UTRECHT UNIVERSITY

# Reducing Procrastination by Scaffolding the Formation of Implementation Intentions

by

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# Declaration of Authorship

I, Bart Anthony Kamphorst, declare that this thesis titled, 'Reducing Procrastination by Scaffolding the Formation of Implementation Intentions' and the work presented in it are my own. I confirm that:

- This work was done wholly while in candidature for a research degree at this University.
- Where any part of this thesis has previously been submitted for a degree or any other qualification at this University or any other institution, this has been clearly stated.
- Where I have consulted the published work of others, this is always clearly attributed.
- Where I have quoted from the work of others, the source is always given. With the exception of such quotations, this thesis is entirely my own work.
- I have acknowledged all main sources of help.
- Where the thesis is based on work done by myself jointly with others, I have made clear exactly what was done by others and what I have contributed myself.

Signed: _____

Date: _____

*"Im going to stop putting things off, starting tomorrow!"*

Sam Levenson

UTRECHT UNIVERSITY

# *Abstract*

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This thesis analyses and addresses the question of how assistive technology can support people in forming effective implementation intentions, in order to overcome the self-undermining behavior of procrastination. Currently, very little is known about how such a purportedly private and mental process as intention formation can effectively be supported by an external system, especially without jeopardizing people's autonomy. To facilitate a better understanding of this area, this thesis surveys the existing research in this field and describes a novel software application ('ii-app') developed by the author for studying the effectiveness of different approaches to intention formation support. In addition, it proposes concrete empirical experiments using the ii-app that will enhance our knowledge of the intention formation process, effective support mechanisms, and their relation to autonomy.

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*Dedicated to my loving parents.*

# Chapter 1

# Introduction

Procrastination is a common phenomenon in all walks of life. Virtually everyone of us has, at some time in our lives, postponed performing a task against our better judgement. In fact, most of us procrastinate on a regular basis. We may postpone writing an essay, or grading it; we may wait until the very last minute to fill out tax return forms, or perhaps we simply put off going to bed on time.

Although procrastination is especially prominent in the academic community (Ellis and Knaus, 1977; Senécal, Koestner, and Vallerand, 1995), it is also commonplace among the general population: a study by Harriott and Ferrari estimates that procrastination is *chronically* affecting 15–20% of the adult population (Harriott and Ferrari, 1996). The fact, however, that procrastination is prevalent in society by no means implies that procrastination is harmless human behavior. In fact, studies show that procrastination negatively influences individual performance (e.g. school performance Beswick, Rothblum, and Mann (1988); Steel, Brothen, and Wambach (2001)), individual well-being (Tice and Baumeister, 1997), and individual health (Strongman and Burt, 2000).

Procrastination is often classified as a type of self-regulation failure (Steel, 2007) and as a weakness of will[1] (e.g. MacIntosh, 2010; White, 2010). Moreover, procrastination is thought to be *irrational* behavior, because in many cases procrastinating runs against one's goals and prevents one from maximizing one's utilities (Steel, 2007). This phenomenon of people behaving contrary to their intentions, is called the *intention-behavior gap* (Hooft, Born, Taris, van der Flier, and Blonk, 2005; Sheeran, 2002). Apparently, people often choose to perform well-known, 'safe' tasks that provide short-term gains, such as watching television, or playing computer games over doing something that they strongly dislike doing (Lay, 1992; Solomon and Rothblum, 1984), or something which they fear they might fail at (Burka and Yuen, 2009, pp. 20–22). Just having

[1] Although not everyone agrees. Stroud, for instance, has argued that neither the classic nor the revisionist understanding of weakness of will truly captures procrastination. See (Stroud, 2010) for an in-depth exposition of the subject.

a *goal intention* is therefore often insufficient to actually reach that goal (Gollwitzer and Sheeran, 2006).

Research shows that to overcome the intention-behavior gap, it helps to furnish goal intentions with concrete and specific plans, called *implementation intentions* (Gollwitzer, 1993). The most effective implementation intentions consist of a cue in the environment coupled with an intended action. For example, 'when the clock strikes ten, I will brush my teeth' might help initiate one's 'going-to-bed-sequence'. A problem with implementation intentions however is that people often fail to make them at all, or settle for weak, *anemic* intentions (Stroud, 2010). Still, forming proper implementation intentions has been shown to be an effective strategy to combat procrastination (Wieber and Gollwitzer, 2010). So the question arises: how can people be supported in adhering to that strategy?

This thesis aims to analyze and address this problem. It is an attempt to pave the way to finding effective methods to promote the formation of implementation intentions, thereby helping people to procrastinate less. As procrastination is so common and the activities people turn to when procrastinating vary widely — anything from watching television to kitesurfing — the present work focuses on a problem domain that is increasingly prevalent: computer game playing. Due to the constant availability of computer games and their immersive nature, people can lose themselves in a game and by doing so lose track of both time and their goals. This phenomenon is perceived by the procrastinators themselves as unwanted behavior, but they often lack the willpower to do anything about it. The main hypothesis of this work then, in its broadest sense, is that assistive technology can help those people to make effective implementation intentions about when to stop gaming.

This work serves three main goals. First, it is concerned with finding evidence from psychological and philosophical literature with regard to the hypothesis, building on the one hand on our current understanding of procrastination as a self-regulatory failure, and on the other hand on a recently developed model of *extended volition* by Heath and Anderson, that provides a useful framework for thinking about how to provide support for self-regulatory capacities. From the existing literature I will argue that the available theory points towards a confirmation of the hypothesis. Secondly, as very little is known about how assistive systems can effectively support such a purportedly private and mental process as intention formation, let alone about the effects it can have on people's autonomy[2], it aims to establish a research domain (gaming as procrastination) and a method of studying interventions in that domain. For the purpose of the latter I have developed a versatile research tool for performing controlled experiments with implementation intentions, outside of laboratory settings. This software application,

[2]The exact meaning of autonomy is subject to much debate in philosophy and psychology. In this thesis I take it to mean one's personal authority, ability and freedom to make uncoerced decisions.

dubbed 'ii-app', enables researchers to test various methods of stimulating people, *prior* to playing a game, to formulate *effective* implementation intentions for when to stop playing. Thirdly, it describes in detail a series of experiments that could be performed to empirically test the main hypothesis, and, as I will explain in Section 4, various sub-hypotheses about the best possible interface and the best possible instructions. If the hypothesis is confirmed, meaning that assistive technology — in the form of the ii-app — can indeed help people to make effective implementation intentions to regulate their undesired gaming behavior, then this will have implications for both the group of gaming procrastinators that wish to regulate their behavior and the role that assisted implementation intention formation could play in other domains.

The outline of this thesis is as follows. The next chapter aims to provide overviews of existing literature in the areas of procrastination (Section 2.1), the Extended Will (Section 2.2), Computer Game Overuse (Section 2.3), and Intentions (Section 2.4). In Section 2.4 I will cover the notions of goal intentions and implementation intentions, and discuss the relation that exists between the two.

Then, in Section 3.1, I will argue from the literature that assisted implementation intention formation is a very promising concept which is likely to generate positive effects in the real world, but one that needs extensive testing because of possible ethical issues with regard to people's autonomy. The remainder of Chapter 3 is dedicated to the developed software application. In Section 3.2, I will put forth the conceptual design of the application, and provide arguments to support the design choices made. This is followed in Section 3.3 by a exposition of how the functional requirements for the application are implemented. Section 3.4 will describe the user interface of the application, both from the perspective of the experimenter, and of the participant. Finally, Section 3.5 will discuss some of the technical challenges that are associated with the development of this kind of support application.

In Chapter 4, then, I will offer detailed suggestions for empirical research with the developed application in order to test the main hypothesis, and to validate the assumptions made. More specifically, I will suggest a series of experiments with the application that aim to a) establish the effectivity of implementation intentions in the gaming domain (Section 4.1), b) determine the optimal human-computer interface and the most effective set of instructions (Section 4.2) and c) find the right balance between offering people structured guidance and allowing them the freedom to make plans that the ii-app cannot measure (Section 4.3).

In Chapter 5, I will set forth some ideas for the future development of the research application in Section 5.1 and describe several promising strands of research that may also be pursued in Section 5.2. Finally, I will conclude that assisted implementation

intention formation is a technique that looks very promising for overcoming gaming procrastination and for regulating other kinds of behavior where people would benefit from the additional structure of the volitional scaffolding that is implementation intentions.

Before moving on to Chapter 2, however, I will conclude this chapter with a discussion of the present work within the broader topic of AI.

### Relevance for Artificial Intelligence

As will be explained in Chapter 3, the ii-app is developed as a flexible research tool to explore different methods of supporting individual's intention formation process. Despite its primary goals being research related, the fact that the ii-app plays a supportive role in the user's decision making process, classifies it as a decision support system. More specifically, the ii-app takes its place among a fairly recently emerged group of decision support systems geared towards inducing behavioral change in individuals (e.g. Philips, 2011; Sorbi, Mak, Houtveen, Kleiboer, and Van Doornen, 2007; Van den Berg, Rondaly, Peeters, Voogt-van der Harst, Munneke, Breedveld, and Vliet Vlieland, 2007). Many of these support systems are deployed as supplements to online coaching by expert human coaches. The Online Digital Assistance (ODA) system, for instance, combines mobile electronic diary keeping with direct online human coaching to support self-management of patients with chronic migraine (Sorbi et al., 2007). Only recently, attention has shifted towards support systems that do not rely on human experts (e.g. Blanson Henkemans, Van der Boog, Lindenberg, Van der Mast, Neerincx, and Zwetsloot-Schonk, 2009; Preuveneers and Berbers, 2008).[3] With this shift, there is also a clear development towards *personalised*, or *tailored* support systems that take user context and user activity into account (e.g. Blanson Henkemans et al., 2009; Lindgren, 2011; Preuveneers and Berbers, 2008; Wilson, Flight, Zajac, Turnbull, Young, Cole, and Gregory, 2010). It is here that AI modeling and reasoning techniques come into play. Consider for example the system developed by Preuveneers and Berbers, which assists diabetic patients with keeping track of their food intake, blood glucose levels and insulin dosage by using relevant user information — provided by user input and GPS and processed with hidden Markov models — to learn trends and give tailored advice to the user (Preuveneers and Berbers, 2008). Similar tailored support systems have been developed to improve exercise behavior in people who are overweight (Blanson Henkemans et al., 2009), to support health professionals in their daily practice by providing tailored advice about individual patient cases (Lindgren, 2011) and for assisting people in the decision to screen for bowel cancel (Wilson et al., 2010). The ii-app described in this thesis does not employ any such advanced tailoring techniques. However, given its purpose and flexibility (see Section 3.2), it is in principle a suitable tool to test such techniques with.

[3] Note that the design process of such applications most likely will rely on the expertise of the human experts.

Given the feedback mechanism already in place, one could imagine that, should the ii-app have access to real-time information about a person's emotional state for instance, it would be possible to provide tailored feedback that would take the user's state into account. Clearly, such an extension goes beyond the ii-app's current capabilities, but with additional programming it could certainly be achieved.

This thesis makes two important contributions to this field. The first is the strategy itself: supporting the formation process of implementation intentions is a novel approach that, once there is a better understanding of which methods are effective and why, may well be applied in other support systems operating in domains where making implementation intentions has already been proven effective under experimental conditions (see Section 2.4 for examples). Secondly, this thesis makes a contribution by emphasizing the importance of respecting people's autonomy. Findings concerning the relation between support systems and autonomy that future research with the ii-app should provide, will have direct implications for the further development of similar support systems in AI.

# Chapter 2

# Theoretical Framework

This thesis relates to, and draws from, several different research disciplines such as Psychology, Philosophy, Computer Science, and Artificial Intelligence. This chapter aims to bring together the relevant theoretical backgrounds that concern procrastination. Section 2.1 is concerned with the psychological literature on procrastination. Section 2.2 continues the theme of Section 2.1, but views procrastination from the broader theoretical perspective of self-regulation, action theory and the will. In that section I will also describe the recently proposed notion of the 'extended will' and explain the importance of that notion in relation to the present work. Then, in Section 2.3, the domain of Computer Game Overuse is discussed. Finally, in Section 2.4, an overview is given of the relevant empirical research into goal intentions and implementation intentions.

