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**Interfaces Homme-Machine et Théorie du Regulatory
Fit : les caractéristiques graphiques d'interfaces
Homme-Machine comme moyen d'adapter l'orientation
stratégique des utilisateurs au type de tâche**

Thérèse Dries-Tônnies

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THÈSE

Pour obtenir le grade de
Docteur

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neuropsychologie**

Présentée par Therese Dries-Tönnies

Human-Computer-Interaction

and Regulatory Focus:

**Using Graphic User-Interfaces' Characteristics to Adapt
Users' Strategic Orientation to Tasks' Framing**

Soutenue le 17.07.2015 devant le jury composé de

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[Vom Sehen anderer Tiere durchaus stark unterschiedlich], sehen wir
[Menschen] “die Welt” gleichsam doppelt strukturiert nach Form und
Farbe.

*[Conversely to other animals' seeing], we [Humans] see „the world“ dually
structured through form and color.*

Reichholf, J. H. (2011). *Der Ursprung der Schönheit: Darwins größtes Dilemma.*
Beck, München.

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Résumé

Résoudre une tâche nous met régulièrement au défi d'adopter les stratégies les plus adaptées au contexte et à la nature de celle-ci. En se basant sur la Théorie du Régulatory Focus, la présente étude propose d'utiliser certaines caractéristiques visuelles, formes et couleurs, afin d'amorcer une régulation cognitive susceptible de correspondre à des tâches demandant soit de la précision, soit de la créativité. Ainsi, une première étude identifie certaines formes et couleurs comme ayant la capacité d'activer une cognition soit de type « prevention », soit de type « promotion ». Ces résultats ont servi de base pour concevoir des interfaces graphiques amorçant de manière ciblée l'une ou l'autre de ces orientations cognitives. Il est suggéré que la concordance entre le type d'amorce (e.g., induisant une cognition « prevention ») et le type de tâche (e.g., demandant de la précision) influence positivement performance ainsi que vécu subjectif. Les résultats supportent ces hypothèses : Les participants exécutent plus correctement les tâches lorsque le type de celles-ci concorde avec l'orientation stratégique amorcée par les caractéristiques visuelles de l'interface graphique. De plus, les participants rapportent un vécu plus positif dans ces mêmes conditions. De manière générale, les résultats soulignent les avantages à utiliser le potentiel inhérent des caractéristiques visuelles afin d'optimiser une situation de résolution de tâche. Ces résultats sont considérés comme développant autant la recherche que les domaines plus appliqués.

Abstract

Task-solving situations are often challenging our ability to approach them in the most adapted state of mind. Building on regulatory focus theory, we propose to use specific color and form characteristics to prime cognitive regulations that are likely to match either creative or accuracy framed tasks. In that line, a first study identified color and form characteristics as being involved in activating either a vigilant prevention cognition or a flexible promotion cognition. These findings were then used to visually design creative or accuracy oriented tasks. It was expected that a fit between the strategic orientations induced by these designs and tasks accuracy or creativity framing, would positively influence both performance and overall subjective experience. Experimental results supported these predictions: Participants performed better when the visual design was composed of colors and forms inducing a regulatory orientation matching tasks' natures. Regulatory fit had also a global positive impact on subjective variables like fun and satisfaction. Overall, the results point out the advantage of taking benefit from visual characteristics' inherent priming potential. Our research can be related both to research domains (RFT, user experience research, color research) and to concrete applications in actual design processes.

1 Introduction

Most of us have experienced the feeling of not being in the right state of mind to solve a specific task: “I am not able to focus on details right now” or “I can’t be innovative at the press of a button” would certainly be what crosses our mind in these particular moments.

This creativity/accuracy dilemma is a well-known issue in work-contexts: Each attribute is globally seen as positive and is considered worth to be supported. Creativity is often seen as a motor for innovation (Gumusluoglu & Ilsev, 2009; Sternberg, 1999) while accuracy is supposed to simplify solving of complicated problems (Hoffman & Spatariu, 2008; Schoenfeld, 1985). In that line, lots of methods and strategies are created and used to support people in thinking more creatively (e.g., brain-storming sessions, design-thinking methods, workplace decoration, etc) or working more accurately (e.g., proofreading, changing a documents format, defining rules, frames, etc.). However, it is also commonly admitted that these two orientations are conflictive: One can hardly be creative if constrained by rules, limitations or pre-established procedures. On the reverse, it is necessarily difficult to be accurate when applying creative and flexible thinking which per definition results in novel, non-standardized and non-tested solutions. Some task-solving situations especially benefit from being handled with creative strategies (e.g., researching, interpreting data, etc) while others would be better supported by accuracy oriented strategies (e.g., detecting incidents, controlling sensitive procedures, etc). Obviously, a mismatch between people’s strategic orientation and tasks’ specificities is likely to impair the quality of solving process (e.g., overlooking of information, difficulty to generate novel solutions, etc.). Thus, favoring this kind of match seems to be a promising approach to support people in task-solving situations.

The present dissertation addresses this specific issue by exploring possibilities to match people’s state of mind to tasks’ natures. Research and experimentation will focus on digitally supported task-solving and build on the regulatory focus theory framework (RFT; Higgins, Shah, & Friedman, 1997; Higgins, 2002a) which comprehends attitude, behavior or task-solving in dependence of people’s motivational orientation.

Concretely, chapter 1 is presenting Regulatory Focus Theory as well as its principles and implications. We will also present an overview of studies which will be used as base for our research. In fact, different researches point out that implicit cues such as stimuli's color or form can impact people's cognition. These effects could be explained by RFT principles. In that line, chapter 2 experimentally explores if color and form cues influence people's regulatory orientation. As we target an application in the context of digitally handled task-solving, chapter 3 proposes to identify if some simple digitally-mediate tasks would benefit either from creative or from accuracy-focused strategies. Finally, chapter 4 explores the benefit of using visual cues such as colors and forms to favor strategies which are consistent with tasks' creative or accuracy nature. Chapter 5 gives an overview of our findings and their implication in research contexts and for concrete applications.

Overall, a targeted activation of specific regulatory orientations is proposed to favor a fit between solving processes and tasks' natures. Thus, the main goal of this research is to investigate solutions to support a task-adapted solving approach of digitally mediated tasks.

2 Chapter 1 – State of the Art

2.1 Digitalization of everyday task-solving

The research presented in this dissertation will focus on digitally supported task-solving. Our daily life is more and more dependent on software based systems. For instance, 82% of German citizens over 10 years are using computer devices nearly every day¹. Furthermore, the growing part of mobile smart devices (e.g., tablets, smartphones) contributes to increase people's everyday usage of these technologies: While people used to depend on fix computers (e.g., home, workplace), mobile devices enable people to handle tasks in novel locations and different time-slots (e.g., during travelling, in public transportation, in waiting rooms, etc.). As a consequence, the type of tasks carried out using digital technologies has evolved: It is nowadays quite common to be supported by software solutions in daily actions such as writing, communicating (e.g., emailing, chatting) or researching. Some domains even migrate to become online-only services (e.g., banking, phone-provider, etc). Regarding work-contexts, it also appears that a predominant part of companies are using digital technologies on a daily base. For example, 64% of employees in German companies are using computers on a regular base on their work-place ¹. Finally, novel devices tend to host numerous independent applications which are often released by different companies. These multiple contexts, different standards and various usages, contribute to make tasks-solving situations highly heterogeneous.

Devices' interfaces (User Interfaces or "UI") are traditionally considered as a crucial point since interactions' quality highly depends on it. In fact, UI are supposed to meet high usability standards in order to support users by presenting sufficient and relevant information. With technological development and systems' growing complexity, UI visual designs are also expected to be aesthetic and pleasant. It is commonly accepted that this aesthetic value is not only a decorative accessory since it probably influences people's interaction with the system. The exact nature of that influence is, however, still far from being completely understood. Some authors (Lavie & Tractinsky, 2004; Tractinsky, Katz, & Ikar, 2000; Tractinsky, 2005) precociously supported a linear

¹ Statistics are available on German Federal Statistical office (Destatis): <https://www.destatis.de/DE/Publikationen>.

relationship that made aesthetics a direct determinant of usability (“What is beautiful is usable”). While this thesis shows convincing results, the underlying principles and processes still need more throughout exploring. The present research aims to approach that issue from a different angle: Our goal is to demonstrate that rather than a global aesthetic value, influences on performance can be imputed to concrete visual characteristics. Thus, our study particularly focuses on the usage of visual cues composing graphical user interfaces since they seem especially suitable in the mostly visually mediated context of computer based task-solving. We hypothesize that the targeted usage of these visual characteristics can improve solving processes and positively impact people’s subjective experience.

2.2 Regulatory Focus Theory

2.2.1 Principles and motivational orientation

Regulatory focus theory has been first presented by Higgins as being a motivational theory which models the relation between a person’s current goals and the strategic decisions he will make in order to accomplish these goals. In fact, every situation is characterized by the pursued goal’s nature, one’s specific strategic orientation and the means actually used to ensure a successful outcome. Individual’s strategic orientation can be defined by his/her natural tendency to prefer one way to accomplish the goal over some other options. Furthermore, a specific goal’s characteristics can make it simpler to be fulfilled using specific means. Two main regulatory foci (or regulatory orientations) are presented in Higgins’ work (Förster, Grant, Idson, & Higgins, 2001; Higgins, 1997, 2002). Each of them is characterized by specific cognitive strategies meant to face the situational setting.

