—I don't really need to take every last one of these chemotherapy pills every day for the next two years" (Principle 3). Because non-adherence to prescribed medications is a behavioral mediator of mortality in adolescent leukemia patients, several game levels were designed to involve missions in which Roxxi must discover and battle residual leukemia cells still lurking inside the body (Principle 4; see figure 1). However, players must also contend with the consequences of non-adherence to treatment; for example, in one level the in-game patient has skipped his chemotherapy doses, and as a consequence, Roxxi's chemo-concentrating blaster misfires periodically, allowing cancer cells to escape and become drug resistant (Principle 5). The entirety of the game-play experience is packaged in a novel environment (within the human body) and based on commercially proven game-play modalities (third-person shooter) to engage the player/patient (Principle 6; see figure 2).

Conflict: Values-Based Management for a Purpose-Driven Game

A major challenge in the creation of *Re-Mission* was the integration of a diverse set of ideas regarding how a "serious game" should work. An often-recurring issue involved conflict between a proclivity toward dramatic license to enhance game appeal (held most strongly by our game designers) and a preference for "biological accuracy" and "scientific evidence" (held by our health professionals). Establishing core game values among team members played a critical role in navigating these conflicting visions. Our supreme value was that the game should be effective—it should change teenage cancer patients' behavior in ways that enhance their health and well-being. To support this vision we defined an additional set of values to guide our process:

1. Empirical testing is the best way to resolve conflict: When in doubt, collect data—the right answer is the one that best changes the target behavior in teenaged cancer patients;
2. Fun game-play is paramount: If it's not fun, they won't play—and the game won't have any impact;
3. Stay focused on the goal but flexible on the means: Creative vision must not block empirical progress—it has to work or it has to go.

It was also helpful to clarify what *Re-Mission* should *not* be—that is, simply fun and entertaining with no impact on health. Without a strong, clear, values-based goal that "this game must change behavior for the better," it is highly unlikely that the game development process would have resulted in an effective behavior-change tool. In addition to guiding the overall approach to *Re-Mission*, these values shaped our implementation of the "rational engineering" approach to behavior change before, during, and after *Re-Mission*'s production.

Formative Research to Define Behavioral Targets

Our behavioral targeting process included review of published literature in health psychology and

Figure 1 *Re-Mission*, Level 1: Roxxi is attacked by an enemy lymphoma cell in patient's lymph node, with a colony of cells lurking in the background.

behavioral medicine, which indicated that a significant threat to survival of teens and young adults with cancer is the difficulty they often have adhering to prolonged self-administered treatment regimens, such as taking oral chemotherapy on an outpatient basis for two to three years (Jamison, Lewis, and Burish 1986; Kennard et al. 2004; Partridge, Avorn, Wang, and Winer 2002; Richardson et at. 1990; Tebbi 1993; Schmiegelow et al. 1995). We also conducted new survey research (Bradlyn, Kato, Beale, and Cole 2004) and informal focus groups of health professionals and young patients to identify the most critical patient behavioral issues and the areas in which adolescents might feel underserved by communications from health professionals. Based on these targeting studies, high-priority behavioral targets included adherence to prescribed medications (especially outpatient oral chemotherapy and antibiotics), timely symptom reporting, and self-care procedures to manage cancer treatment side effects (e.g., oral hygiene to minimize mouth sores). Psychological processes identified as playing a major role in treatment adherence were also targeted, including knowledge about cancer and its treatment and confidence in one's ability to meet the demands of cancer treatment and recovery (cancer-specific self-efficacy). Together, these behavioral and psychological objectives constituted the fundamental conceptual structure around which game content was designed.

Consumer-Centered Product Development

Once psychological and behavioral targets were identified, HopeLab assembled a team of video game designers, health psychologists, and cancer researchers to collaborate in translating behavioral objectives into

Figure 2 *Re-Mission*, Level 2: Roxxi destroys an enemy cancer cell with her radiation gun while patrolling patient's spinal column.

game play. Video game designers brought a diverse array of play concepts and game conventions (e.g., third-person shooter in 3D space, forced scroll surfing and jumping, etc; see figure 3), game-design principles, and an essential sense of "what is fun" to the table. Their work began with two originating themes of the *Re-Mission* concept: Fly around inside the body, and blast the cancer enemy.