## 2.1 Procrastination

Most likely, everyone will recognize their own thoughts in Figure 2.1. This is because everyone procrastinates at some point in their lives. To deny this "would elicit a suspicion [...] [of] either lying or responding in a socially desirable fashion" (Senécal et al., 1995, p. 607). As noted in Chapter 1, procrastination is a commonplace phenomenon that chronically effects 15–20% of the general population (Harriott and Ferrari, 1996). Procrastination is even more prominent in academic circles: Ellis and Knaus estimated that 80–95% of college students engage in procrastination (Ellis and Knaus, 1977) and Day, Mensink, and O'Sullivan found that 50% of them procrastinate consistently (Day et al., 2000).[1]

Despite some chronic procrastinators arguing that delaying the task at hand until the very last moment drives them to do their best work (Tice and Baumeister, 1997), most procrastination leads to poor performance. Students who put off writing their term paper until the last minute usually perform worse than their non-procrastinating

[1] It is not surprising therefore that students are often faced with the stereotype that all they do is procrastinate!

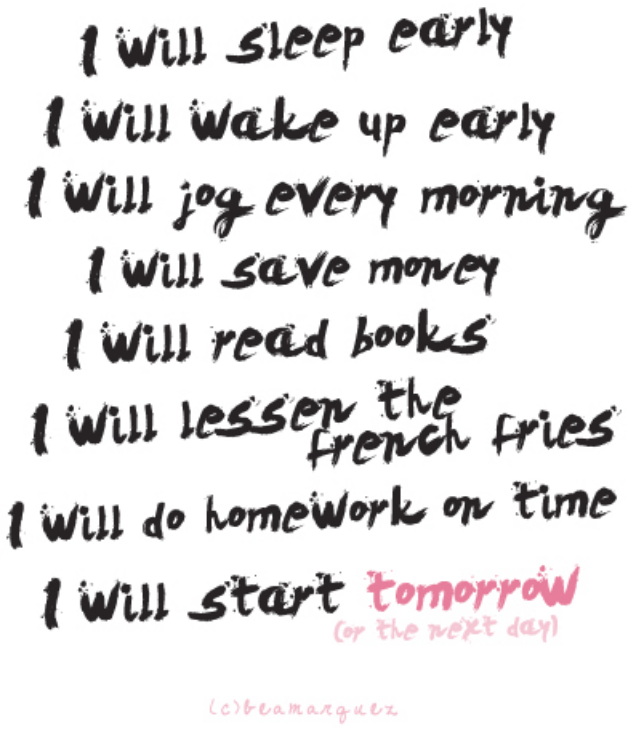


FIGURE 2.1

colleagues (Beswick et al., 1988) and people who delay filling out their tax return forms end up paying too much taxes due to rushing (Kasper, 2004). Other studies have shown that procrastinating can negatively influence individual performance (e.g. school performance (Beswick et al., 1988; Steel et al., 2001)), individual well-being (Tice and Baumeister, 1997), and individual health (Strongman and Burt, 2000). It is no surprise, therefore, that 95% of all procrastinators wants to reduce their procrastination (Steel, 2007).

So it is established that procrastinating is unwanted behavior, but what exactly constitutes procrastination? Looking again at Figure 2.1 it is likely that at first glance one would regard it to purport acts of procrastination. However, in some cases it makes perfect sense to decide to go to bed early tomorrow instead of today, for instance because tonight one has a birthday party to attend to. So what defines the demarcation between procrastinating and deciding to delay something because you give priority to another action? There are a lot of definitions of procrastination available, but the most comprehensive one-liner is that procrastination is "to voluntarily delay an intended course of action despite expecting to be worse off for the delay" (Steel, 2007, p. 7). This definition captures implicitly that procrastination is often classified as *irrational* behavior (e.g. Akerlof, 1991; Ellis and Knaus, 1977) and satisfies all of the criteria of procrastination

that Wieber and Gollwitzer have identified:

> A person has to (1) commit to the goal in question, (2) have the opportunity to act on the goal, (3) expect to be worse off later in the case of a delay, and (4) voluntarily decide to put off the intended action or inaction until a later point. (Wieber and Gollwitzer, 2010)

So, in the case of the birthday party, the answer to the question whether going to the party and not going to bed on time constitutes an act of procrastination, is 'it depends'. It depends not on the intention itself, but on the circumstances. The positive effects of the social gathering may outweigh the one-night sleep deprivation, so that one is not worse off for the delay. However, if the next day one has an important exam to take, one is likely to suffer from the sleep deprivation, perform poorly on the exam, and be worse off by not going to bed on time.

Although procrastinators generally offer a myriad of rationalizations for their behavior, causes of procrastination can mostly be classified under two main groups: task characteristics and motivational factors. The first group includes *task aversiveness* and *temporal discounting*. People tend to delay tasks that they dislike doing, such as doing the dishes, making homework, or filling out tax return forms. This is called task aversiveness: the degree to which a task is unpleasant or unenjoyable to perform (Blunt and Pychyl, 2000; Lay, 1990, 1992; Milgram, Marshevsky, and Sadeh, 1995; Milgram, Sroloff, and Rosenbaum, 1988; Solomon and Rothblum, 1984). Blunt and Pychyl found that boredom, frustration and resentment are associated with task aversiveness, and that each of these components is positively related to procrastination (Blunt and Pychyl, 2000). They also found that tasks that are "forced upon [one] by others [are] generally more stressful, less meaningful and less structured" (Blunt and Pychyl, 2000, p. 165), a finding that is in accordance with the current theory of *self-determination*: the idea that there exists a distinction between intrinsic and extrinsic sources of motivation, where intrinsic motivation is most effective in goal striving (Deci and Ryan, 1991; Koestner, Horberg, Gaudreau, Powers, Di Dio, Bryan, Jochum, and Salter, 2006; Milyavskaya and Koestner, 2011). Another task characteristic is whether the rewards or punishments associated with the task are nearby or far away in time. As people tend to 'discount' rewards and punishments that lay further into the future — a phenomenon called temporal discounting — the timing of rewards and punishments has also been used to explain certain types of procrastination (O'Donoghue and Rabin, 1999; Steel, 2007).

The second group of reasons why people procrastinate are related to motivational factors, most notably a fear of failure. Solomon and Rothblum for instance showed that the majority of procrastinators suffers from performance anxiety, perfectionism and lack of self-confidence (Solomon and Rothblum, 1984). This fear of failure is best illustrated

by the idea that a blank canvas still has the possibility to become a masterpiece, as long as one never paints the first stroke. Because procrastination of this kind has more to do with the individual than with the task, it has been classified as a personality trait (Lay, 1986) that is closely related to conscientiousness (Schouwenburg and Lay, 1995). Moreover, Senécal et al. suggested that at least for academic procrastination non-autonomous forms of self-regulation, i.e. "lack of task initiative, negative or conflicted task emotions, and inability to behave consistently with attitudes or goals" (Senécal et al., 1995, p. 611), contribute to procrastination as well. Indeed, they found that "less autonomous forms of motivation were associated with higher levels of procrastination" (Senécal et al., 1995, p. 616).

Today, many researchers approach the issue of procrastination from the standpoint of self-regulation failure (e.g. Baumeister, Heatherton, and Tice, 1994; Wohl, Pychyl, and Bennett, 2010). Steel has even called procrastination "the quintessential self-regulatory failure" (Steel, 2007). The present work follows in this tradition and assumes that procrastination is associated with self-regulation. Moreover, it conforms to the recent shift of focus in self-regulation theories from the self and one's willpower to maintain one's actions in line with one's goals, to the role the environment plays in regulating the self (e.g. Bargh and Chartrand, 1999; Baumeister and Sommer, 1997; Heylighen and Vidal, 2008).[2] In order to understand procrastination as a self-regulatory failure, it is necessarily to understand how self-regulation is related to concepts of willpower and weakness of will (Kuhl and Fuhrmann, 1998). The next section therefore provides a brief overview of the relevant literature on the will and its relation to self-regulation theory, before turning to a recent theory of the extended will in which the environment is granted its fundamental status.

[2] Attesting to the importance of the environment is the immense popularity of Allen's *Getting Things Done*, which "stimulates to utilize the environment by externalizing memory in an actionable way" (Heylighen and Vidal, 2008, p. 593).

## 2.2 The (Extended) Will

To say anything meaningful about the *extended* will, it is inevitable to dedicate a few words to the notion of the will itself. The will is generally considered an essential component of human behavior, but the nature of the will has been a much discussed, controversial topic since Aristotle.[3] For a while the notion of the will fell into disuse after Ryle made a strong case that the will is in fact a myth, arguing that theories of the will assume "that there are mental states and processes enjoying one sort of existence, and bodily states and processes enjoying another" (Ryle, 1949, p. 63). This, according to Ryle, is a category mistake because it means that "[a]n occurrence on the one stage is never numerically identical with an occurrence on the other" (Ryle, 1949, p. 63).

Of late, however, theories of the will have received renewed interest, especially the relation between volition, voluntary human action and agency (e.g. Bratman, 2007; Gustafson, 2007; Libet, Freeman, and Sutherland, 2000; Mele, 2009; Shanahan and Pychyl, 2007). Today, the debate continues as to which theory of the will best explains aspects of people's executive faculties. One interesting discussion is whether the will can be reduced to intentions.[4] Proponents of such a view are Adams and Mele, who argue that "the major functional roles ascribed to volition are nicely filled by a triad composed of intention, trying, and information feedback" (Adams and Mele, 1992, p. 323). Others, such as Zhu, find that even though intentions and the (technical) concept of *trying* — an internal event that has as a goal the performance of a particular action and "is initiated and (normally) sustained by a pertinent intention" (Adams and Mele, 1992, p. 326) — "can capture most of the essential conceptual and explanatory properties ascribed to volition" (Zhu, 2004, p. 184), intentions have to be supplemented by volitions because intentions are mental states that persist over time, not events, nor actions. There has to be something — volition — that initiates an action.

Despite the jury still being out on these matters, it is common for philosophers and psychologists alike to use the term volition, or *willpower*, to designate the cognitive process by which an individual decides on and commits to a particular course of action. Volitions are viewed "as special kinds of *mental action* by which an agent actively and mindfully bridges the gaps between deliberation, decision, and action" (Zhu, 2004, p. 177). Put in relation to intentions, one may say that when "an agent makes efforts or endeavors to realize his intentions, [...] he is exerting 'the strength of his will' " (Zhu, 2004, p. 180). It is this willpower that people employ when going for a run, or refrain from eating snacks. The other way around, when "an agent has decided that it

[3] Aristotle said that *'hekousion'* — a willed action — was the result of *'prohairesis'* — a notion strongly resembling the current notion of the will, which itself is the result of deliberation. For good discussions on Aristotle's philosophy of practical wisdom, see Eterovich (1980, pp. 44-54) and Pakaluk (2005, pp. 119-140).

[4] See Section 2.4 for more background on intentions.

is better to do A, but instead is intentionally doing B, his action is a case of *akrasia*[5], which embodies 'the weakness of the will' " (Zhu, 2004, p. 180) (italics added). From this definition of weakness of will — which, as mentioned in Chapter 1, procrastination is often classified as — it becomes clear that classical theories of the will are primarily concerned with individual, *rational* thought: one rationally deliberates about which action to take, forms an intention to perform the chosen action, and then acts upon (or: executes) that intention. This same assumption about the primacy of human rationality has long played an important role in other disciplines as well. In the fields of experimental and behavioral economics, for example, this assumption can be found at the heart of rational choice theory: the framework for understanding social and economic behavior that presumes that individuals will always try to maximize their benefits and minimize their costs, and will act accordingly. Contemporary empirical studies, however, seem to suggest that rational choice theory is seriously flawed. For example, people display (i) *inequity aversion*: a preference for fairness over personal gain (Fehr and Schmidt, 1999), (ii) *loss aversion*: a tendency to prefer loss avoidance over gains (McGraw, Larsen, Kahneman, and Schkade, 2010; Tversky and Kahneman, 1991), and (iii) *the endowment effect*: a tendency to value objects higher if they are owned (Thaler, 1980).[6] But if rational choice theory is indeed flawed, what does that say about human rationality?

Contrary to many others, the conclusion that Heath and Anderson draw from the studies that demonstrate poor performance with regard to certain isolated rational tasks, is *not* that humans are irrational beings, but that "human rationality is heavily *scaffolded*" (Heath and Anderson, 2010, p. 233) (italics in original). They emphasize that humans most of the time do function rationally, but that they are able to do so because "they 'offload' an enormous amount of practical reasoning onto their environment" (Heath and Anderson, 2010, p. 233). It is when people are put in unfamiliar environments, that these scaffolds are removed, and that people perform poorly, even on seemingly easy tasks. The lesson here is that the environment plays such an essential role in the human volitional system, that "[t]o limit our attention to what lies within the skin-skull boundary is, in effect, to miss the big story on human rationality" (Heath and Anderson, 2010, p. 234). Drawing on the work of Clark and Chalmers and the 'extended mind', Heath and Anderson therefore argue the case for a theory of the 'extended will', in which the will and the environment are intertwined. Although the question remains open whether this would have to be a 'strong' extended will thesis — parts of the environment as components of the volitional system — or a weaker embedding thesis — the environment playing a crucial explanatory role in the processes of the volitional system — the main point is that individuals' will should not be viewed separately from their

[5] I will come back to akrasia in Section 2.4.