2.2.1.1 Promotion Focus

Promotion focus can be compared to the approach tendency earlier described in literature (Elliot & Covington, 2001; Förster et al., 2001). This orientation is mainly characterized by the pursuit of growing, development, progress and gain. Effort is engaged and mobilized to increase chances to succeed by generating alternatives and novel solutions (i.e., creativity processes), multiplying attempts and solving proposals, trying not-yet tested and/or risky options. Promotion focus is thus sustained by an

increased ability in linking and associating information in order to generate new meanings. Moreover, high cognitive flexibility promotes changes regarding strategies and supports the adaptation characterizing this modus (for a deeper understanding see Friedman & Förster, 2001).

2.2.1.2 Prevention Focus

Regarding the prevention focus, it can be compared to an avoidance tendency and is mostly focused on preventing negative outcomes or diminishing risk of failure (Elliot & Covington, 2001; Förster et al., 2001). To do so, behavior will be characterized by an enhanced vigilance and reutilization of reliable or familiar strategies. Individuals in a prevention modus are particularly sensitive to security, safety or health issues and are more generally focused on maintaining the current situation, rather than taking the risk of worsening it. This modus is characterized by endurance and increased attention to situational relevant details which also leads to enhanced accuracy and memorization performances. In contrast to the promotion focus, prevention focus consists in applying well-known methods or behavioral patterns even if those ones do not lead to optimal results or solutions, the focus being more centered on maintenance than on progress.

2.2.2 Chronic and situational induced focus

People's personal history of success or failure regarding vigilant or eager strategies increases the use of those turning out to be reliable. This preference to apply either promotion or prevention oriented strategies becomes an individual trait referred to as his/her chronic focus. Nonetheless, external cues can temporarily induce a specific focus (i.e., situational focus) which temporarily overrides one's chronic tendency (Higgins & Silberman, 1998). This situational focus only lasts for a brief moment and does not differ from the way individuals' respective chronic focus usually intervenes.

Depending on the context, one's strategic choices can be more or less fitting: If some situational settings have the potential to sustain a specific orientation, a disrupting effect may occur when cues do not correspond to this orientation (Camacho, Higgins, & Luger, 2003; Cesario, Higgins, & Scholer, 2008; Higgins, 2000, 2002). In other words, situational elements and cues inducing or favoring specific strategies can point in the same direction than one's current regulatory focus. Conversely, a context

sustaining unfitting strategies will lead to a misfit between focus and means. For example, a promotion focus will match tasks demanding creativity, whereas the same kind of task would mismatch a prevention orientation which is characterized by reutilization of familiar solutions.

2.2.3 Regulatory Fit

The match between situational characteristics and applied strategies generates what is called a regulatory fit situation. Conversely, a mismatch between people's strategies and situation's characteristics is called a regulatory non-fit. This specific phenomenon has been shown to influence variables directly related to task solving like efficiency and performance (Cesario, Plaks, & Higgins, 2006; Elliot, Maier, Moller, Friedman, & Meinhardt, 2007; Freitas & Higgins, 2002; Higgins, 2005; Mehta & Zhu, 2009), but also other aspects such as satisfaction, value attribution, willingness to repeat the task or engagement in the action (Cesario et al., 2008; Higgins, Idson, Freitas, Spiegel, & Molden, 2003; Higgins, 2006).

As presented above, regulatory fit depends both on people's current orientation and on situation's or task's framing. As a consequence, there are two different ways to facilitate a fit situation: One consists in adjusting the situational framing so it sustains a specific focus, while the second one requires to temporarily induce the strategic orientation that is adapted to the given situation.

2.2.4 Adjusting the Frame.

The first method used to induce a fit situation consists in adjusting the situational framing to a specific regulatory focus. The nature of the task is an important aspect to consider since it determines which strategies are especially fitting to face the situation. Concretely, promotion focused individuals would benefit from tasks oriented on creativity and flexibility. Conversely, prevention oriented individuals would be comfortable in solving tasks demanding accuracy, memorization and detail-oriented attention. Furthermore, framing depends on the situational alignment which consists

in highlighted promotion or prevention oriented information or aspects. Precisely, a same task can be presented either in terms of a promotion orientation or in terms of a prevention orientation. Indeed, the instructions provided can insist on giving as much correct answers as possible (i.e., promotion alignment) or, conversely, on giving the less wrong answers as possible (i.e., prevention alignment). Note that a situation alignment is not limited to this kind of verbal framing, since it can also be mediated through visual information as we will see later in a next section.

2.2.5 Priming a Focus.

The second method to create a fit-situation consists in inducing the regulatory orientation likely to match the situational framing. This can be achieved by activating (i.e., priming) topics relevant for a specific regulatory orientation (e.g., safety-issues for a prevention focus, progress-issues for a promotion focus). Because the present overview is particularly interested in the mechanisms involved in motivation adaptation, a basic understanding of the priming effect is necessary.

Priming is known as an implicit memory phenomenon in which the exposure to an initial stimulus (i.e., prime) influences processing of a second one (i.e., target). Basically, a prime will activate some memory-contents following the network-spreading principle so that concepts will see their activation-potential increased depending on how closely related they are to the prime (e.g., Collins & Loftus, 1975). The target then benefits from top-down processing which interacts with bottom-up processing during the perception procedure. This interaction has been shown to affect recognition, interpretation, memorizing as well as decision-making and can be measured through behavior, processing-speed or performance. Whereas classically used to facilitate (or hinder) processing, priming can also be used to activate a specific state of mind, an affective state or a behavior (Förster, Liberman, & Friedman, 2007). Note that a prime can be either internal (i.e., thoughts, auto-generated stimuli) or external (i.e., concrete, perceptible stimuli). Priming a specific regulatory tendency follows the same principles: a prime (e.g., instruction to concentrate on one's failures or successes) activates constructs related to safety or progress issues, making these memory-contents likely to influence information-processing involved in perception (e.g., target).

Most studies using regulatory focus induction are based on verbal instructions presented either independently (i.e., incidental activation) or integrated in the main task (Cesario et al., 2008). For example, participants are specifically instructed to generate strategies which could either enhance chances to avoid some difficulties or, on the reverse, to achieve some goals (Freitas, Azizian, Travers, & Berry, 2005). This procedure pre-activates constructs closely related to safety or progress issues and induces participants in a state of vigilance and error-avoidance, or in a state of eagerness and gain-orientation.

Yet, the use of verbal instructions is not the only method available to prime a motivational orientation. It is already accepted that non-verbal stimuli can also activate the associative network of related constructs. Compared to verbal stimuli, the benefit of this kind of prime relies on the fact that conscious processing is not required to integrate the initial input. Indeed, purely perceptual processing mostly happens unconsciously and has therefore a smaller impact on cognitive resources than verbal processing. Especially, visual elements seem to have the potential to be processed very quickly while transporting (and activating) a large amount of related constructs. Visual information constitutes a fundamental cue to evaluate whether a situation or element somehow represents a danger or not. In other words, the evaluation of visual information is essential regarding regulatory focus since the choice of adopting an avoidance tendency or an approach tendency depends on it (Elliot & Covington, 2001).

To sum up, both methods used to induce a fit situation (i.e., framing versus focus adaptation) can be mediated by either verbal or non-verbal cues. In the next section, we will focus on the latter since non-verbal cues were rarely examined despite the fact that they mostly benefit from unconscious processing. If we consider that those unconsciously-processed perceptual cues (e.g., visual cues) can be particularly relevant for an approach or an avoidance tendency, highlighting them would sustain the corresponding regulatory orientation. In addition, the question is to know whether these unconsciously-processed cues can influence individual's regulatory focus by activating a state of vigilance or eagerness. In the following section, the characteristics susceptible to be related to progress or safety issues will be described. Especially, we will try to determine which orientation is concerned by these cues and if they are likely to not only sustain but also prime a specific orientation.

2.2.6 Verbal vs. nonverbal Priming

Classically, two kinds of priming are used in RF researches: Verbal priming that is unrelated to the task itself on one hand, and verbal priming that is integrated in the task on the other hand. The first method is based on tasks that are presented before starting the main tasks in order to prime participants in the relevant motivational orientation. Participants are asked to generate ideas that are either related to promotion strategies or to prevention strategies, independently of their chronic tendency. For example, some authors made participants write down three strategies for either “attaining good grades” (promotion condition) or “avoiding bad grades” (prevention condition) (Freitas et al., 2005). To maintain the motivation manipulation, at apparently random intervals during the evaluation phase of the experiment, participants were prompted to write six additional strategies, three pertaining either to “attaining good health,” (in the approach condition) or to “avoiding bad health” (in the avoid condition), and three pertaining either to “attaining financial success” (in the approach condition) or to “avoiding financial failure” (in the avoidance condition). Participants wrote each strategy on provided paper and then pressed a key to continue the evaluation task.