Health behavior researchers brought theoretical recipes for translating cognitive and affective experiences into behavior change, including the self-regulation model of health and illness (Cameron and Leventhal 1995; Leventhal 1993; Leventhal, Brissette, and Leventhal 2003; Leventhal, Diefenbach, and Leventhal 1992; Leventhal, Leventhal, and Contrada 1998), social cognitive theory (Bandura 1977), and learning theory (Choi and Hannafin 1995; Ellis, Raines, and Hakanson 1982; Kulik and Kulik 1991). Cancer researchers brought a biological portrait of the cancer drama, including the look and behavior of the characters (e.g., tumor cells, bacteria, immune cells), the player's resources/weapons (treatments such as chemotherapy, radiation, and antibiotics), and the general setting (cancer-related body locales such as the bone marrow, lymph nodes, brain, lung, and intestine; see figure 4).

On many occasions, conflicting visions emerged in efforts to synthesize fun game play, cancer biology, and behavioral science. In those cases, player-focused data collection provided the basic recipe for choosing the right answer. Empirical demonstrations that "that's what kids want, and it works" played a major role in helping health professionals embrace a video game based on shooting, stool softener, and a sassy back-talking protagonist.

Future Work

HopeLab's future work seeks to generalize the play-based behavioral intervention approach developed

Figure 3 *Re-Mission* organic environments. (See supplements.)

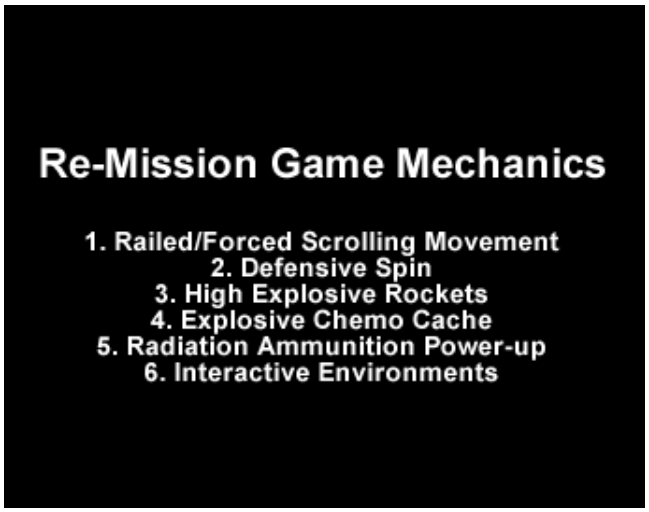

Figure 4 *Re-Mission* game mechanics. (See supplements.)

for cancer to other disease areas such as obesity, sickle cell anemia, autism, and major depressive disorder. The *Re-Mission* project offers broad lessons that may be applied to the development of other game-based interventions:

1. Know What You're After: Identify and target specific, mission-defined behavioral objectives at the outset of product development;
2. Engage Your Target Population: Conduct in-context research to understand the determinants of behavior and inform product design principles;
3. Reverse Engineer Target Behavior: Focus on behavior as a target outcome, and structure game play around its environmental and psychological determinants;
4. Measure Your Impact: Establish meaningful efficacy metrics for both formative research (iterative product optimization) and summative impact studies (documenting efficacy);
5. Continually Grow Your Product: Iterate in the research and product development processes to optimize intervention efficacy, refresh creative content, and deepen theories of play-based behavior change.

In implementing these abstract principles, it has been especially helpful to follow a values-based approach emphasizing player primacy and real-world impact and to identify a clear guiding analogy from an allied field with established product-development paradigms (e.g., the biomedical analogy of rationally engineered targeted drug development).

Much remains to be learned, but the lessons of *Re-Mission* suggest that product development models integrating customer-centered behavioral science, domain-specific content expertise, and the well-developed arts and practices of the entertainment-driven play industry can achieve significant real-world impact.

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