[6] For a rich body of work on irrational human behavior, see Thaler (1994).

environment. This important insight is shared by others as well. Heylighen and Vidal for instance, write:

> Both cognition and action [...] are *situated*: they are determined much more by the concrete external situation than by internal reasoning or planning. This shifts most of the burden of memory and reasoning from the brain to the environment: instead of having to conceive, predict and remember the potential results of an action, the action is simply executed, and its actual results read off from the environmental situation. (Heylighen and Vidal, 2008, p. 593)

It is this situatedness — more commonly recognized in discussions about cognition — that has been undervalued in previous discussions about the will. Given, namely, that people off-load cognitive burdens onto the environment and that the environment provides natural supports for the human will, interesting possibilities arise as how to use the environment proactively. As Heylighen and Vidal put it: "we should choose or arrange the external situation in such a way that it can reliably store information, stimulate new actions, and provide feedback about the effectiveness of previous actions, and thus allow a complex train of activity to be efficiently sustained, coordinated and steered towards our intended goals" (Heylighen and Vidal, 2008, p. 593). Consider for instance placing a mirror on the fridge to confront yourself every time you reach for a snack. Even though the manipulation of the environment in this example is minor, it has the potential to seriously affect your snacking behavior!

To make discussions about extended volition and volitional scaffolds[7] more feasible, Heath and Anderson distinguish three general types of environmental kluges that can help to initiate or inhibit certain behavior: triggers, chutes, and ladders. *Triggers* are environmental cues that "set automatic processes in motion (or bring them to a stop)" (Heath and Anderson, 2010, p. 245). An example of a trigger is a note on the kitchen door that reads 'drink a glass of water', so that each time you enter the kitchen, you will drink some water. *Chutes* aim to make "certain desirable courses of action particularly smooth and effortless" (Heath and Anderson, 2010, p. 245). In other words, chutes lower the threshold for performing a desirable action. Consider for instance laying out your running gear next to your bed before you go to sleep, so that the next morning the threshold is lowered to actually go for a run. Finally, *ladders* aim to do the opposite of chutes: they are scaffolds that "can be positioned to raise the threshold to undertaking wasteful actions, especially when it comes to procrastination" (Heath and Anderson, 2010, p. 245). For example, one could install a software application such

[7] A similar notion is that of *volitional prosthetics*, a term coined by Millgram (2010) to designate intermediate dummy-goals and other requirements that are used to help reach an actual goal. Although these dummy-goals can also be classified as volitional supports, they do not involve the environment in the way that the volitional scaffolds of Heath and Anderson do.

as Freedom (Stutzman, 2011) that blocks one's internet access for periods up to eight hours at a time, and which can only be disabled by rebooting one's computer.

As Heath and Anderson state, "by structuring one's environment effectively, one can reduce the distractions and temptations behind much procrastination" (Heath and Anderson, 2010, p. 245). The present work builds on this idea by focusing on the use of very specific, environment involving plans as volitional scaffolds for people who spend too much time (by their own standards) playing computer games. The next section will further explain the problem domain.

## 2.3 Computer Game Overuse

Computer game playing (gaming) is often presented as a 'bad thing', which, when done excessively, can be linked to poor performance in school, and various health problems such as depression, anxiety and social phobia (Gentile, Choo, Liau, Sim, Li, Fung, and Khoo, 2011). Gaming is also an activity that people frequently turn to when they are procrastinating: a behavior that can be harmful by itself (as seen in Section 2.1). My main concern in this section is determining whether gaming is indeed such a big problem, and if so, how come?

While there are a multitude of scenarios in which people can benefit from a serious use of games, such as training emergency staff (Shapiro, Morey, Small, Langford, Kaylor, Jagminas, Suner, Salisbury, Simon, and Jay, 2004), training student pilots (Dennis and Harris, 1998), stimulating young people with diabetes to self-care (Brown, Lieberman, Gemeny, Fan, Wilson, and Pasta, 1997), or teaching students basic computer memory concepts (Papastergiou, 2009), computer game playing as leisure activity has been linked to a wide range of negative effects. A study by Anand, for instance, shows that "[t]he amount of time a student spends playing video games has a negative correlation with students' GPA and SAT scores" (Anand, 2007, p. 552). Another study by Griffiths, Davies, and Chappell demonstrates that especially male adolescent gamers are likely "to sacrifice their education or work" (Griffiths et al., 2004). A recent exploratory, correlational study by Padilla-Walker, Nelson, Carroll, and Jensen suggests even more negative links:

> [V]ideo game use was linked to greater drug use, drinking behaviors, and lower relationship quality with friends and parents. Furthermore, violent video game use by men was linked to more drinking behaviors. For women, video game use was associated with lower self-worth, and both video games and violent video games were associated with lower perceived social acceptance. (Padilla-Walker et al., 2010)

So what characteristics of games cause them to be so problematic? The answer is threefold. First, games are highly available and thus form a constant temptation. In today's society, high-tech devices (desktop computers, tablets, PDAs and smart-phones) are virtually everywhere, and people use them in all aspects of their professional and personal lives. Besides being useful tools for managing all sorts of information, almost all of these devices are sophisticated and powerful enough to also offer interesting and interactive games. The availability of these devices make it so that people are faced with the temptation, day and night, to go ahead and play these games. It is no wonder, then,

that for millions of people[8] all over the world, computer game playing is an entertaining way of procrastinating, both at home (Porter, Starcevic, Berle, and Fenech, 2010) and at work (Block, 2001).

Secondly, what makes gaming more problematic than other procrastinating activities such as vacuuming, cleaning out the fridge, or playing sports, is that according to Van den Bulck, computer game playing is an *unstructured leisure activity*: the activity is not by itself limited in time. In contrast to other pastime activities, unstructured activities "can expand and take up more time, whereas structured pastimes have fixed starting and stopping points" (Van den Bulck, 2004, p. 101). This suggests that computer game playing is more likely to displace time than structured activities.

Thirdly, there is the interactive nature of games. Games are designed to keep people playing: whether it is by setting high scores, learning new tricks, beating computer players ('beating the game'), or simply discovering new and interesting dimensions of the game. It is these aspects of games that provide players with feelings of accomplishment that compel them to keep at it. Moreover, many recent games, such as World of Warcraft and Guild Wars, allow players to submerge themselves into virtual worlds and interact with other people online. These types of games, called *immersive games*, add a social dimension to the gaming experience, allowing people to actually build relationships of various strengths (Williams, Ducheneaut, Xiong, Yee, and Nickell, 2006).

Combine the availability of games with the unstructured nature of gaming and the immersive and (socially) interactive phenomenology of it, and it is easy to see why people can lose themselves in games. In a recent study, Longman, O'Connor, and Obst identified a sample of people who played no less than 45 and up to 82 hours per week (Longman et al., 2009, p. 564)! With immersive games becoming more and more prevalent — the World of Warcraft subscribers base reached the 12 million mark in 2010 (Blizzard Entertainment, 2010) — it is likely that so too will the negative effects. So the question arises: what can people do to reduce the time they spend playing games, without having to swear gaming off entirely?[9]

One approach would be to rigorously attack the source of the temptation and make games less available by removing or disabling the gaming devices in one's proximity. However, besides being practically unfeasible, this approach may also be undesirable. After all, people play games because it's fun to do, and people like to feel that they are in control of when and where they can play them. Because the immersive nature of games is not generally something that the people themselves can influence or control,

[8]The Entertainment Software Association (ESA) estimated that in 2009 68% of American households played computer or video games, and reported that in 2008 the combined sales of computer and video games totaled a whopping 11.7 billion dollars (Entertainment Software Association (ESA), 2009).

[9]Note that giving up gaming altogether is also a valid approach, but a disproportionate one for most cases. The problem is not the activity of gaming itself, but rather game playing *in excess*. The approach taken in this thesis is to help people take control of their gaming behavior, while respecting their freedom to play computer games.

a better approach would be to focus on when to stop playing. In this light, Van den Bulck suggests that "[i]mposing more structure (eg, end times) might reduce impact" (Van den Bulck, 2004). The rationale is that if the activity is more structured, it is less likely that the activity will expand and take up more time than is desirable. The most obvious way to add structure, as Van den Bulck says in the parenthetical remark, is setting end times for games. Notice, however, that end times are not the only way to increase structure. End times do not consider one's progress in the game, so they may come at very inconvenient times. If the end time is indeed inconvenient, it could a) make quitting the game a frustrating experience ('I was in the middle of a battle!'), and b) lead to people ignoring the end time altogether. Other *termination conditions* than end times, such as advancing two levels, or failing three times to clear a level, may be more suitable. For illustrative purposes however, I will continue to use end times as the default example.

The idea is simple enough: if people supplement their goal to regulate their gaming behavior with a specific plan to stop playing at a certain time, they might see a reduction in their game playing time. By involving the environment — e.g. the clock that tells the time, or the alarm that goes off — in their plan, people are in effect creating volitional scaffolds in the form of triggers: when a predefined condition $X$ is met (the clock strikes ten), they will perform action $Y$ (quit the game). Because the decision to stop has been made ahead of time, one does not have to make a decision again when the trigger occurs (this will be discussed further in Section 2.4). Unfortunately, it's not that simple in practice. People have to make a conscious effort to decide on a plan ('I will stop at ten o'clock') each time they decide to play a game, an effort they often cannot summon the willpower for, or simply forget to make. This brings us to the following question: how can people who wish to spend less time playing games be assisted, in an unobtrusive way, to specify effective plans that add structure to the unstructured activity of gaming?

In Section 2.4 I will first elaborate on the notions of intentions and plans. As I will show, people are often tempted to settle for unspecific and vague intentions, where they would really benefit from clear-cut, highly specific ones. This fact will contribute to the hypothesis that assistive systems that help people make proper intentions, might be a solution to the problem of not being able to muster the willpower to pull away from the game that one is immersed in. Before this hypothesis can be tested empirically, however, it needs to be refined, and there has to exist a tool for testing it with. In regard to the latter issue, I will describe in Chapter 3 a software application that I have developed that is flexible to the experimenter's research needs, runs unobtrusively on a participant's computer used for gaming, and is designed to help study the best possible ways of stimulating people to formulate specific plans as to when they will quit playing a game.

## 2.4 Intentions

Like the will, the concept of intention has a rich philosophical history. At the foundation of our current understanding of intentions is Anscombe, who wrote that actions are intentional when "a certain sense of the question 'why?' has application" (Anscombe, 1963, p. 11). For instance, one's action of chopping up vegetables may be intentional under the description 'to make a salad', but not under some other description such as 'to contract these muscles'. Only a little later, Davidson added to this that an intentional action has a primary reason for performing the action, and that said reason is the cause of the action. It was Bratman, however, who emphasized that many intentions are not reducible to intentional actions. Instead, a lot of intentions are *future directed*, meaning that they relate to an action — or a set of actions — intended to occur in the future (but may not). For instance, one can have an intention to go to Boston next month. There may be absolutely no action presently in relation to this intention, but there will be in a months' time: getting on the bus to the station, taking a train to the airport, boarding the plain to Logan Airport, are all actions to which the answer to the why-question will prove to be one's current intention to go to Boston. The current intention, then, expresses a commitment to action in the future. Bratman realized that these types of intentions are concerned with the human capacity to make plans. In what he has called "the planning theory of intention" (Bratman, 1989, p. 444), he defines intentions as "conduct-controlling pro-attitudes, ones which we are disposed to retain without reconsideration, and which play a significant role as inputs to yet further intentions" (Bratman, 1987, p. 20). Moreover, intentions are elements of *plans*, and as such play an important role in planning for the future. Plans, according to Bratman, are mental states involving commitment to action: "I have a plan to $A$ only if it is true of me that I plan to $A$" (Bratman, 1987, p. 29). As such, "[p]lans [...] are intentions writ large" (Bratman, 1987, p. 29), because they share the properties of intentions: "they resist reconsideration, and in that sense have inertia; they are conduct controllers, not merely potential conduct influencers; and they provide crucial inputs for further practical reasoning and planning" (Bratman, 1987, p. 29). Plans have an hierarchical structure — i.e. general ones embed more specific ones — and are often *partial plans*, because the specific details of the plan will be filled in as the future comes. For instance, one's plan to go to Boston is a partial plan, because it is not yet clear when one will go, or how. When one decides to take a train to the airport, instead of a cab, the plan is more complete.[10] It is this characteristic of plans that plays an important role in the theoretical argument in favor of implementation intentions, because, as I will explain below, filling in the blanks of a plan can help initiate action.