The second method is based on integrating the priming material directly in target-task. More precisely, instructions or messages involved in the actual task are framed in a way to use promotion (e.g., gaining energy, satisfaction, happiness) or prevention (e.g., preventing diseases, increasing health) relevant vocabulary: For example, Cesario, Grant, and Higgins, (2004) investigated message-persuasion. Participants were presented either with a message version that emphasized increased energy and general fulfillment (i.e., “*A diet rich in essential nutrients, like those found in fruits and vegetables, has direct effects on the biochemistry of the brain, resulting in increased energy, better moods, and a general sense of happiness and fulfillment.*”) or with a message version that highlighted possible protection from harmful daily elements (i.e., “*Eating fruits and vegetables supplies the body with the nutrients it needs, enabling the body to produce substances from within which buffer it from the physical demands of the world we live in, like pollution, daily stress, bad weather, etc.*”) While globally rarely used, some non-verbal primes have also been explored.

2.3 Implicit cues and Regulatory Focus

We choose to explore implicit factors in the framework of regulatory focus theory. A throughout research in relevant literature allowed us to compile different implicit cues that can be related to factors relevant for RFT. The selected cues are suggested to share associations either to prevention relevant ideas and concepts like vigilance, error, risks; or, on the contrary, to promotion relevant ones like progress, development, harmfulness. The following overview presents these cues as well as literature supporting our hypotheses about their respective potential to induce promotion or prevention orientations.

2.3.1 Shape

Form is a characteristic which is processed in the very first moments of perception process. Today, it is well admitted that objects' shape is handled as a primordial cue involved in building judgments and preferences (Bar & Neta, 2006, 2007). It also appears that sharpness respectively roundness is what mainly distinguishes forms in terms of implications. For instance, Bar and Neta (2006), compared pairs of visual items which only differ in their shape, one being sharp-angled, the other one being round. Stimuli included real items (e.g., a watch, a sofa, a pan) as well as abstract and meaningless patterns. Participants liking-judgments demonstrated that curved items, real and abstract ones, were preferred over their edgy counterparts. The authors suggested that underlying associations with danger respectively harmlessness can explain this phenomenon: Edgy forms and shapes would unconsciously be perceived as threatening and activate a state of vigilance adapted to face the potentially critical situation. Furthermore, these same stimuli would be rated as negative since they may represent a source of trouble. On the opposite, rounder shapes would be spontaneously associated with harmlessness and therefore be rated more positively.

In a second study, Bar and Neta (2007) reinforced that assumption by demonstrating a correlation between stimuli's sharpness and amygdale-activation, this brain region being known for its implication in fear processing (Adolphs et al., 1999; Whalen,

1998). For instance, the authors used functional magnetic resonance imaging to compare amygdala-activation when participants were presented either with sharp-contoured or with round stimuli (real objects and abstract patterns). The results showed a significant higher activation-level of the amygdala for sharp contoured stimuli compared to the round ones.

These studies point out the fact that the shape of stimuli is everything but trivial since it is considered as informing individuals about their potential dangerousness. The question about harmful- respectively harmless is also an essential aspect within the regulatory focus theory, especially concerning a security-focused prevention orientation. Accordingly, we assume that this theory would be an appropriate framework to interpret the results just described: If a stimulus is categorized as threatening (versus harmless) because of its shape, that does not mean this shape is negatively perceived by nature since its evaluation may depend on individuals' focus. We hypothesize that sharp-edged contours would be rated as negative only by prevention oriented individuals since this characteristic transmits a potential threat for the positive outcome of their loss-prevention strategy. Concerning the rounder counterparts, they signal the absence of harm and would therefore be much more valorized by prevention oriented individuals compared to promotion oriented ones.

The results of the studies previously mentioned (Bar & Neta, 2006, 2007) seemed to show converging evaluation of round versus edgy shapes. Based on the idea that it is unlikely that all the participants presented the same chronic modus, this obvious equal sensitivity to safety aspects could be explained by a situational induced prevention focus. In other words, stimuli's shape being highly safety-relevant, it probably activates the danger-sensitive prevention modus regardless individuals' chronic focus. Further explorations of this idea should deepen this issue by comparing participants' situational focus when presented with round and sharp-edged stimuli.

2.3.2 Colors

Explored in a large field of disciplines, stimuli's color has been shown to massively influence information processing. Indeed, this highly dominant visual characteristic is extracted automatically during the very first moments of its presentation and is

involved in top-down as well as in bottom-up processes. More precisely, some colors are commonly associated with preexistent semantic or conceptual knowledge which basically comes from learning and cultural habituation. That linkage can be about concrete objects predominantly characterized by a specific color (e.g., a banana is usually linked to yellow while a mouse is usually associated to grey) or concerning more abstract concepts like danger (red), temperature (orange and red for heat, blue for cold), liberty (white) and nature (green). This kind of associations suggests that color can be a relevant aspect in terms of safety or progress issues.

A first set of studies clearly demonstrating this kind of connection has been performed by Mehta and Zhu (2009) who compared results when combining task's nature (i.e., creativity, accuracy) and background color (i.e., blue, red). The authors expected that these two colors would induce alternative motivation foci because of their widely shared association with promotion and prevention relevant aspects. More precisely, colors mainly conjuring the idea of danger and the risk of mistakes (in this case red) would activate a state of vigilance (i.e., avoidance) adapted to face the threatening situation (see also Elliot et al., 2007). Conversely, colors bringing up associations to security and progress (in this case blue) would activate an approach tendency. To test this hypothesis, both colors of interest were included as backgrounds in tasks known to benefit from a specific orientation: Facilitation (versus hindering) would then translate a fit (respectively a non-fit) with the orientation induced by the color. Four independent studies supported this hypothesis: A first experiment demonstrated that a matching setting (i.e., blue + promotion oriented target; red + prevention oriented target) enhanced brand-preference and anagram solving-performance compared to a mismatching setting (i.e., blue + prevention oriented target; red + promotion oriented target). Two additional studies showed that creative tasks (versus detail-oriented tasks) benefit from a promotion-inducing blue background (respectively prevention-inducing red background). A final experiment demonstrated that an ad's persuasiveness can be enhanced when the kind of product-characteristics pictured on the poster match the focus triggered by the background color: The authors showed that participants rated ads as being especially persuasive when functional information was presented on a red colored background and when hedonic information was presented on a blue colored background. To sum up, the authors demonstrated that

two colors unrelated to the task can induce specific motivational orientations because of their implicit associations to safety or progress issues.

Regarding those results and in line with these authors (Mehta & Zhu, 2009), we argue that similar effects may underlie findings in other studies about colors and are likely to explain the various discrepancies in this research domain. Especially, the combination of color-induced focus and task's nature (i.e., detail or creativity oriented) should be taken into account since it conditions the occurrence of the regulatory fit effect and, as a consequence, participants' performance. However, this crucial factor was rarely controlled and interpretations were limited on a color-inherent facilitating or hindering effect. We assume that numerous color-studies would benefit from being interpreted within the regulatory focus theory framework. For example, Skinner (2001) compared performance when participants executed a multiple-choice test printed on different colored papers (i.e., blue, green, red, yellow, white). The results revealed lower scores in the blue and green conditions than in the other ones. The methodology was replicated by Tal, Akers, and Hodge (2008) and led to identical results. However, converse effects were observed in studies performed by Elliot and colleagues (Elliot et al., 2007) who demonstrated in four independent experiments how the red color impairs performance. The authors included colored stimuli (i.e., colored ink used for numbering or colored flyleaves) in one anagram and three association tests. The results showed systematically lower performance in the red condition compared to the green or achromatic (white, grey and black) conditions.

With respect to the regulatory fit theory, these results can be interpreted in terms of fit versus non-fit effects. Multi-choice tests like those used by Skinner (2001) and Tal et al. (2008) would definitely benefit from an accuracy oriented focus whereas association or anagram test-solving like those used by Elliot et al., (2007) requires flexible and creative processing. In view of that, Skinner (2001)'s and Tal et al. (2008)'s multi-choice results could come from a non-fit situation between the characteristics of the task and the modus induced by the presented color (i.e., green, blue). As for anagram and association test-solving, a non-fit effect probably occurs when combined to the prevention modus induced by red color.

To summarize, color is assumed to implicitly transmit hints about the situation in terms of safety aspects or progress potential. Thus, we hypothesize that this

characteristic deserves to be considered as a relevant cue to align a situational framing either in a promotion orientation (e.g., using blue colored elements) or in a prevention orientation (e.g., using red colored elements). Furthermore, the results presented in this section strongly suggest that color is also able to induce individuals in a specific regulatory orientation.

2.3.3 Familiarity

Familiarity is a complex phenomenon which basically describes a feeling of “knowing” the stimulus of interest. As a matter of fact, familiarity usually results from repeated exposures but has also been observed for stimuli characterized by a high degree of prototypicality or processing fluency. Coming along with familiarity, the widely accepted mere-exposure effect (Zajonc, 1968) establishes how familiar stimuli are preferred over new ones. This phenomenon is based on primary safety issues: Familiarity presumes previous exposures which obviously have not turned out in one’s disadvantage (following the principle “it has not killed me yet”). As a consequence, known stimuli are spontaneously valorized whereas the ones considered as being new, are not. The latter would indeed be associated to potential threat as they have not yet proven to be harmless.

A recent study pointed out that familiarity is not systematically perceived as a positive aspect. Indeed, some authors (de Vries, Holland, Chenier, Starr, & Winkielman, 2010) demonstrated that the familiarity of a stimulus only matters when participants are receptive to safety issues. Following the assumption that a good mood signals a safe environment and that a bad mood signals an unsafe environment (more details will be reported in the section about Affective state), the authors compared how appealing familiarity is rated in both conditions. More precisely, they used the dot-pattern paradigm (Posner, Goldsmith, Welton, & Kenneth, 1967) which opposes a prototype-pattern composed of nine points randomly placed in a grid, to patterns differing slightly in their composition, referred to as category-members. Their studies consistently showed that the prototype-patterns are considered as highly familiar compared to category-members. In De Vries et al. (2010)’s study, participants were primed either on a positive or on a negative mood before rating the prototype- and

member-patterns. Despite their high assimilation to familiarity, the prototype-patterns failed to generate systematic preference. Precisely, ratings as well as Zygomaticus EMG measurements demonstrated that participants valorized familiarity exclusively when their negative mood signaled an unsafe environment. Conversely, in the context of safe environment coming along with a positive mood, familiarity “loses its warm glow”.

Based on the regulatory focus theory, we assume that familiarity, whether objective or not, becomes relevant only when individuals are in a vigilant, safety-focused orientation. In other words, a prevention orientation individual should be particularly sensitive to security aspects and thus to familiarity, and would valorize such factors sustaining a positive outcome. On the opposite, these aspects will not become salient in a progress-oriented promotion focus since they are not relevant in a context already categorized as safe. Further explorations of familiarity effects should test this hypothesis by systematically controlling or manipulating participants’ regulatory focus.

2.3.4 Processing fluency

In line with familiarity, we also expect processing fluency (i.e., ease of stimulus integration) to be a relevant factor for motivational regulation. For instance, processing fluency has been related to safety issues because of an attribution error about its origin: Easiness being associated to experience and habituation, high processing fluency is thought to result from a previous exposure to this same stimulus. In line with the mere-exposure effect (see section *Familiarity*), high processing fluency is categorized as being harmless and consequently is rated as positive (Reber, Schwarz, & Winkielman, 2004).

Freitas et al. (2005) further explored this phenomenon and established that processing fluency’s valorization depends on individual’s current receptiveness to security relevant aspects. Participants in a situational promotion or prevention focus had to express their preference about images more or less fluent. Images’ fluency was manipulated by preceding their presentation by pictures which contours matched or mismatched the actual stimuli. Matching contours were expected to enhance

processing easiness (i.e., high processing fluency) whereas mismatching ones were expected to hinder it (i.e., low processing fluency). The results showed that prevention-focused individuals preferred stimuli easier to process over less fluent ones. However, no difference in preference-ratings was observed in the promotion-oriented group. These findings demonstrate that processing fluency has to be considered as a relevant aspect when individuals are in a security-oriented prevention focus. Signaling harmlessness, fluently processed stimuli are valorized since they sustain the current avoidance orientation. Conversely, differences in processing easiness do not become noticeable for challenge-oriented individuals (i.e., promotion orientation).

Another study suggested that processing fluency can even induce a specific regulatory orientation. Song and Schwarz (2008) explored how processing fluency can impact the “Moses illusion”. When asked “How many animals of each kind did Moses take on the Ark?” people usually respond “Two” despite knowing that Noah rather than Moses was the biblical actor. The authors varied processing fluency by altering question’s print condition (i.e., less legible corresponding to low processing fluency). Results demonstrated that people did detect more often the misleading nature of the question when processing fluency was low.

Remember that it is now commonly accepted that prevention oriented individuals are focused on accuracy and details whereas promotion ones tend to see the situation (or task) more globally and spontaneously (see section about regulatory focus). Combining these principles with the fact that processing fluency is relevant for safety issues, we argue that low fluency, categorized as a hint for potential threat, becomes salient and activates a state of vigilance (i.e., prevention focus) independently from the initial orientation. Individuals exposed to low processing fluency would therefore be in a detail-oriented prevention modus which facilitates error identification. High processing fluency, on the other side, is assumed to have no effect on motivational regulation. Further studies should test these assumptions by varying stimuli’s processing fluency and by controlling the associated regulatory focus.

2.3.5 Affective state

As we already argued in the previous section (*Processing fluency*), information-processing is not limited to sensorial input (e.g., stimuli's physical characteristics, familiarity) since information about individual's own cognitive or affective state is also likely to be integrated. As a matter of fact, a specific internal state can be integrated similarly to classic sensorial information since it is seen as a result from one's own adaptation to the current situation (Clore, Schwarz, & Conway, 1994; Schwarz & Clore, 2003, 1983, 2007) : A globally positive affective state would be attributed to an overall "good" situation (e.g., safe, satisfying, manageable) whereas a negative state would be interpreted as being caused by "something wrong" about the situation.

Kramer and Yoon (2006) demonstrated that avoidance and approach oriented individuals use their internal input differently depending on its valence. Individuals in an approach modus are known to frequently monitor their internal state, whereas those in an avoidance orientation mostly focus on external input. They only become aware of internal information when it deviates notably from their chronic affective valence. Furthermore, avoidance oriented individuals report globally more negative feelings than positive ones (Dillard & Anderson, 2004; Gable, Reis, & Elliot, 2000). For that reason, the authors hypothesized that only "unusual" positive feelings would become enough salient to be integrated into information-processing. Conversely, approach oriented individuals were expected to integrate both positive and negative feelings during information processing. Two studies confirmed this hypothesis. In a first experiment, participants were grouped depending on their chronic motivational orientation (i.e., approach or avoidance). One half of each group was primed respectively on a positive or a negative state of mind. Then, participants were asked to express their appraisal about presented products. The results showed that individuals chronically using approach strategies (i.e., approach orientation), integrated both positive and negative internal input in their judgment. On the contrary, avoidance-oriented individuals integrated exclusively positive internal input. The second study was designed in the same way concerning the affect-priming phase, the products used and the rating phase, but this time participants were experimentally primed on a specific motivational focus (i.e., situational focus) instead of being grouped in dependence of their chronic tendency. Results were identical to the first study:

Avoidance-primed participants integrated exclusively positive internal feeling in their judgment whereas approach-primed participants integrated both positive and negative feelings. These results confirmed that people's motivational orientation, situationally induced or chronic, determines which kind of internal input becomes enough salient to integrate information processing.

We assume that these effects based on the approach/avoidance theory could be replicated within the regulatory focus theory (see Förster et al., 2001, for a better understanding about the junction between these two motivation-theories). Accordingly, we expect that one's affective state should be especially relevant for promotion oriented individuals, regardless of its valence. As for prevention focused individuals, they would globally be little receptive for internal input, unless it notably differs from their chronic affective valence (i.e., negative) and thus becomes salient.

This topic will be further developed in the following section since different studies point out that receptiveness to specific aspects (and therefore their influence) depends on individual's current regulatory orientation. Those findings also suggest that aspects usually not relevant in the current motivational orientation can move into individuals focus when they become particularly salient. The following discussion will *inter alia* deepen implications of receptiveness and stimuli's salience.

2.4 Cues activation potential

The previous sections enlist different aspects identified as being likely to matter for a progress or a safety focused orientation. As previously mentioned, shape is a relevant aspect for safety issues since contours' sharpness can be implicitly associated with threat. Color has also been shown to be highly associated either with safety or progress issues. As we already stated, the red color seems to be associated to danger (prevention) and the blue color to progress (promotion), these associations making each color respectively relevant for one specific focus. As for familiarity (versus novelty), it seems relevant for a safety orientation because highly correlated to harmlessness (versus threat). Processing fluency is also relevant for safety issues as it is associated with familiarity and consequently with harmlessness. Finally, one's

affective state is relevant for both promotion and prevention oriented individuals since it is integrated differently depending on its valence.

In sum, we assume that depending on their current motivational orientation, individuals would be particularly sensitive to contextual cues conveying information matching this focus. We especially examine non-verbal aspects since they remain rarely explored regardless of the fact that they constitute a frequently used source of information. Consequently, our overview puts forward a new framework to interpret existent studies but should also give rise to further fundamental and applied exploration. Specifically, we propose that the effects we pointed out should be taken into account in areas mainly based on visual communication: Our everyday context being more and more dominated by visual media (e.g., internet, television, smart phones), it seems essential to gain a deeper understanding of how specific characteristics interact with our motivational system. Regulatory focus theory would then become, from our point of view, an adapted framework to build on.