[10]Notice that one now also has a plan to take a train, which itself is partial plan, because one still has to decide on whether to take the eleven or the twelve o'clock train.

As mentioned, having an intention, for example to go to Boston, "involves a characteristic kind of commitment" (Bratman, 1987) to act on the intention. This means that under normal circumstances, the intention will not be revised and one will follow the plan to visit Boston. This gives plans a sense of stability. However, plans are not set in stone: as time progresses, new information can come to light that makes it necessary to reconsider the plan. For example, one may have to cancel the trip, due to illness or extreme weather conditions. Minor revisions to embedded plans are also possible: taking a cab to the airport when it turns out that the trains are not running. Moreover, partial plans are "subject to rational demands of consistency" (Bratman, 2007, p. 26), meaning that the partial plans may not contradict each other.

As Bratman successfully argues, intentions and plans are crucial for us to organize and coordinate our activities with each other and over time. Humans are *planning agents*, not "frictionless deliberators" (Bratman, 1987, p. 28). People "settle in advance on prior, partial plans and tend to reconsider them only when faced with a problem" (Bratman, 1987, p. 28). It is "these partial plans [that] shape further planning and action [...], thereby helping us to coordinate our activities over time and with each other, and thereby helping us extend the influence of present rational reflection to future action" (Bratman, 1989, p. 44). Given this important role of intentions in human behavior, Bratman defends the position that any viable model of human agency should extend beyond the classical belief-desire models in which "the agent's desires and beliefs give her various reasons for acting in various ways, and intelligent action is the output of psychological processes primarily involving such desires and beliefs" (Bratman, 1989, p. 443), and should include intentions and partial plans "as basic elements of the model, on all fours with ordinary desires and beliefs" (Bratman, 1989, p. 444). Based upon this planning theory of intention, Bratman has proposed a formalism for human practical reasoning called *BDI*, which is short for 'Belief-Desire-Intention' (Bratman, 1987).[11]

The present work builds on this idea that intentions play an important role in the human planning capacity. People have intentions that express goals that they wish to achieve, such as to lose weight, or to earn a degree. These types of intentions are known as *goal intentions*, and are of the form 'I intend to achieve $X$', where $X$ is an end-state (Gollwitzer and Oettingen, 1998, p. 691). Goal intentions play an important role in goal striving and goal attainment (Sheeran, 2005), but because they do not specify *how* a goal is to be attained, having goal intentions alone does not reliably lead to action in cases where goal achievement is hard, or when there is no routine to guide the action (Gollwitzer and Oettingen, 1998; Gollwitzer and Sheeran, 2006). It is this intention-behavior gap that is so characteristic for procrastination: one intends to achieve $X$, but

[11] An interesting side note is that outside the realm of action theory, the BDI formalism has had a huge practical impact on the development of intelligent, autonomous and situated computer agents (e.g. Dastani, 2008; Rao and Georgeff, 1991).

despite expecting to be worse off later, does not follow through. The question of how to overcome this gap, is a major focus of research in health psychology today. The main reason for ineffective goal pursuit is that people "fail to specify when they will initiate their goal pursuit and how they will ensure their persistence in the face of distractions and obstacles" (Koestner et al., 2006, p. 1548). Looking at this closely, one can see that there are two factors at play. First, people make plans that are *underdetermined for action*, meaning that the plans are not specific enough to act on. Solely having the plan to earn a degree may not get one to write two paragraphs of an essay today, while the plan to write two paragraphs today, probably will. This phenomenon is explained by Velleman, who suggested that people hesitate to undertake action unless they know enough about it to act (Velleman, 1985).[12] Only when one can already name and explain one's next action, will one move to act. Secondly, people lack a strategy to deal with temptations, other than relying on one's attention to identify the temptation and on one's sheer (mental) willpower to — in some cases constantly — deflect it. People may succumb to temptations that are inconsistent with their goal intention (e.g. eat crisps at a party whilst trying to lose weight), simply because their resources for willpower had been depleted by a hard day's work. By specifying beforehand a strategy to deal with temptations (e.g. turn down anything to eat unless it's veggies), the strain of consciously deciding what to eat and what not to eat (which can easily lead to a point of giving up and simply eating anything and everything at the party), can be significantly reduced (see for example Adriaanse, De Ridder, and De Wit (2009)).

When looking to overcome the intention-behavior gap, then, starting from the first factor, one promising strategy would be filling in the blanks of the overarching, partial plans. By supplementing a goal intention with concrete, specific plans, and executing those, the main partial plan would become more determined, which would make it easier to progress towards it. On the same token, specifying specific plans for how to act in the face of temptation, would help to steer away from the temptation and persist with the goal striving. It is this strategy of making concrete plans that was shown by Gollwitzer to indeed be effective for people to increase goal attainment. More specifically, Gollwitzer showed that making *implementation intentions* (Gollwitzer, 1993) can help people to reach their goals. Implementation intentions are very specific plans that a) work at the level of operative planning, b) involve the environment and c) are of the specific form 'if I encounter $A$, I will do $B$' (Gollwitzer and Sheeran, 2006). In other words, they are "concrete plans of action that specify when, where, and which actions should be taken to achieve an intended goal" (Verplanken and Faes, 1999, p. 593). The strategy with implementation intentions is to further goal attainment by linking

[12] This is also the reason why we almost always know both *what* we are doing, and *why* we are doing it: we do not act and then examine our actions, but instead act upon our anticipated and preferred next action (which, for Velleman, is just our what our intentions are: a particular belief that one will perform a particular action (Velleman, 1985, p. 51)).

cues in the environment to specific behavioral responses. These environmental cues may be considered as volitional scaffolds in the form of triggers (discussed in Section 2.2), as they set automatic behavior in motion. Because implementation intentions "install contingencies between situational cues and goal-fulfilling responses" (Verplanken and Faes, 1999, p. 593), when the cue occurs, automatic processes take over, and "the intended goal-directed action is initiated immediately, efficiently, and without conscious intent" (Gollwitzer and Schaal, 1998, p. 124).[13] So, for example, given that one has made an implementation intention that 'if the alarm goes off, I will get up and jump in the shower immediately', when the alarm goes off, one will immediately, automatically and without reconsideration act in accordance with that intention. In this respect, implementation intentions can be categorized as part of people's 'extended will': by forging a connection between a part of the environment (a cue) and an action, one's will extends past the boundaries of skull and bones, into the environment.

The use of implementation intentions has already proven its value, for instance as a means of facilitating response inhibition in children with Attention Deficit/Hyperactivity Disorder (ADHD) (Gawrilow and Gollwitzer, 2008), in increasing job seeking activities (Hooft et al., 2005), in stimulating breast self-examination (Orbell, Hodgkins, and Sheeran, 1997), in stimulating people to take their vitamin C tablets (Sheeran and Orbell, 1999), and in establishing a more healthy diet (Adriaanse et al., 2009; Verplanken and Faes, 1999). Recent research also shows that implementation intentions can help overcome procrastination (Hooft et al., 2005; Owens, Bowman, and Dill, 2008; Wieber and Gollwitzer, 2010). Taking into account that computer game playing is a known source of procrastination (see Section 2.3), and that the problem of game playing could be reduced by adding more structure to the activity (for instance by setting end times, see again Section 2.3), it seems that making implementation intentions about when to quit playing games could be a very effective strategy to reduce the time people spend playing. For example, if people were to set an alarm beforehand for 20 minutes, and say to themselves 'When the alarm goes off, I will quit the game', they are more likely confine their game playing time to only 20 minutes. The problem with this approach, however, is twofold. For one, people often also procrastinate about forming implementation intentions. The task of making one is not particularly enticing, especially when the alternative is to start gaming right away. This problem is worsened by the fact that people who have already succumbed to the temptation to play games instead of doing something important, are less likely to have any willpower left to determine the conditions under which to quit gaming. Secondly, people are usually all-too-happy to settle for *anemic intentions* (Stroud, 2010). Where the strategy of making implementation intentions is meant to clarify the next action as well as the conditions under which

[13] It is also this mechanism of coupling a predetermined action with an environmental cue, such as the temptation of being offered crisps at a party, that will help to decline the offer.

one will initiate the action, people sometimes tend to cheat themselves and refuse to tie themselves down. As a result, people will in such cases come up with implementation intentions that follow the syntactical requirements, but specify vague conditions and as such are practically useless. Consider for instance a particularly ineffective implementation intention such as 'if I tire of the game, I will do something else'. It sure specifies a condition and an action, but it will be of little help to reduce game playing time.

To sum up then, people who wish to decrease their procrastination could benefit from making concrete, environment-involving plans called implementation intentions, but they often either don't make implementation intentions at all, or make vague, ineffective ones. Thus, what is needed, are ways of supporting the task of forming *effective implementation intentions*. Many different approaches can be taken, though, and it is important not only to know what works, but also *why* it works. So, to study assisted implementation intention formation, I have chosen the domain of computer game playing (Section 2.3) and have designed and implemented a software application that in its most basic form detects when people start their games, and prompts them to make an implementation intention about when to stop playing that game. The application is built with research in mind: it is flexible to suit the researcher's experimental setup. In the next chapter, I will describe the software application in detail, as well as explain and discuss the various implementation choices made.

# Chapter 3

# The Application

This chapter is dedicated to the research application 'ii-app', developed as a deliverable for this thesis project. Section 3.1 explains why the application was developed; Section 3.2 turns to the 'how'-aspect of the application and describes its conceptual design. Then, Section 3.3 discusses the functional design of the application, followed by a detailed description of the application's interface in Section 3.4. Finally, Section 3.5 discusses details of the inner-workings of the application.

## 3.1 Motivation

As mentioned in Section 2.3, computer game overuse in itself is not only a major problem, it is also a problem on the rise. Moreover, gaming often goes hand in hand with procrastination. People play computer games when they are supposed to do something else instead (Klassen and Kuzucu, 2009), and people who lose themselves in games will often procrastinate as a result. In today's world, people find themselves surrounded by high-tech, computerized devices, each of which powerful enough to allow games as a complementary feature. Because they are always so close-to-hand, games provide easy distractions, especially when one is faced with an unpleasant task, or a task one dreads to fail (see Section 2.1). Take for instance writing an essay: when it is hard to find the right words, it is easier to play a game instead. And while work-breaks are generally considered beneficial to overall performance (e.g. Galinsky, Swanson, Sauter, Dunkin, Hurrell, and Schleifer, 2007; Rana Balci and Aghazadeh, 2004), the unstructured, immersive nature of the games makes it hard to quit gaming and get back to doing what you were doing before.[1]

In many cases, prolonged computer game playing hinders both personal and work-related goal attainment, because the time spent playing games conflicts with people's

[1] Of course, in some corporations, managers have taken countermeasures of their own, for instance by having proxy-servers installed that prevent employees from visiting certain websites. The effectiveness of these approaches is debatable, though, especially because it can affect people's autonomy.

other goal intentions (e.g. to do (school) work, or to work out). When people play games instead of doing what they actually intended to do, they fail to persist in their goal striving. This makes procrastinating by means of gaming a type of self-regulation failure. As explained in Section 2.2, one can utilize one's environment to create scaffolds that support one's will: by setting up triggers, chutes and ladders, one can help oneself to stay on the right track. Implementation intentions, the concrete intermediate plans discussed in Section 2.4, are primary examples of triggers: by specifying a plan, one forges a cue from the environment to a predetermined action. Then, when the cue occurs, the action is triggered automatically. Theoretically, the strategy of forming implementation intentions to further goal attainment, is sound. By making them, people make their goals less underdetermined by clarifying for themselves what actual actions are needed to reach their goal. In other words, they are making their partial plan 'to achieve $X$' more complete. This has two important effects. First, recall Velleman's argument in Section 2.4 about people only acting when they have enough information about the upcoming action. By making more concrete what their next action will be, people will be more inclined to actually do it. Secondly, it allows people to specify strategies for *persistent* goal striving: what to do in the face of temptation.