2.5 The current proposal

The previous sections expose the context that motivates the present research (1) as well as the theoretical fundamentals grounding its realization (2). First (1), technological development involves a growing usage of graphical user interfaces to control systems, solve task and handle machines. However, the impact of visual elements -which are necessarily part of this kind of interactive environment-, is still not fully understood: While it is commonly admitted that interfaces' aesthetical value somehow influences cognition (Tractinsky et al., 2000), no research has yet established an objective link between UI's visual characteristics and people's information processing, understanding and resulting behaviors. As these factors are crucial to lead task-solving situations to successful outcomes, we propose to address this issue by a throughout investigation of visual characteristics' impact on people's task handling. The second point highlighted in the first chapter (2) is the fact that a specific theoretical framework, regulatory focus theory (Higgins, 1997, 1998), seems especially suitable to be applied in the context of the present research. In fact, regulatory focus has been used to understand and predict choices, behaviors and

performance (Cesario et al., 2008; Förster, Higgins, & Idson, 1998; Liberman, Idson, Camacho, & Higgins, 1999). Furthermore, regulatory orientations have been demonstrated to be influenced by subtle and unconsciously processed cues (see section Chronic and situational induced focus). As a consequence, regulatory focus framework will be used in the present research to a) understand principles underlying visual elements' influence on people' cognition and b) control subjective experience, behavior and performance related effects associated to these visual cues.

To be more precise, we expect visual cues to impact cognitive regulation and thus the likelihood that people handling task-solving situations in a way that is most adapted to that specific context. Depending on these specificities, we hypothesize factors related to information sensitivity, understanding, decision taking or behavioral responses to either support or hinder successful and satisfying situation handling.

In that line, the present work is composed of three experimental parts which aim to provide responses regarding the issues listed above. The first one (chapter 2) proposes to identify and categorize visual characteristics having potential to act on people's regulatory orientation. We investigate through qualitative testing visual characteristics that have potential to influence people's regulatory focus (i.e., color, form). Then, an anagram solving experiment provides a base to classify these characteristics regarding their ability to induce either a promotion or a prevention focus. These findings also constitute the basis for further experimental phases (chapter 3 and chapter 4).

As the main purpose of this research is to propose guidelines for combining regulatory orientations to tasks that will benefit from that specific strategic orientation, our second experimental part (chapter 3) proposes to identify criterions to categorize tasks on their prevention or promotion framing. More precisely, a throughout review of relevant literature allowed us to selected some criterions expected to categorize tasks' framing. Using some every-day computer tasks selected from requiring either promotion or prevention strategies, the criterions were tested about their accuracy to reveal these tasks' framing. Overall, this chapter provides criterions to categorize tasks regarding their framing. In addition, some tasks are selected in order to be used in the third experimental part (chapter 4).

The third experimental section (chapter 4) builds on the findings collected in the first two parts (chapter 1 and chapter 2) and explores the feasibility and benefits of using visual cues to influence cognitive regulation in the applied domain of user interface mediated task solving. More precisely, specifically framed tasks are combined to graphical designs using visual characteristics identified in chapter 2. Depending on tasks' framing, that visual design is expected to favor or to hinder adapted solving strategies. Overall, this last part demonstrates the influence of regulatory fit or non-fit in actual task-handling situations.

Finally, the last part (chapter 5) gives an overview of the different results and discusses findings regarding their applicability in ecological contexts, related benefits and limitations. Figure 1 is presenting an overview of the different parts constituting the present research.

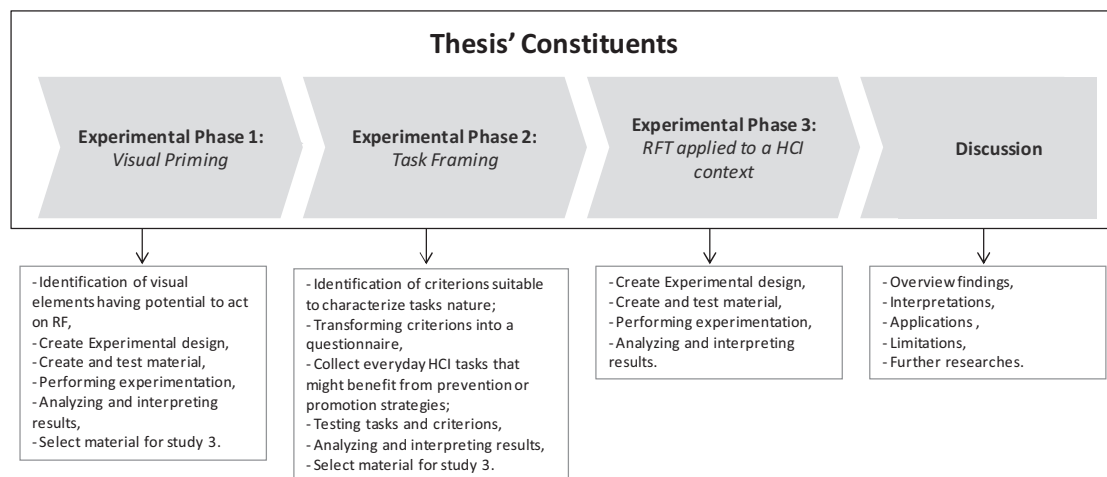


Figure 1: Overview and details about thesis' experimental groundings and constituents.

3 Chapter 2 - Exploring Visual Characteristics

The next sections will investigate more thoroughly if specific color and form items can be associated to unique and measurable effects on people's cognitive regulation. First, a preliminary study will use qualitative methods to determine which items (i.e., specific colors or forms like red or round forms) have associations relevant for promotion or prevention regulations and thus would be used in the main study. The latter is splitted in two parts: The first one (Study 1a) tests color items on their potential to activate either promotion or prevention regulations while the second study (Study 1b) tests these factors in relation to form items. Both studies have identical procedures but were performed separately.

3.1 Preliminary study 1: Categorizing form and color elements

Based on literature review reported in Chapter 1 | Implicit Cues and RF, visual characteristics like color and form are expected to influence people's regulatory orientation. Depending on the ideas or concepts especially linked to specific color or form items, they can be categorized as promotion or prevention activating. For example, items linked to safety or security ideas can be hypothesized to induce individuals in a vigilant prevention focus. Conversely, other items can be associated to progress and development concepts and are thus expected to prime a progress oriented promotion focus. The present preliminary study aimed to assess concepts or ideas that are associated to specific items. Those would then be associated in dependency with these associations.

3.1.1 Methods

3.1.1.1 Participants

Twelve participants took part in this preliminary study (two females, 10 males). Their age ranged from 24 to 37 (mean age = 28.3, SD = 1.9).

3.1.1.2 *Material*

Building on Mehta and Zhu (2009)'s researches, we used a word association test to assess people's association related to specific items. A professional designer generated six basic shaped form items and seven color items. The form items had a similar size and a comparable grade of complexity (all shapes had four angles). They differed in the sharpness of the angles (from very pointy to very round) and the degree of curvature of the lines (from convex to concave). It is to remember that Bar and Neta (2006) pointed out "edginess" as being the factor that made the difference between forms categorized as positive or negative and thus their potential threatening or harmless character. See figure 2 for a visualization of presented form items. Regarding colors, we tested samples of red, green, orange, purple, yellow, blue, dark grey and light grey.

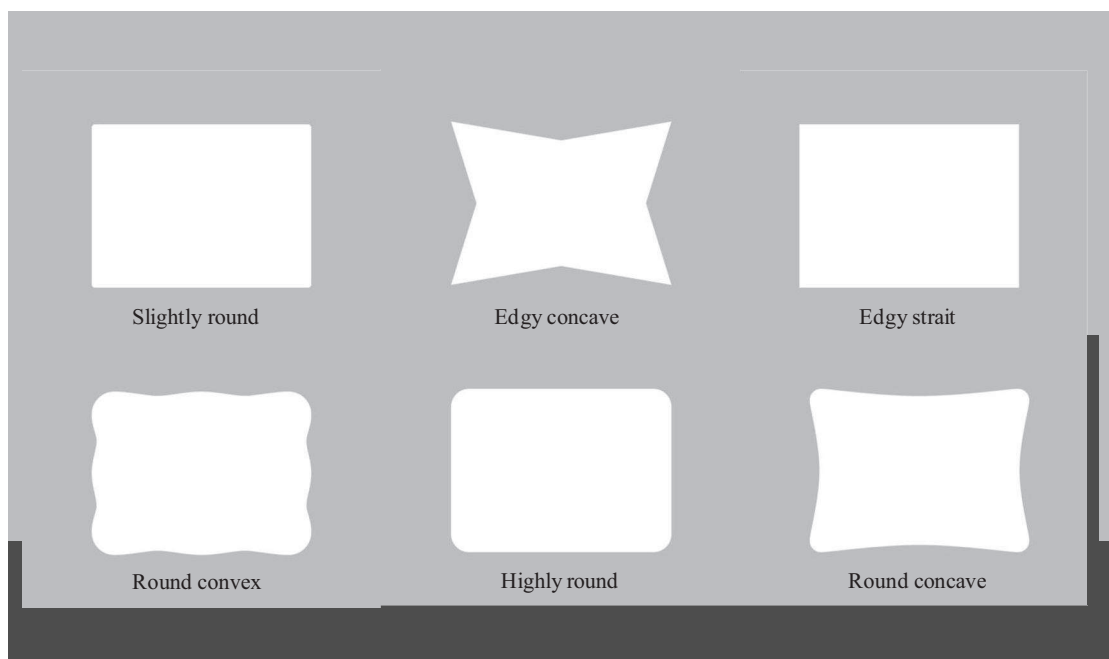


Figure 2: Forms that have been included in the pre-test.

3.1.1.3 *Procedure*

Participants saw the items separately on a screen. No time limitation was given. Directly after seeing one item, were asked to write down their spontaneous associations (i.e., "at least one or two nouns or adjectives"). Finally, participants had to evaluate the item they just saw on four simple item scales in 5 points. The

measured dimensions were chosen in adequacy with vocabulary commonly used in relevant literature to refer to the promotion and prevention dimensions. For instance, promotion primes are often referred to in dimensions of progress (Camacho et al., 2003; Crowe & Higgins, 1997; Florea, 2003) or threat (Crowe & Higgins, 1997; Lee & Aaker, 2003; Werth & Foerster, 2007; Werth & Förster, 2007). Also, Bar and Neta (2006, 2007) established a link between stimuli's valence and their threatening or harmless nature. Finally, stimuli's intensity or their potential to challenge and intimidate is often mentioned in researches focusing on aesthetics and visual appraisal (Bennett, 2010; Hassenzahl, 2004; Leder, Belke, Oeberst, & Augustin, 2004) or hedonic value (De Dreu, Baas, & Nijstad, 2008; Higgins, 1997, 2006). In that line, participants were asked to rate each item on following dimensions:

- Intensity: "Not intense at all" (1) to "highly intense" (5);
- Valence: "Positive" (1) to "negative" (5);
- Harmlessness: "Harmless" (1) to "aggressive" (5);
- Degree of challenge: "Challenging" (1) to "intimidating" (5)

Participants saw and evaluated each color and form item.

3.1.2 Results

The main goal of the present pre-test was to provide a base for categorizing form and color items regarding their associations to promotion and prevention related vocabulary. In that line, the analysis provided a qualitative classification of the vocabulary participants generated. In addition, descriptive statistical analysis was performed on participants' ratings.

3.1.2.1 Vocabulary analysis

Vocabulary participants' generated was first classified on its valence (i.e., negative, neutral, positive). Then, each category was divided regarding recurrent and relevant themes (e.g., unpleasantness, pragmatic, natural, etc). Only directly related vocabulary was integrated in these categories: For example, words such as "unpleasant", "ugly", "unattractive" were grouped in the category "unpleasant". See table 1 for vocabulary associated to colors and table 2 for vocabulary associated to forms.

| | | Items | | | | | |
|------------|------------|----------------|--------------|-------------|--------------|---------------|--------------|
| | | Slightly round | Edgy concave | Edgy strait | Round convex | Round concave | Highly round |
| Vocabulary | | | | | | | |
| Negative | Unpleasant | - | 3 | - | 6 | - | - |
| | Threat | - | 16 | 6 | - | - | - |
| | Boredom | - | - | 2 | - | - | - |
| | Sum | - | 19 | 8 | 6 | - | - |
| Neutral | Neutral | 7 | - | 3 | - | - | 3 |
| | Pragmatic | 4 | - | 13 | 2 | - | - |
| | Sum | 11 | - | 16 | 2 | - | 3 |
| Positive | Comfort | 2 | - | 2 | 6 | 6 | 8 |
| | Dynamism | - | 5 | - | - | 12 | - |
| | Smoothness | 5 | - | - | 14 | 4 | 7 |
| | Sum | 7 | 5 | 2 | 20 | 19 | 15 |

Note: Numbers stand for the sum of produced words that are related to the specific category.

Table 1: Categories of words generated to qualify the form items.

| | | Items | | | | | | |
|------------|------------|-----------|-----------|-----------|-----------|------------|-----------|----------|
| | | Dark grey | Blue | Green | Red | Light grey | Orange | Purple |
| Vocabulary | | | | | | | | |
| Negative | Unpleasant | - | - | - | 6 | - | - | 3 |
| | Threat | 9 | - | - | 11 | - | - | 6 |
| | Boredom | 2 | - | - | - | 5 | - | - |
| | Sum | 11 | - | - | 17 | 5 | - | 9 |
| Neutral | Neutral | 2 | 3 | 2 | - | 10 | - | - |
| | Pragmatic | 8 | - | 4 | 5 | 3 | - | 4 |
| | Sum | 10 | 3 | 6 | 5 | 13 | - | 4 |
| Positive | Comfort | - | 5 | 3 | - | 2 | 4 | 2 |
| | Nature | - | 11 | 13 | - | - | 7 | 5 |
| | Warmness | - | - | 1 | - | - | 12 | - |
| | Sum | - | 16 | 17 | - | 2 | 23 | 7 |

Note: Numbers stand for the sum of produced words that are related to the specific category.

Table 2: Categories of words generated to qualify the color items.

3.1.2.2 Ratings

Participants' ratings were averaged to provide mean values associated to each item. Figures 3 to 6 show items' ratings for each of the four dimensions measured on 5-point scales. The minimal and maximal graduations are representing either a full support for one aspect (e.g., negative character) or for the opposite aspect (e.g., positive character). The medium line (i.e., "neutral") represents a judgment of neutrality (e.g., item rated as neither particularly negative nor particularly positive).