Importantly, implementation intentions have already been proven effective as a means of overcoming procrastination under experimental conditions (see again Section 2.4). However, it turns out that in daily life people tend not to make them, or to make anemic ones that are ineffective. Still, procrastination is a more and more prevalent issue in society (Section 2.1), and implementation intentions do offer a very promising way of dealing with it. Thus, what is needed, is to find ways to *support* the process of effective implementation intention formation.

For the domain of gaming, a software application is the obvious solution, but it is far from obvious *how* the application should offer the support. What type of instructions work best for stimulating implementation intention formation? What type of interface do people respond positively to? How restrictive should an application be in terms of the implementation intentions that can be made? What is the relation between enforcing intentions and the user's satisfaction with the application? And, very importantly, there is the question of how such a supportive system would affect people's autonomy. The use of technical solutions to enhance our capabilities is not new, nor is it problematic in itself. Just think of our use of calculators for solving difficult arithmetic: people have no problem outsourcing computational operations so that they can reason with the outcome. In this case, though, the application offers *active* support to the intention formation process — offering guidance by making suggestions — so that the result will be a well-formed, effective implementation intention. It is here that we face the unknown, because that process of forming intentions is one that we intuitively feel to be private and

of a mental nature. How will people respond to an external application that supports — or interferes with — the intention formation process?

As these questions are all in need of answering, the ii-application that was developed for this project, is designed as a research tool that can help us investigate different aspects of supporting the process of forming implementation intentions that are effective, without reducing personal satisfaction with the application, self-efficacy or self-concordance. Then, possibly, when enough data has been gathered, a second application can be designed on the basis of the current one, incorporating the results, for personal use.

The current application can be used to test a variety of different variables, such as (i) the type of instructions for stimulating implementation intention formation, (ii) the effectiveness of artificial cues and (iii) the effectiveness of enforced intentions. Moreover, it can be used to experiment with different techniques of supporting the task of (i) selecting the right cue (the application also offers additional artificial cues), (ii) choosing the right action to couple to the cue, and (iii) providing feedback. In Chapter 4, several experiments are proposed to collect initial data. First, however, I will describe in more detail the design of the application.

## 3.2 Conceptual Design

The application allows experimenters to select programs (games) on the participants' computers for which they, from then on out, will have to form implementation intentions that specify the cue — the condition — that will trigger them to stop using that program. These implementation intentions can vary from 'when the clock strikes 12.00 hours, I will quit this program', to 'when I have advanced three levels, I will save the game, exit the game, and start doing the next item on my to-do list'. Depending on the experimental settings, the application can supply certain cues, such as audible or visual notifications (a bell or a pop-up screen, respectively), that may be used as the 'if-part' (the trigger) of the implementation intention. The application also offers the possibility to enforce certain intentions: depending on the experimenter's design, it can temporarily suspend the game and present the user with their implementation intention on screen, or it can quit the game altogether without further intervention by the user.

Figure 3.1 shows a typical flow of the application. It shows that when a user launches a game, the ii-app intervenes by prompting the user with instructions and a form to formulate an implementation intention. For this case, let's assume that the user chooses the audible notification (the sound of a bell), supplied by ii-app, for the if-part of the implementation intention. Once the user has completed the form, the ii-app returns the game to the user to play. Then, later, the ii-app intervenes once again, but this time with the audible notification, to provide the user with the cue that should trigger him to stop playing. At this point in this case, the user will face a choice, either to terminate the game, or to keep playing.[2] Note that Figure 3.1 represents just one of many possible configurations, but one that demonstrates the basic application logic. Experimenters can configure the ii-app differently, for instance by having the ii-app terminate the user's game without user intervention, or by offering the user a third option to keep playing for a predefined number of minutes (i.e. a 'remind me later' button).

The application is designed to be (i) situated, (ii) as unobtrusive as possible, and (iii) flexible. First, it is situated for consistent availability. Many support systems currently being developed rely in some way or other on mobile devices such as tablets or smart phones, because these devices are complex enough to deploy sophisticated software on, can send and receive information using the internet, and many people have one. However, one of the difficulties with these kind of support systems is that they also rely on people having mobile devices with them at the moment when they need the support the most. Given that people sometimes forget to bring their phone, or have them switched off, these support systems aren't always reliably available at the right time. Not only is the application barred from offering its support at such times, it is also

[2] A video demonstrating typical application behavior — here with a visual notification — is available for download here: `http://www.phil.uu.nl/~kamphors/download/demo.zip`.

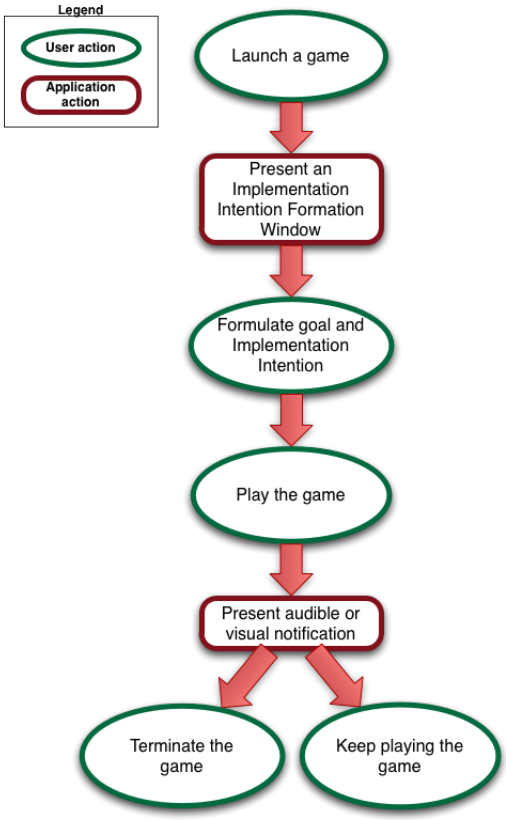


FIGURE 3.1: A typical application flow.

hindered from collecting reliable data about the user's (gaming) behavior. This defect can limit the effectiveness of the support system tremendously, and also makes it harder to accurately assess the effectiveness of the system.

Situated and ambient systems are rapidly evolving technologies that generally involve monitoring the environment and dynamically displaying behavior. Examples of such systems are 'smart' traffic lights that efficiently manage the flow of traffic (Wiering, 2000), driver-less cars and Library checkout stands that register books that the user wants to loan without user intervention. The ii-application should be categorized as situated: it is integrated in the source of temptation (the computer) and therefore is available when the 'coachable' moment presents itself. Notice that in this case, it is the domain of computer game playing that makes a software application the right choice. If, however, this thesis were concerned with watching too much television, it would make much more sense if the application would be integrated into the television set.

Second, the application has to be as unobtrusive as possible, because poorly designed, obtrusive interfaces can lead to serious frustrations, which in turn can lead to

"personal dissatisfaction and loss of self-efficacy" (Lazar, Jones, Hackley, and Shneiderman, 2006).[3] This can then obfuscate results concerning the effectiveness of the implementation intentions. The first step taken to accomplish unobtrusiveness, is having the application operate in the background of the operating system. Visually, there is nothing but a tiny icon in the menu bar that indicates that the application is running: there is no window cluttering on screen. In its running state, the application monitors computer usage and game playing without user interaction, meaning that it does not bother the user with prompts or pop-up windows during working hours. The only time that the application does present a window on its own accord, is when a user starts a particular game, and only when it has been instructed to do so for that game in an earlier configuration stage. However, should one wish to design an experiment to test how different interfaces and prompts affect personal satisfaction and self-efficacy, the application's behavior can be altered with a set of configuration options.

This leads to the third point: the application has to be flexible. As many different research questions may be asked and answered using this tool, it is crucial that different types of behavior can be set easily. For instance, some experiments will require users to always make implementation intentions, whereas in others they will be optional. It is settings like this that can be configured in the Preferences-pane of the application. This pane is locked for regular users, but accessible for the administrator of the computer (the experimenter). Other settings include whether or not to offer artificial cues, and whether to enforce any of the intentions. Furthermore, the ii-app allows experimenters to provide feedback to the user, for instance for positive reinforcement when quitting a game early. This feedback mechanism is optional, and consists of a pop-up window containing a text message (e.g. 'Well done!') and a single OK button.[4] When enabled, the Feedback Window is triggered when a user terminates his game. Note that experimenters can define different notification strings for when the user quits either before or after the predefined end time.

The next sections aim to paint a detailed picture of the application. First, I will describe its functional design in Section 3.3. I will then present the components of the interface in Section 3.4. Subsequently, I will discuss data storage, data collection, issues of portability and development tools in Section 3.5.

[3] Just consider the worst helper application of all times: Microsoft's Office Assistant 'Clippy'!

[4] This Feedback Window is classified as a reactive prompt as discussed in Section 3.4.3.2, and looks very similar to the Visual Notification Window shown in Figure 3.9.

## 3.3 Functional Design

This section describes seven functional requirements that were identified for the ii-app to satisfy. The first and most crucial requirement was that it should know in real-time when other applications (games) were being launched or terminated. This was accomplished by hooking into Apple's notification system using the NSNotificationCenter API. When running, the ii-app receives launch/termination notifications from all other applications in the operating system, which it registers and acts on when appropriate. These actions include presenting the user with a prompt (see Section 3.4.3), or updating the database (see Section 3.5.2 for more). The second requirement stated that the ii-app should be able to manipulate other applications, by hiding and unhiding them. This manipulation is necessary as an incentive for people to formulate an implementation intention in the Implementation Intention Formation Window (Section 3.4.3.1). This requirement was implemented in the hideApplication(pid) and unhideApplication(pid) methods, using the NSRunningApplication API. The third requirement concerned the ability to provide audible and visual notifications to the user. This was fulfilled using the NSSound API for audible notifications, and either the NSRunAlertPanel API for basic pop-up windows, or custom-made serialized interface components for more complex windows (e.g. the Implementation Intention Formation Window). The notifications are employed for providing users with artificial cues to use in their implementation intentions, as well as for providing users with feedback. The fourth requirement was that the ii-app should be able to elicit user input. This requirement was satisfied mainly through the Implementation Intention Formation Window, that is presented to a user whenever a monitored game is launched. The fifth requirement was that the ii-app should flexible and configurable for different experimental setups (see Section 3.2). This was accomplished through the use of persistent preferences, using the NSUserDefaults API. These preferences can be manipulated through the Preferences window as described in Section 3.4.2. The sixth and seventh requirement are related, but not the same. The sixth was that the ii-app could collect data. Most data collection is performed in the methods appWillLaunch(notification) and appTerminated(notification); the process of collecting data is described in Section 3.5.2. The seventh requirement was that this data would not just be written to a file, but stored persistently for further use. This was done by using the Apple Core Data Framework. The reasons for choosing this framework are set forth in Section 3.5.1.

The functional requirements and their details are summarized in Appendix A. Appendix B complements this by listing technical challenges that needed to be overcome during the development of the ii-app.

## 3.4 The Interface

The interface of the application consists of several visual components. This section describes and depicts each of them.

In its normal operating state, the application does most its work in the background of the operation system. During this time, the only sign that the application is running, is a distinctive icon in the menubar as shown in Figure 3.2. When one clicks on the icon, a menu appears. This menu is depicted in Figure 3.3. The menubar structure consists of the following options: Status, Preferences, About, and Quit. The behavior of each of these options will be discussed in the following subsections.


FIGURE 3.2: The ii-app's icon in the menubar.


FIGURE 3.3: The ii-app's main menu.

### 3.4.1 Status: usage information

The Status option opens a window that shows some interesting statistics about the user's gaming behavior. It is shown in Figure 3.4, and currently shows:

- The total number of implementation intentions made.
- The total time spent playing the monitored games.
- A short list of suggestions of applications to monitor (based on actual usage of those applications). With just the click of a button the experimenter can add the suggested application to the list of monitored applications (located in the Preferences window). A 'don't suggest again'-button removes the application name from the list of suggestions (consider applications that people keep open all the time such as browsers, or productivity applications that run in the background).

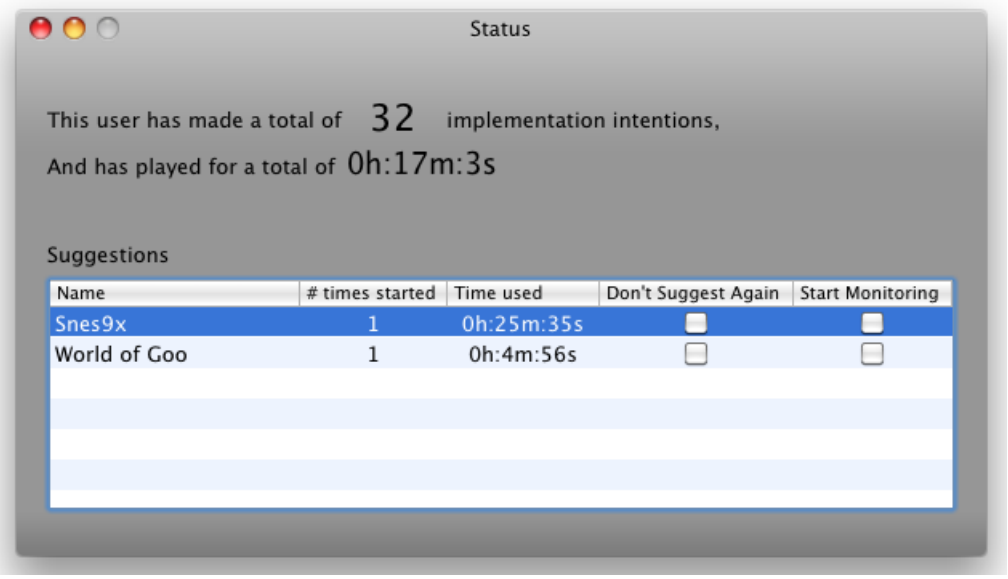


FIGURE 3.4: The ii-app's Status window.

### 3.4.2 Preferences: experimental settings

In most applications, preference panes are used by end-users to set up personal usage preferences. However, as the ii-app is an experimental tool, the ii-app's preference panes reflect the experimental settings that can be configured by the experimenters (not the participants). The Preferences window itself consists of one toolbar and two views (panes): one for general options and one for managing the list of applications that are monitored by ii-app. The general options view is shown in Figure 3.5. It contains fields to change the instructions that are given to people when they have to make implementation intentions, but also settings such as whether implementation intention formation is required, whether and when people will receive visual and/or audible notifications, and whether the ii-app will force the termination of games.

The application preferences view is shown in Figure 3.6. It contains a table (NSTableView) which is configured to allow experimenters to drag and drop applications (files with the file extension .app) into the table. For each application in that table, the ii-app will ask the user, prior to playing, to make an implementation intention about when to quit playing. In this case, the games Urban Terror, Chess, and Quake 3 are monitored.

The Preferences window is controlled by Apple's authorization framework through the use of the SFAuthorizationView class. This class handles the 'locking' process of the preferences: without authorization from an administrator, the preferences are locked and cannot be altered. In the locked state, a closed lock icon is shown in the bottom left corner of the window. When that lock is clicked, an authorization window appears, asking for administrator credentials. If you fail to provide those, the preferences stay

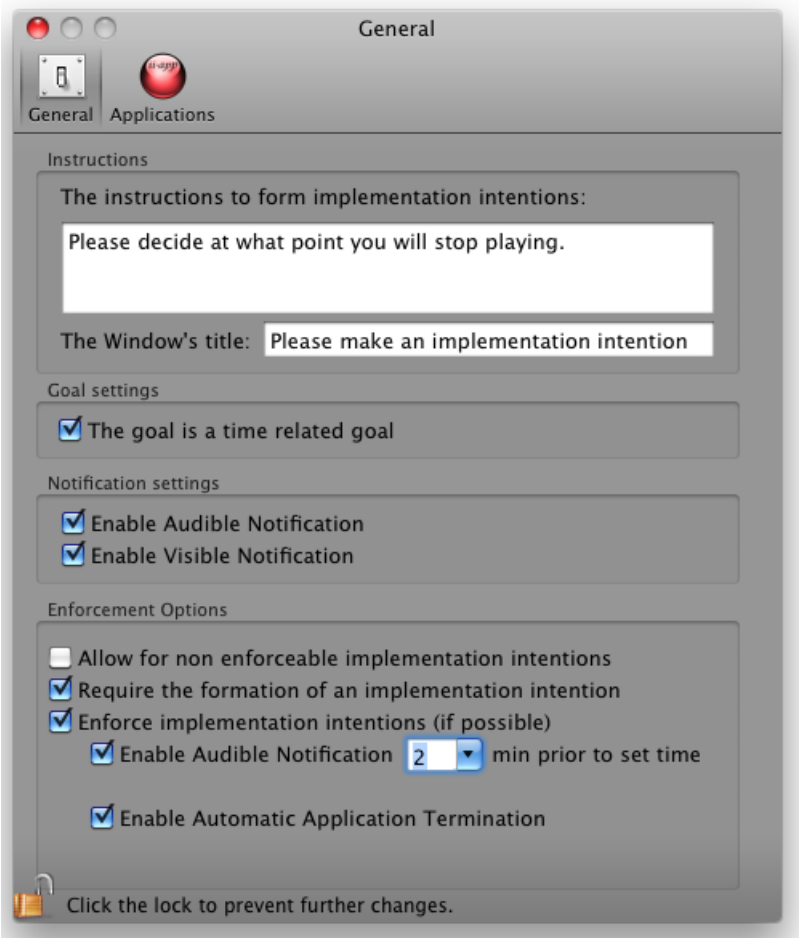


FIGURE 3.5: General Preferences in unlocked state.

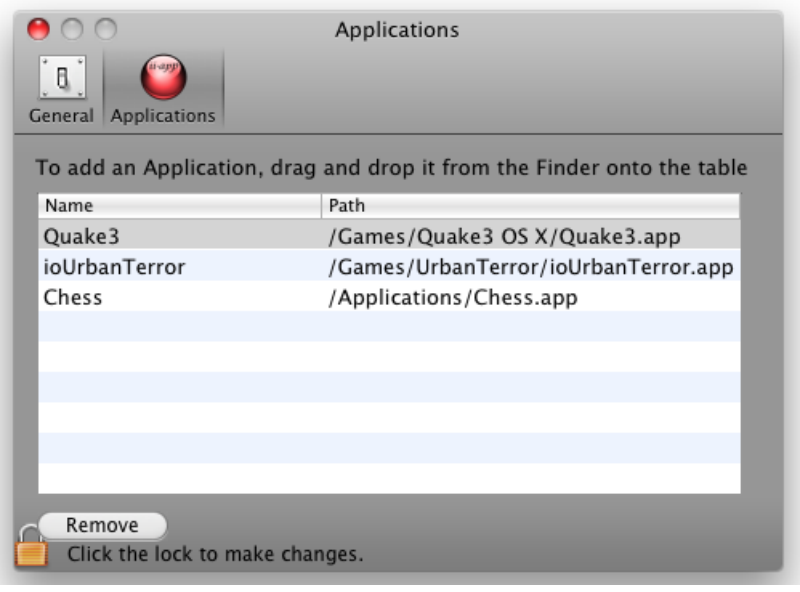


FIGURE 3.6: Application Preferences in locked state.

locked. If you provide the right credentials, however, the lock at the bottom left corner opens up and the preferences become editable. The visual locking mechanism is shown in Figure 3.7. In experimental setups, the experimenters will generally be the ones with administrator access, so that the participants cannot change the experimental setting.[5]

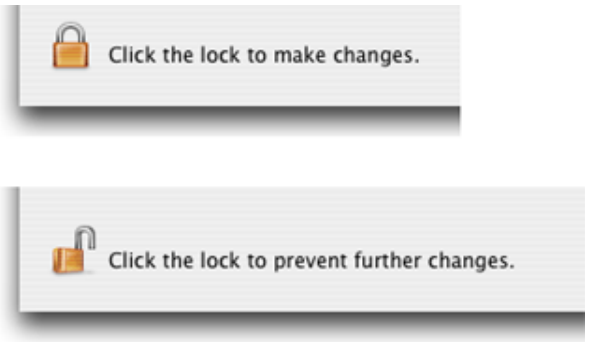


FIGURE 3.7: OS X Authentication View.

Lastly, all ii-app preferences are stored in a so-called property list (.plist) file. This file is essentially a set of key-value pairs, written in a specific XML format and converted by OS X into binary form for reasons of space-efficiency. Each key-value pair corresponds to one setting, for instance

$$< key > EnableAutomaticTermination < /key >< true/ >$$

corresponds to the setting whether or not ii-app will, under a certain condition, try to terminate a game without user intervention.

The preferences are set and retrieved using Apple's default Preferences mechanism NSUserDefaultsController. The ii-app preferences are stored in a file called **nl.uu.phil.ii-app.plist** in Apple's default location `~/Library/Preferences`.

### 3.4.3 The prompts

Sometimes, the ii-app presents the user with interactive prompts. These prompts can roughly be divided into two groups: preemptive and reactive prompts. The main preemptive prompt is the one where the user is asked to set a goal, and formulate an implementation intention. This prompt will be discussed in Section 3.4.3.1. Reactive prompts are the ones that are presented when a certain event takes place, or a specific amount of time has passed. A good example of such a reactive prompt is the visual reminder window, which will be discussed in Section 3.4.3.2.

[5]It would also be possible to use the authorization mechanisms to authenticate against a separate ii-app username and password combination, should the current authorization scheme not do. This feature, however, is not implemented at the time of writing.

#### 3.4.3.1 Preemptive prompts: Implementation Intention Formation Window

In Figure 3.8 the main preemptive prompt is shown. It contains instructions and input fields for people to set a goal (in this case, a time related goal to play for only 20 minutes), and to supplement this goal with an implementation intention: '**if** a pop-up window appears, **then** I will quit the game'. Once all the fields are filled in, the Continue-button becomes enabled (clickable), and the user will be presented again with his game of choice.

Note that the contents of the text field in this window corresponds to the one in the Preferences window of Figure 3.5. Moreover, notice that many of the fields can be removed or made optional by the experimenter. Depending on the configuration of the preferences, it is possible that setting a goal is a requirement, but formulating an implementation intention is optional, or that the user is asked to set a non-time related (open) goal, or that the user may choose to skip this window altogether (by clicking a 'Skip', or 'Remind me Later' button).

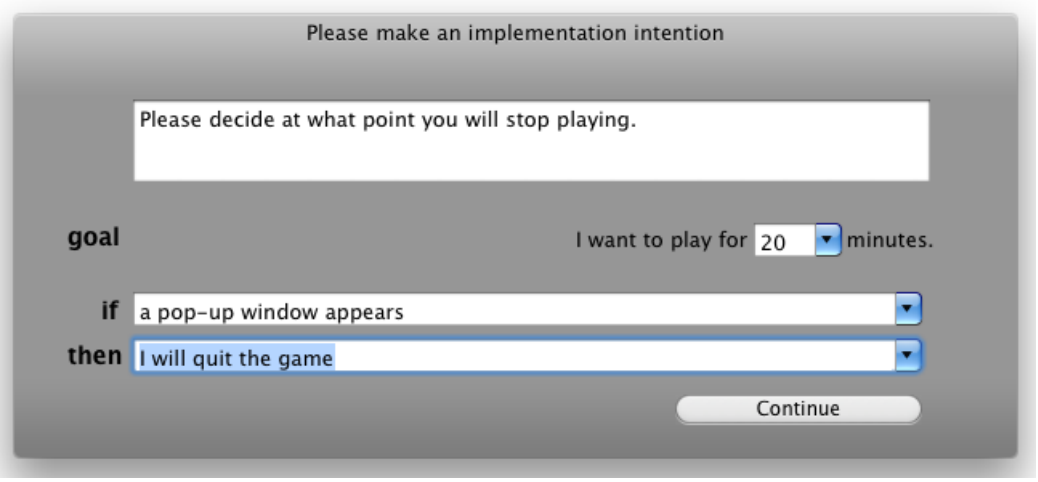


FIGURE 3.8: The Implementation Intention Window.

#### 3.4.3.2 Reactive Prompts: the Visual Notification Window

When particular events occur, for example when a certain amount of time has passed, the ii-app can send visual notifications in the form of a pop-up window. These notifications can contain text and a set of buttons, both of which can be configured by the experimenter. In Figure 3.9 an example notification is shown that provides a friendly reminder to the user, after having played Chess for 20 minutes, that his or her 20 minutes of playing time are up. This particular notification presents the user with a choice to either quit the game (as intended), or to keep playing (regardless of earlier intentions). In different scenarios, however, there may be need for different notifications, and the

ii-app is flexible in that regard. For instance, it is possible to send out a notification with just one button that terminates the game when clicked.


FIGURE 3.9: The visual notification (pop-up window).

### 3.4.4 About and Quit

The About Menu Item displays a window that contains the application's name, version information, and developer credits. It is shown in Figure 3.10. The Quit Menu Item terminates the application.


FIGURE 3.10: The ii-app's About Window.