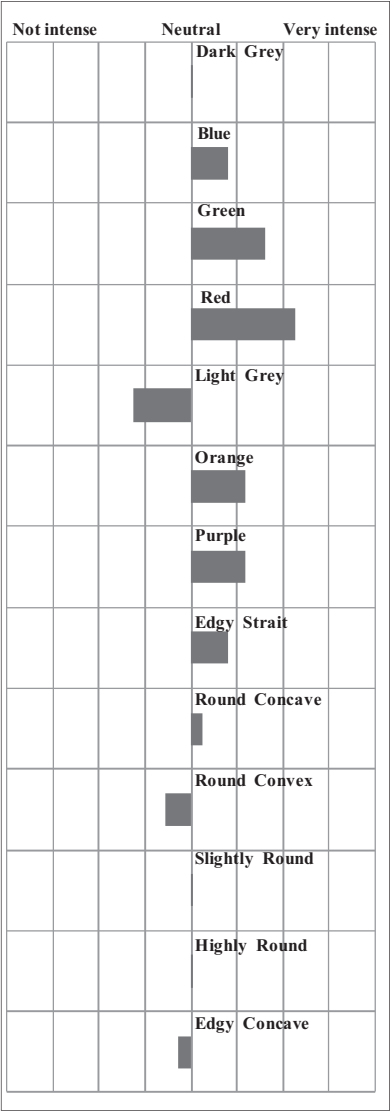


Figure 5: Intensity ratings depending on the stimuli

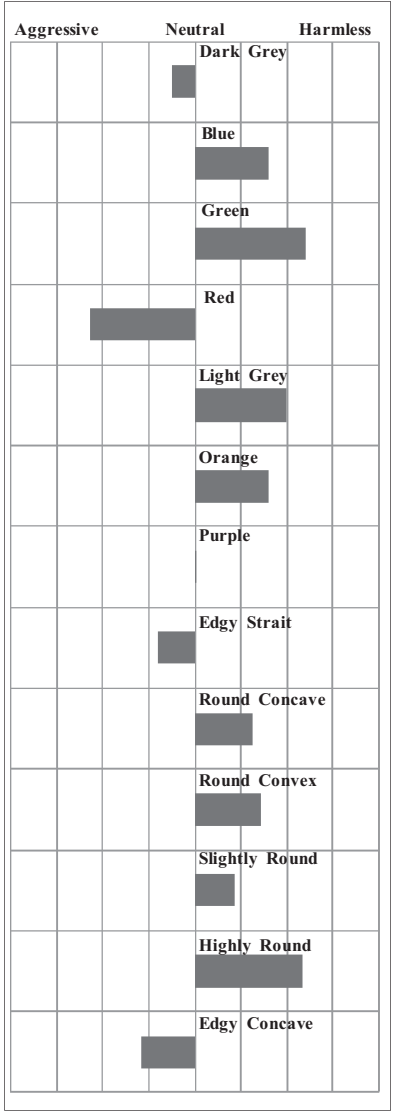


Figure 4: Rating of stimuli's harmless/aggressive character

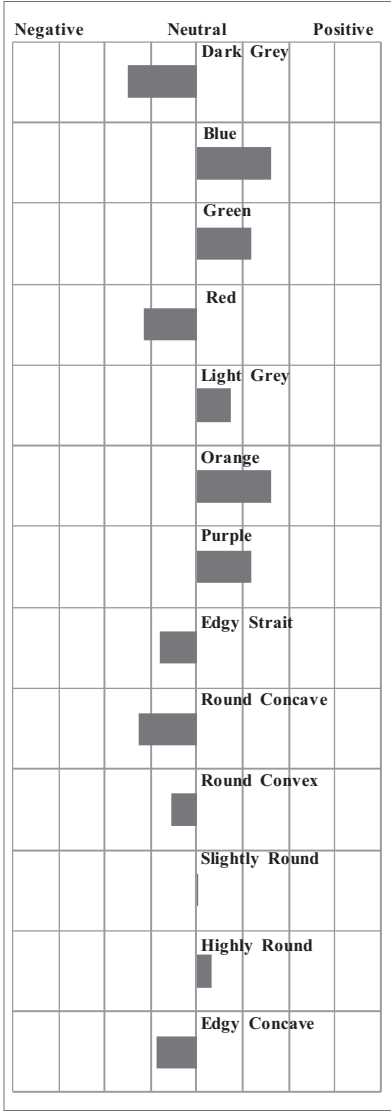


Figure 3: Valence ratings depending on the stimuli

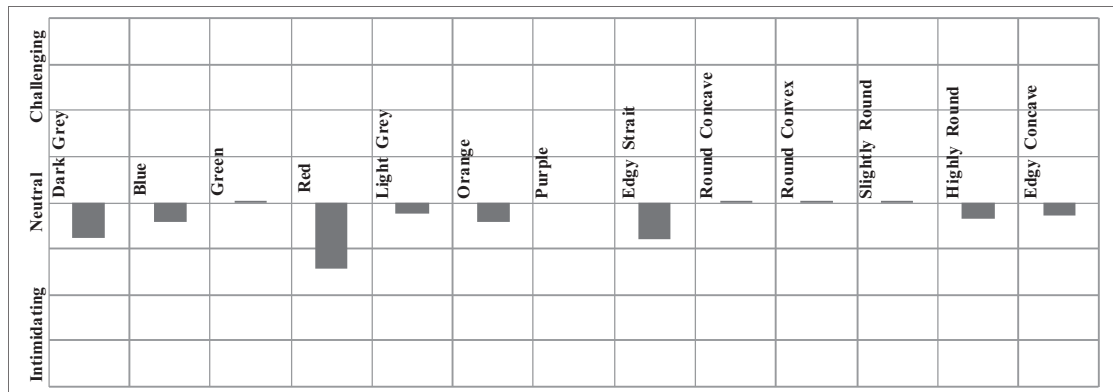


Figure 6: Rating of stimuli's challenging/intimidating character

3.1.2.3 Interpretation

Based on both word association analysis and ratings, color and form items were divided into four groups: Those unanimously classified in terms of prevention relevance, those classified in terms of promotion relevance, neutral ones and finally ambiguous ones. First, the items dark grey, red, edgy concave and edgy strait were mostly categorized as negative or neutral on valence scale as well as regarding participants' word associations. Indeed, these items were associated with pragmatic concepts (e.g., strait, clean, rigid) or ideas related to threat (e.g., aggressive, intimidating, edgy, hard). This character was also confirmed by relatively high aggressivity and intimidating ratings. On this base, we argue that these items can be associated to a regulatory prevention orientation. On the other hand, the items blue, green, orange, round concave and highly round were mostly categorized as positive and also associated to the ideas of comfort (e.g., reposing, comfortable), nature (e.g., ocean, fresh, nature) or smoothness (e.g., soft, tender, smooth). Participants also rated these items as globally positive and harmless. Thus, we argue that these items can be related to a regulatory promotion orientation. The items light grey, slightly round and round convex were mostly categorized as neutral and associated to vocabulary also related to neutrality (e.g., classic, discreet, neutral). Finally, the color purple could not clearly be categorized since it was associated to different and partly opposite dimensions (e.g., threat, positivity).

Furthermore, it is to note that the valence and aggressivity ratings seemed closely related to items' promotion (i.e., positive, harmless) or prevention (i.e., negative, high aggressivity) categorization. Regarding intensity ratings, they enabled us to

distinguish neutral items (i.e., low intensity) from promotion and prevention related ones (i.e., neutral to high intensity). Finally, the intimidating/challenging scale showed consistent high intimidating scores for prevention items. However, promotion items were not associated to consistent ratings since their scores varied between neutral and intimidating categorizations.

Overall, collected data showed that items we selected were qualified quite differently: While we expected such differences for color items, the gap between shapes that only slightly differed on the form of their angles was surprisingly high. Obviously, the sample size ($N = 12$) is not sufficient for a statistically valid analysis. However, we argue that the observed trends can be used for understanding specific items' effect. In addition, they constitute a base for creating the material we used in the main study described in Chapter 4.

3.2 Study 1A: Colors as primes

Color has been largely explored for its obvious impact on information processing and emotions but studies failed to provide consistent results (Elliot et al., 2007; Skinner, 2001; Tal et al., 2008). A first study explored colors' influence on regulatory tendencies in order to demonstrate that some of them (i.e., blue, red), for being associated to specific ideas and topics, could change individuals' current orientation (Mehta & Zhu, 2009). Our preliminary study (Chapter 2 | Preliminary study 1) was able to link other colors (i.e., green, orange, dark grey) to promotion or prevention relevant topics. Some colors, purple and light grey, were also tested and resulted either in ambiguous or neutral categorizations.

The present study aims to test these colors on their potential to prime promotion or prevention regulatory foci. Based on preliminary categorizations (i.e., preliminary study), the colors blue, green and orange were hypothesized to activate a progress promotion focus. Conversely, the colors red and dark grey were expected to prime a vigilant prevention focus. Finally, the light grey color was expected to have no influence on participants' regulatory orientation and no hypothesis was proposed for the purple color.

3.2.1 Methods

Classically used to facilitate or hinder processing, priming is also suitable to activate a specific state of mind, an affective state, a behavior (Förster et al., 2007) or, in our case, a regulatory orientation. Indeed, priming procedures can pre-activate constructs closely related to safety issues (respectively progress issues) and thus induce individuals in the adapted state of vigilance and error-avoidance (respectively a state of eagerness and gain-orientation). At the same time, memory contents matching the current orientation have a higher activation level than those mismatching it, which makes them easily accessible.

The present research's is based on an anagram paradigm in reference to Mehta and Zhu, (2009)². The target words were selected for belonging either to prevention

² It is to notice that we performed a first study involving a preference choice paradigm was performed but failed to show any results related to regulatory focus. This study provided valuable information that was utilized in anagram study. For example, the results suggested that participants were exposed too shortly to relevant stimuli and thus no effects were detected. Consequently, anagram study was

relevant vocabulary, to promotion relevant vocabulary or for being neutral (see also material for more details about vocabulary selection procedure). Participants were expected to solve anagrams faster when target-words were consistent with their current cognitive regulation. For example, we expected promotion oriented participants to be especially sensitive to the target-word “success”. Conversely, prevention oriented participants would be more receptive to target-words like “error” and thus slower in recognizing promotion target-word “success”. In other words, participants’ quickness in guessing anagrams’ target words will provide indication about their current regulatory orientation.

3.2.1.1 Participants

Sixty-six persons took part in this study (i.e., 39 were female). The age ranged from 18 to 66 with a mean age of 24.68 years (SD = 6.65). Most of them were students who participated for course credits. It is to note that participants were predominantly chronically promotion focused (i.e., 44 out of 66). Fourteen were prevention focused and eight were neither predominantly promotion nor prevention focused.

3.2.1.2 Material

3.2.1.2.1 Stimuli

All color items tested in the preliminary study were included as stimuli and separately presented as backgrounds for the anagrams. In order to make results ecologically more valid, we chose to present each color as gradients: We argue that associations are not bound to a unique color but rather to a family of shades (e.g., red shades). In fact, associations are “learned” through repeated encounters with the stimulus of interest paired to specific information (e.g., red color and warning signs, red pen ink and highlighted errors in tests, red traffic lights and the injunction to stop). Different shades of red should therefore have similar associations and it is unlikely that there is only “one” red color able to activate a state of vigilance. Accordingly, our stimuli were decomposed into darker (i.e., same lightness, different saturation) and lighter (i.e., same saturation, different lightness) gradations of the color of interest (e.g., green) while conserving its hue (see figure 7 for an example of stimulus).

designed so that stimuli were presented in longer-lasting sequences. Study design, methods, analysis as well as related conclusions are reported in Appendix I.