## 3.5 Implementation Details

This section discusses some of the implementation details of the ii-app. First, Section 3.5.1 sets forth the method of persistently storing and retrieving data. Secondly, Section 3.5.2 explicates what data is stored, and why. Thirdly, Section 3.5.3 discusses the issue of porting the ii-app to other platforms than Mac OS X. Finally, Section 3.5.4 describes the developmental environment and the tools used to build the ii-app.

### 3.5.1 Data storage

The ii-app uses the Apple Core Data Framework to persistently store its data. Core Data has a mature and highly stable code base that is well-documented and provides excellent error-handling. The advantage of using this framework is that developers can write code that is agnostic regarding the actual methods of writing and reading data. This means that with Core Data, it takes just one line of code to switch for instance from a XML file as the backend of the application, to a SQLite database.

During the developmental stages, the ii-app uses the XML store, for reasons of human readability. In the production environment, however, the ii-app will use the SQLite store, because it is faster and because it scales much better. Moreover, as the actual data will be stored in a standard SQLite database, the data will extractable with the SQLite query language.

Figure 3.11 displays the current Core Data data model. The three most important Entities (objects) are Application, ImplementationIntention and LaunchTerminationEvent. Each Entity has attributes, like most objects have specific features. In this model, all Applications have a name, a path, and an attribute *monitored* that determines whether the particular application is one that the ii-app should watch for. Finally, the arrows in the Figure indicate the relationships that exist, for instance a one-to-many relationship between an Application and LaunchTerminationEvents (one application is launched and terminated many times).

### 3.5.2 Data collection

The ii-app collects data for both the workings of the application, and for statistical analysis later on. This section provides an overview of the data that is collected, and explains how that data is used. It concludes with a brief note on privacy.

First, the ii-app keeps track of applications (stored as Application entities). Each time a user launches an application, the ii-app performs two actions. One, it checks whether it has any information about that application. If it doesn't, it adds the application to its database of applications as a non-monitored, suggestible Application. Two, it creates a LaunchTerminationEvent entity in its database, with a launch timestamp,

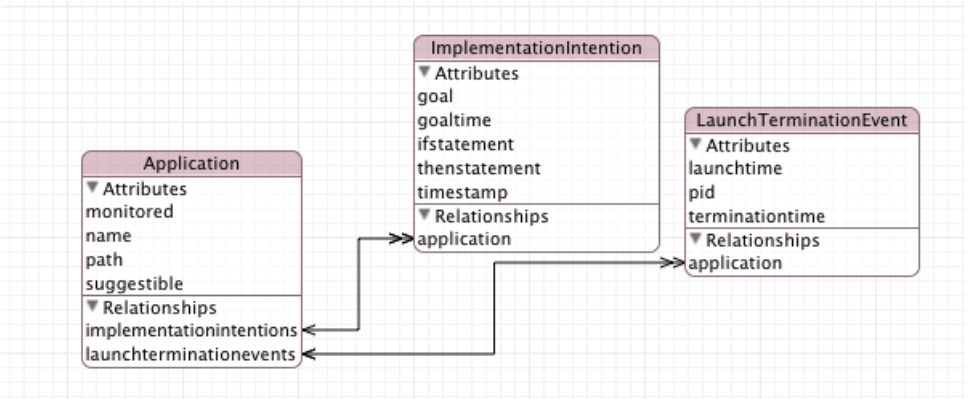


FIGURE 3.11: The Core Data graph.

and puts that LaunchTerminationEvent in relation to the Application entity. When a user terminates an application, the ii-app queries its database for the corresponding LaunchTerminationEvent, and adds to it a termination timestamp.[6] It is this data that is represented in one form or another in the Application Preferences (Figure 3.6: Applications of which the *monitored* attribute is set to true) and the Status Window's suggestion table (Figure 3.4: Applications that aren't yet monitored, but could (or should) be in the future). Moreover, it is with this information, that it is possible for the experimenter to extract i) the number of unique applications the user uses, ii) the frequency with which the user launches and terminates one particular application, iii) the duration of the intervals that the user uses that application, and iv) the total time the user spends on the application.

Secondly, the ii-app collects ImplementationIntention entities, which have attributes such as *goal*, *ifstatement*, *thenstatement* and *timestamp*. Also, there is a many-to-one relationship with an Application: there can be many unique implementation intentions for when to quit playing Chess. Each time a user is prompted with the Implementation Intention Formation Window (see Figure 3.8), fills in the input fields, and hits Continue, a new ImplementationIntention is stored. This allows experimenters to know about v) the number of implementation intentions made per application, vi) the type of implementation intentions made, and vii) the type of goals that were set. Finally, it allows experimenters to calculate the times between setting a goal, the (time-related) goal itself, and the termination event of the game in question.

As with all software applications that collect data, there are privacy concerns to address. For the ii-app, note that all collected data is stored locally on the user's computer, in a place that is accessible only by the user himself and by administrators (i.e. the researchers). The ii-app does not gather any sensitive personal information from

[6] Applications that were running before the ii-app itself was launched are ignored when terminated, as it's not possible to calculate an accurate usage time based on termination time only.

the operating system without permission from the user. Should the ii-app in a future release send collected data to a central storage location, it will do so using encryption to ensure that no third-party will be able access the information.

### 3.5.3 Portability

This application was developed specifically for the Mac OS X platform. The general strategy of supporting people in making implementation intentions, however, does not have to be limited to just one platform. So the question, then, is whether this application can be ported to other platforms, such as iOS, Android, or Microsoft Windows. The short answer is 'no'. The tools used for the development of this application are specific to OS X. Although it might be possible to abstract some of the application logic, any similar application on another platform would have to be built from the ground up.

There is one platform that seems exempt from this reasoning: the iPhone Operating System (iOS). Do iOS developers not use a very similar toolset? To this question the answer is 'yes', but unfortunately it does not follow from this that the ii-app can be ported to iOS. The reason is that applications on iOS are *sandboxed*, meaning that they cannot interact (interfere) with other applications. That is, on iOS it is impossible to receive launch/termination notifications of other applications (games). This means that users cannot be prompted just prior to starting a game. Sadly, similar restrictions are at work on the Android platform.

The possibilities for ii-applications as described in this section for different platforms, are summarized in Table 3.1. Note that this table reflects which platforms are suitable for ii-app-like applications, not whether the OS X ii-app can be ported these platforms.

| **Platform** | **ii-app possible** |
|---|---|
| Mac OS X: | ✓ |
| MS Windows: | ✓ |
| iPhone OS: | ✗ |
| Android: | ✗ |

TABLE 3.1: Possibilities for ii-applications on different platforms.

### 3.5.4 Platform and tools

The application is designed for the Mac OS X platform, mainly because of Apple's extensive and well-documented APIs. The application's interface was designed using Apple's Interface Builder (v.3.2.6), the programming was done in Apple's XCode (v.3.2.6, 64-bit) and in MacroMates' TextMate. The application logic of ii-app is programmed in

the Apple supported open source language MacRuby (v.0.10), because of Ruby's clear and concise syntax and its dynamic typing. The application was designed on a MacBook (Model MacBoook5,1), 2.4 GHz Intel Core 2 Duo processor with 4GB 1067 MHz DDR3 memory.

# Chapter 4

# Suggestions for Experimental Research

In the previous chapters I have argued that procrastination is an increasingly prevalent problem in society today, and that volitional scaffolds, in the form of effective implementation intentions, are a promising way to decrease procrastination, given that people are assisted in making them. In Section 3.1 I mentioned the various research questions that the concept of assisted intention formation brings forth, and explained the need for proper research on this topic. For this purpose I have defined a research domain in Section 2.3 and designed a software application to study it (as described in Chapter 3). The next logical step for this research, which fits into a research programme larger than this thesis work alone, is to perform (clinical) trials with the ii-app, in order to provide empirical evidence of both the application's effectiveness and the effectiveness of the strategy in general. Empirical trials should provide evidence for at least the following claims:

- For regulating gaming behavior, furnishing goal intentions with implementation intentions leads to better results than having goal intentions alone.
- The more the application restricts autonomous intention formation, the less people will like it and use it.
- Forming implementation intentions — any kind of implementation intention — *prior* to starting a game decreases total game playing time.

In this chapter I will suggest three types of experiments to test these claims, which can be performed in future research. Section 4.1 describes an experiment that aims to validate that making implementation intentions is indeed an effective strategy to decrease game playing. Section 4.2 concerns a series of experiments that focus on finding the optimal human-computer interface for the ii-app specifically, and for identifying

important structures and components of interfaces for this type of application in general. Section 4.3 proposes an experiment that aims to show that making implementation intentions will work, even when conditions are less controlled than those provided by standard experimental settings. Then, in Chapter 5 I will suggest several other promising strands of research that I believe should be pursued.

## Suggestions for Experiments

*Acknowledgment:* The experiments proposed in this section have originated from a discussion with Dr. Marieke Adriaanse. Moreover, they have been used in an augmented form in a grant proposal for an STW/Philips grant on 'Healthy Lifestyle Solutions', which has recently been accepted.

## 4.1 Experiment One: The Benefits of Controlled Implementation Intention Formation

The first experiment should validate the assumption that implementation intentions indeed provide benefits in the gaming domain beyond having goal intentions alone. To test this, I suggest a basic experiment with two conditions that targets a group of participants who wish to regulate their gaming behavior. In both conditions participants will be prompted to state their goal: they aim to limit their game playing time to $X$ minutes. All participants are told that they will be presented with a pop-up window when the indicated time has passed. In the experimental condition, there is an additional step involved: participants will be prompted to supplement their goal intention with an implementation intention, that takes the form of 'if the pop-up window appears, I will terminate the game'. The two conditions will be compared on i) the time spent gaming, ii) terminating the game on encountering the pop-up window, and iii) general satisfaction with the application.

From the results of this experiment I expect to see that people in the experimental condition will be more likely to quit when they encounter the pop-up window, and that they spend less time gaming overall than the people in the control condition. As for the satisfaction with the application, I expect to see no significant difference between the two conditions, because the interface as well as the task itself will differ minimally between the conditions.

## 4.2 Experiment Two: The Human-Computer Interface

The second experiment is really a series of experiments, geared towards finding the optimal human-computer interface — including identifying the optimal instructions — that

is not only effective, but also satisfactory to the user (i.e. not being offensive, nor annoying). As mentioned in Section 3.1, the ii-app is concerned with supporting a process that intuitively is one's own: being able to decide what to do and when to do it, is strongly connected to autonomous agency. Any system that actively supports intention formation, should be very careful not to impede the process. Therefore, understanding how certain interface components affect autonomy, is crucial for the development of volitional scaffolds that are respectful of people's autonomy. Additionally, the individual's satisfaction rate with the application is most likely what will determine actual use outside of experimental settings in a future version of the ii-app (See Section 5.1).

Like in the previous experiment, the target group of participants will consist of people who have the overall intention to regulate their gaming behavior. The setup is as follows. There are two conditions, both in which participants are asked to form an implementation intention about when to quit. The key to this experiment is that people are given a choice: they can either form an implementation intention, or decline to do so. The optimal interface will be determined by examining a range of factors, including a) the tone of the textual instructions (e.g. neutral, or optimistic), b) the type of cue that the application offers (e.g. the sound of a bell, or a flashing LED on the keyboard, or a pop-up screen), c) the level of freedom in choosing a cue (e.g. time spent playing vs. the number of levels progressed in the game)[1] and d) the way the application helps to execute the implementation intention (e.g. by combining the cue with a motivational message, or by proposing to terminate the game with a 'YES/NO' choice, or by terminating the game without any further user intervention.)

The primary dependent variable is whether participants actually make implementation intentions when they have a choice. The hypothesis is that the happier people are with the interface, the higher the likelihood is that they will form implementation intentions. In support of this hypothesis, user satisfaction will be measured through extensive surveys as well. In addition, it will be examined how different components of the interface, especially the ones concerning assisted execution of the implementation intention, affect feelings of autonomy and control.

## 4.3 Experiment Three: The Benefits of Unbound Implementation Intention Formation

In Experiment 4.1 and 4.2 both the cues and the conditions under which the cues would appear were controlled. The cues were supplied by the application, and the conditions were such that they could be measured by the application. From the user's point of view, the application is there to assist with implementation intention formation and

[1] Note that in this experiment, the conditions have to be such that the application can measure them. Conditions such as 'when my sister comes home from school' are non-valid.

prevent the formation of ineffective plans, but it should in principle allow one to make self-concordant intentions. If the application is too strict, people will feel constricted ('*my plan* is not an option!') and will soon become frustrated. This may affect people's autonomy, as they might feel that they are being coerced in their decision-making. The difficulty is finding the right balance between guiding users to form effective implementation intentions, and letting users make self-concordant plans. Ideally, the implementation intentions that users end up with are both effective and self-concordant, but this does not necessarily have to be the case. In the third experiment it will be determined whether self-proposed cues outside of the application's support scope (e.g. 'when my spouse comes home') will increase the effectiveness of the application. Because self-proposed cues are more likely to be in accordance with one's intentions, my hypothesis is that it does.[2] In addition, given a proper instrument to measure autonomy, this experiment can also be used to study the effect that freedom in cue-choosing may have on one's autonomy.

This experiment compares three conditions.[3] In all three the participants are required to form implementation intentions. In the first condition, the only cue available is a (visible or audible) notification after $X$ minutes of playing time. The implementation intention would be of the form 'when I perceive the notification, I will quit the game'. In the second condition, participants can choose from several conditions for when a notification appears (e.g. when they have progressed two levels, or lost 5 matches in the game). In this condition, the implementation intention itself would be similar to the implementation intention in the first condition. In the third condition, there is no notification supplied by the application. Instead, participants are free to come up with their own cue to use in the implementation intention, which they will have to enter into the application. An example intention in this third condition is 'when my spouse comes home, I will quit the game'. The effectiveness of the application will be determined by taking the total time spent playing the game as the relevant outcome measure.[4] The decrease in playing time, then, indicates the degree of effectiveness. Aside from effectiveness, the satisfaction level of the participants with the application could also be measured through surveys. I expect that participants in the third condition will have the highest satisfaction level, given that their autonomy in forming the implementation intentions was not impeded in any way.

[2] However, and this is what the results will show, it could also be that too much freedom in choosing cues will lead to poor, ineffective implementation intentions, which would negatively affect the effectiveness of the application.

[3] Notice that in this experiment, only the cue of the implementation intention is variable. A similar experiment may be designed in which the freedom to choose the action is investigated.

[4] Note that a baseline of one's game playing time will have to be determined first. This baseline can be measured by the application during an intake period, or could be derived from a pre-experiment questionnaire.

# Chapter 5

# Future Work & Conclusion

This thesis has focused on the use of assistive technology to combat the self-undermining behavior of procrastination. I have discussed the prevalence of procrastination in Section 2.1 and have shown the variety of negative effects it can have on people's lives. As I mentioned in Section 2.1, almost all procrastinators define their procrastination as unwanted behavior and are looking to change their ways. In Section 2.2 I approached procrastination from a standpoint of self-regulation failure, and discussed how by putting up volitional scaffolding in the environment, one could reduce many of the distractions and temptations that lead people to procrastinate. From the available psychological literature on the issue I discussed evidence for a promising strategy for overcoming procrastination. This strategy was discussed in Section 2.4, and consists of making concrete, environment-involving plans of a very specific 'if-then' syntactical structure, called implementation intentions. In Section 3.1 I argued in favor of using implementation intentions as volitional scaffolds, but noted a serious shortcoming of the strategy: without help people tend to either not to make implementation intentions at all, or make really ineffective ones. To deal with this shortcoming, I have suggested finding ways of assisting people with the implementation intention formation process. This concept of *assisted* intention formation is a delicate one, because the intention formation process itself is strongly related to people's sense of being autonomous agents. In order to assist this process in a way that is effective without obstructing people's autonomy, there is a need to perform extensive empirical and theoretical research on the exact relation between intentions, self-efficacy, and autonomy. To kick off this research, I have defined an initial research domain (procrastination and gaming, Section 2.3), developed the flexible research tool 'ii-app' (Chapter 3), and described a series of experiments to perform with that tool (Chapter 4).

This final chapter offers suggestions for future research. It starts with a foreshadowing of the direction that the development of the ii-app will take in Section 5.1. Then, in Section 5.2, I will give an overview of related research strands that I think are

also worth pursuing. Finally, Section 5.3 concludes this thesis with a few words on the contributions it makes.

## 5.1 Future development of the ii-app

In its current state, the feature set of the ii-app for the initial experiments as suggested in Section 4 is complete. Initial testing with the application will no doubt though uncover the wish for new features that would enhance its capabilities as a research tool. In very broad strokes, these are some of the features I myself foresee. The first is extending the different measurement methods. Currently, the ii-app can only send out reactive prompts (Section 3.4.3.2) on the basis of the time passed, whereas it might be better if the ii-app could also respond to certain in-game information. If the ii-app could poll information from a game about the user's progress (rounds played, levels progressed), it could adequately deal with more natural implementation intentions such as 'If I have advanced three levels, then I will quit the game'.

Secondly, the ii-app could be extended with other notification methods. For example, the OS X platform comes complete with a text-to-speech application, which could be used to notify (warn) the user without interrupting his game visually, while experimenting with the contents of the message (compared to just, say, the sound of an alarm).[1]

Thirdly, the ii-app could benefit from an export function for the data. Currently, all data is stored in a SQlite database, which can be queried using the default SQLite query language. Moreover, there are some excellent front-end applications available for SQLite that have export functions of their own. Ideally, though, an experimenter could export the data straight from the ii-app to applications such as IBM SPSS, R, and Microsoft Excel.

Finally, once extensive information has been gathered on what works and what doesn't, I suggest building a version of the ii-app with sensible defaults and offer it to the public for personal use.

## 5.2 Other suggestions for further research

The ii-app for regulating gaming behavior is just one possible application of the general strategy for promoting the formation of implementation intentions. Assuming that empirical research with the ii-app will confirm the effectiveness of that strategy, the next logical step is to explore the applicability of this strategy in other domains. For example, a related but separate problem is people who watch too much television. Like

[1] A frivolous, but nonetheless interesting suggestion on this topic was made by Timothy Pychyl at the 7th Biennial Conference on Procrastination in Amsterdam: use the voice of one's mother to instruct one to get back to work. Surely that would have some interesting effects!

computer game overuse, people tend to go to bed too late because they are immersed in the television shows that they are watching. Vague intentions such as 'I will go to bed soon' do not suffice for getting people to stop watching television. Making implementation intentions such as 'I will switch off the television at the next commercial break', however, should help people to go to bed on time. An application that would support people to form the implementation intentions for this domain would ideally be integrated into the television itself. A promising development in that respect is 'Google TV' (`http://www.google.com/tv/`): a smart television framework that allows software applications to be deployed on the television itself.

Another example application would be a local proxy-server that would channel all web-browsing traffic on a computer and could prompt the user to form implementation intentions about the amount of time they will spend on Facebook, slashdot, or CNN news. Just as the ii-app does not necessarily block any games, this proxy-server would not necessarily block access to particular websites, but it would help people to specify a plan about when to stop procrastinating and get back to whatever they were delaying doing.

Another way the strategy may be used is for *promoting* behavior. So far, all the aforementioned possible applications, including the ii-app, have been about making plans to stop an activity: stop gaming, stop watching television, stop updating your Facebook profile, etc. Implementation intentions, however, are just as effective for starting behavior. For example, Sheeran and Orbell have shown that implementation intentions can be used to increase attendance for cervical cancer screening (Sheeran and Orbell, 2000). Other concrete examples would be to eat more fruit, or to work out more often. With an eye on healthy lifestyle solutions, I foresee applications that implement the assisted implementation intention formation strategy to promote healthy behaviors. Device (or temptation) integration for these applications would be very difficult to achieve, however, because there is generally no temptation involved (it's new behavior, after all). Future research should therefore focus on integrating the strategy with techniques from the field of ubiquitous computing to design support systems that are context-aware[2], and so will be able to offer support at an appropriate time, in an appropriate way.

On the same note, but within a broader scope, the strategy may be employed for *replacing* bad habits (Adriaanse et al., 2009; Adriaanse, Gollwitzer, De Ridder, De Wit, and Kroese, 2011; Adriaanse, Oettingen, Gollwitzer, Hennes, De Ridder, and De Wit, 2010). Habits — routine behaviors that have been decoupled from their original goals (Wood and Neal, 2007) — are hard to break because it is automatic behavior that is triggered by critical cues in the environment. Interestingly, Adriaanse et al. have shown that by consciously specifying an alternative response to the habitual response in an implementation intention, bad (eating) habits might be overruled (Adriaanse et al.,

[2]See (Dey, Abowd, and Salber, 2001) for a good discussion of context-awareness.

2009). Here the implementation intention aims not just to stop or start behavior, but to *switch* behaviors. As many problematic behavior is of a habitual nature (smoking, drinking, poor food consumption), further research is warranted to see how the idea of assisting people to formulate effective implementation intentions can help people in their struggle with bad habits.

Finally, the empirical experiments suggested in Chapter 4 should lead to a better understanding of the relation between methods of supporting the intention formation process, and autonomy. For instance, the experiment described in Section 4.3 might demonstrate that the possibility for using self-proposed cues in implementation intentions leads to only a minor decrease in effectiveness, while it boosts people's autonomy. This kind of information is key, because as we progress from the academic research domains towards successful deployment of volitional scaffolding in the real world — be it with a version of the ii-app or through other methods in other domains — it will be even more important to build applications that take autonomy considerations into account. From this perspective I believe that the future research with the ii-app in the proposed gaming domain should lead to a general set of ethical guidelines for the development of assisted intention formation applications.

## 5.3 Contributions

This thesis makes several contributions.[3] First, it is novel work in that it describes the psychological literature on both procrastination and on implementation intentions, and brings that together with the broader philosophical work on volitional scaffolding. Secondly, it makes a contribution by exposing a severe shortcoming in the real-world strategy of using implementation intentions as a method for overcoming procrastination, and by suggesting to mend that shortcoming using assistive technology. Recognizing that this approach needs further research before it can be applied, a suitable research domain was chosen (gaming), and a new research tool was developed especially for studying assisted implementation intention formation. Lastly, it has made a considerable contribution by acknowledging the important but little understood relation between assisting the intention formation process, and the notion of autonomous agency, emphasizing that future research should shed light on this subject.

[3] Note that its contributions to the broader field of AI have already been discussed in Chapter 1.

# Appendix A

# Functional Requirements ii-app

| The system must | Implemented? | Details |
|---|---|---|
| listen for and respond to launch and termination events of other applications. | ✓ | Accomplished by observing selectors from the shared NSNotificationCenter. |
| be able to hide and unhide a given game or application. | ✓ | Implemented in methods hideApplication(pid) and unhideApplication(pid), using the NSRunningApplication API. |
| be able to send audible and visual notifications. | ✓ | Audible notifications through NSSound, visual notifications through the use of serialized interface components (.xib). Includes Visual Notification Window as well as the Feedback Window. |
| be able to elicit user input (goals, implementation intentions). | ✓ | Input through Implementation Intention Formation Window. Uses serialized interface components (.xib), initialized through makeImplementationIntention(notification) method. |

| | | |
|---|---|---|
| store preferences. | ✓ | Uses NSUserDefaults API. The Preferences Window is the interface to the preferences. Used for configuring experimental setup. |
| collect usage data. | ✓ | Data is collected in the appWillLaunch(notification) and appTerminated(notification) methods. |
| store collected data. | ✓ | Uses NSManagedObjectContext and NSPersistentStoreCoordinator to persistently store data in the Apple Core Data Framework. Relevant methods include applicationExists?(name), fetchApplication(name), applicationMonitored?(name), addApplicationUnlessExists(name, path, monitored, suggestible), addLaunchTerminationEvent(name, pid,action), fetchLaunchTerminationEvent(name, pid). |

TABLE A.1: The functional requirements for the ii-app.

# Appendix B

# Technical accomplishments

| | |
|---|---|
| Learn Objective-C syntax | ✓ |
| Learn MacRuby syntax | ✓ |
| Learn the XCode and Interface Builder interfaces | ✓ |
| Implement a status bar item | ✓ |
| Add a working menu to the status bar item and connect its items to actions | ✓ |
| Figure out how to store and retrieve user preferences (Preferences file) | ✓ |
| Design and implement User preferences window | ✓ |
| Design and implement status window | ✓ |
| Learn about Cocoa data binding and use it to bind data to the user interface | ✓ |
| Figure out how drag and drop works | ✓ |
| Verify that a dropped item is actually a proper application | ✓ |
| Find out how to receive launch and termination notifications of applications | ✓ |
| Figure out how to work with persistent data (Learn about Core Data) | ✓ |
| Design and implement data structures | ✓ |
| Design and implement user input window (II formation, pop-ups) | ✓ |

Table B.1: Technical Accomplishments.

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