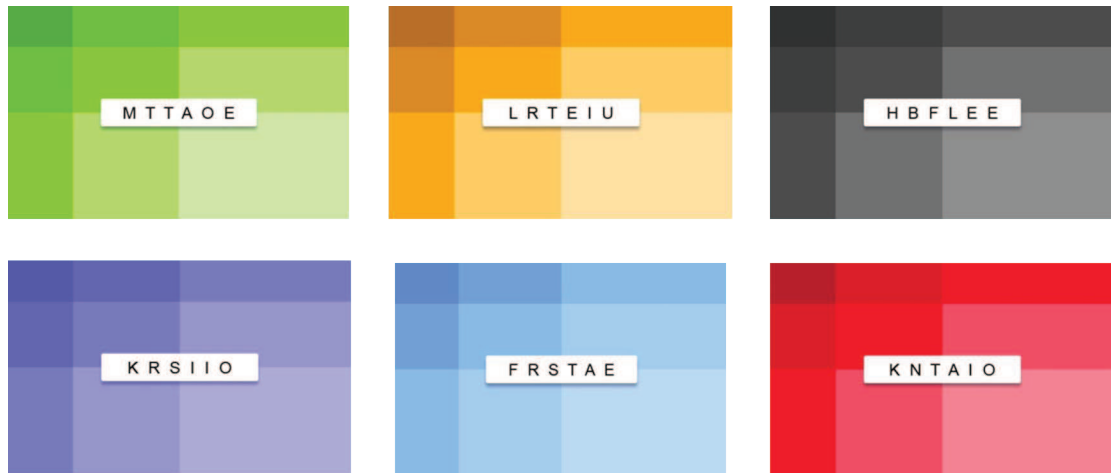


Figure 7: Stimuli variants “green”, “orange”, “dark grey”, “purple”, “blue” and “red”.

3.2.1.2.2 Anagrams

Participants’ main task was to solve anagrams whose target words were either neutral, promotion framed or prevention framed. All target words had six letters and were equally frequent in the German language³. They were selected because they transmit values especially important either for promotion or for prevention oriented individuals: Concepts like progress, success or holidays were selected for representing a desired end-state for the promotion focus whereas concepts like failure, error or danger represent an end-state prevention focused individuals would try to avoid. Neutral words were also included and chosen for having a neutral valence (e.g., planet, plate). The vocabulary was pre-tested (e.g., valence, perceived familiarity, aggression, comfort) to confirm that the promotion or prevention framing was predominant (e.g., a high perceived aggression is a cue for the word’s relevance regarding a prevention focus). Four anagrams of each kind were selected and used in the study (i.e., four neutral, four prevention and four promotion framed anagrams).

Anagram presentation was based on specific rules which avoid phenomena of pattern or word-shape recognition (Perea & Rosa, 2002): Consonants were written down in alphabetic order first, followed by the vowels in the same order (e.g., ERFOLG “success”: FGLREO). The anagrams were presented on a white label in the middle of

³ frequency was assessed accordingly to the online corpus provided by the Universität Leipzig: http://wortschatz.uni-leipzig.de/ws_norm/index_wm.php#

the colored backgrounds (i.e., stimuli) to ensure identical legibility (see Figure 12 for an example of the anagram-presentation). A text-field was integrated in the bottom of the screen for participants to write down their response.

3.2.1.2.3 Procedure

The study was hosted on a free survey-platform (<http://www.qualtrics.com>) which provided links to start individual sessions. Participants were guided through following steps: Instructions, RFQ questionnaire to determine their chronic focus (Higgins et al., 2001), a practice task and the main task. In order to become familiar with task's structure, two anagram-solving tasks were proposed during the practice sequence. The main task consisted of two sequences of six anagrams (i.e., two prevention framed, two promotion framed and two neutral anagrams per sequence) which were subsequently presented on a same colored background (i.e., stimulus). Anagram-screens were separated by neutral (blank) screens which participants would manually skip when they were ready to begin the next anagram task. The presentation would either begin with a prevention or a promotion framed anagram. Anagrams of a same kind (e.g., prevention framed) were not displayed consecutively. The background color and the anagram type were both within-subject variables: Each participant viewed the twelve anagrams and two randomly selected background colors (e.g., sequence A with an orange colored background, followed by sequence B with a grey colored background). Furthermore, each anagram was associated to all seven background colors. Overall, every background color has been seen at least by sixteen participants and at least thirty-two anagrams of each type (i.e., neutral, promotion or prevention framed) were presented in association of each background color. See figure 8 for an overview of the procedure.

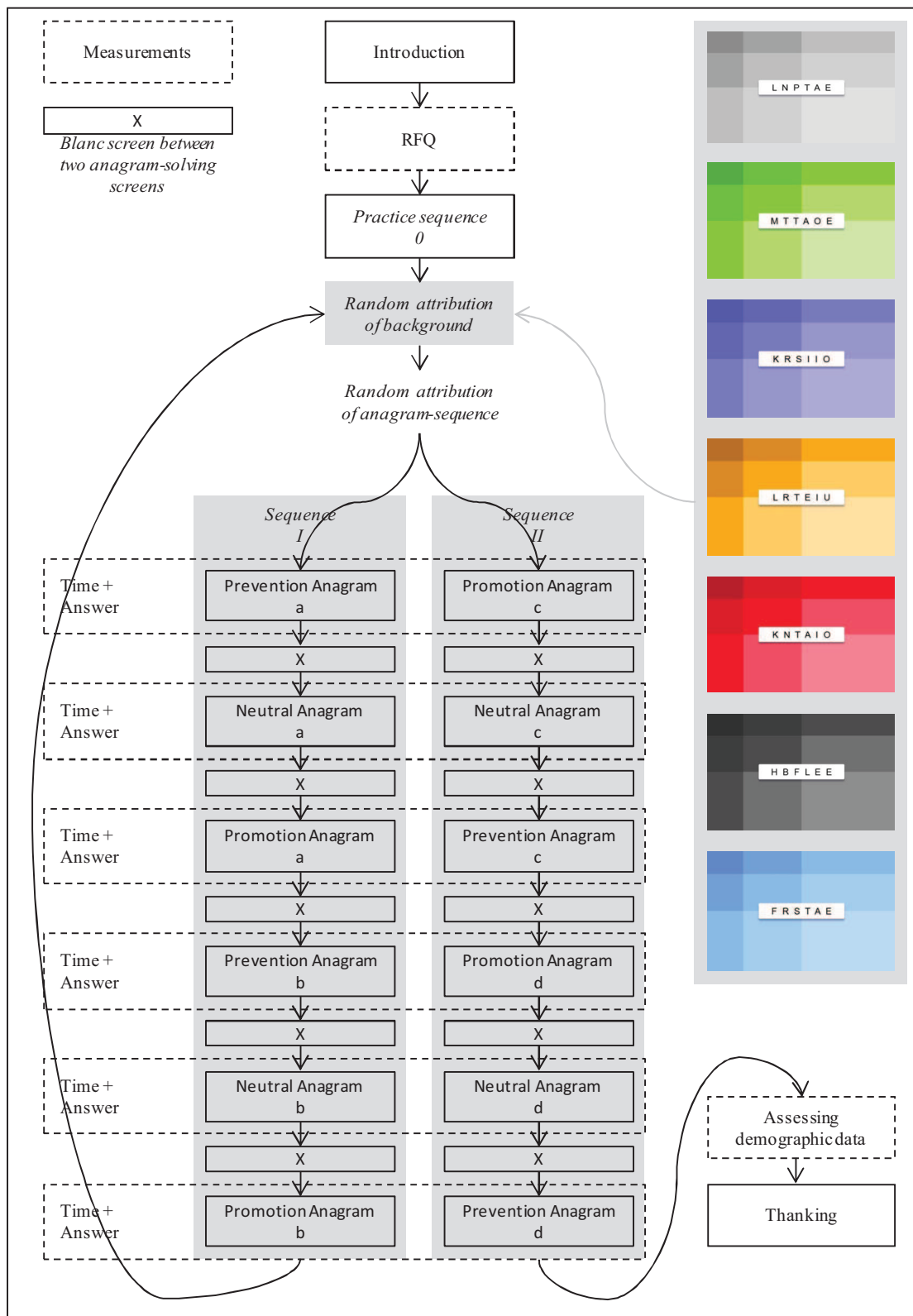


Figure 8: Detailed Procedure of Study 1A

Participants were informed that their response time (i.e., time between the anagram's presentation on the screen and the moment they validated their response) as well as

their responses were registered. Solving time was not limited and participants were allowed to quit anagrams without giving a response. However, they had no possibility to come back and correct already validated responses.

3.2.2 Results and Interpretation

Participants' response time (RT) for each kind of correctly solved anagrams was averaged to generate a promotion RT index, a prevention RT index and a neutral RT index. An analysis of variance was performed with type of anagram (prevention, neutral, promotion) as within factor and color (red, dark grey, purple, light grey, blue, orange and green) as between factor. First, a main effect of the type of anagram was detected $F(2, 452) = 7.19, p = .001$ as well as a main effect of the factor color $F(6, 452) = 2.82, p = .01$. As expected, both factors also interacted: $F(12, 452) = 3.76, p < .001$. Post hoc analysis showed significant differences associated to the colors red ($p < .001$, prevention anagrams were solved faster than promotion ones), dark grey ($p < .001$, prevention anagrams were solved faster than promotion ones) and orange ($p < .001$, promotion anagrams were solved faster than prevention ones). In other words, the colors red and dark-grey facilitated solving prevention framed anagrams while the color orange facilitated solving promotion framed anagrams. The other colors were not associated to differences in solving the three kinds of anagrams. Figure 9 shows the stimuli that were associated to significantly different solving times regarding the three types of anagram. Also, table 3 reports all mean anagram solving times depending on anagram type and stimuli.

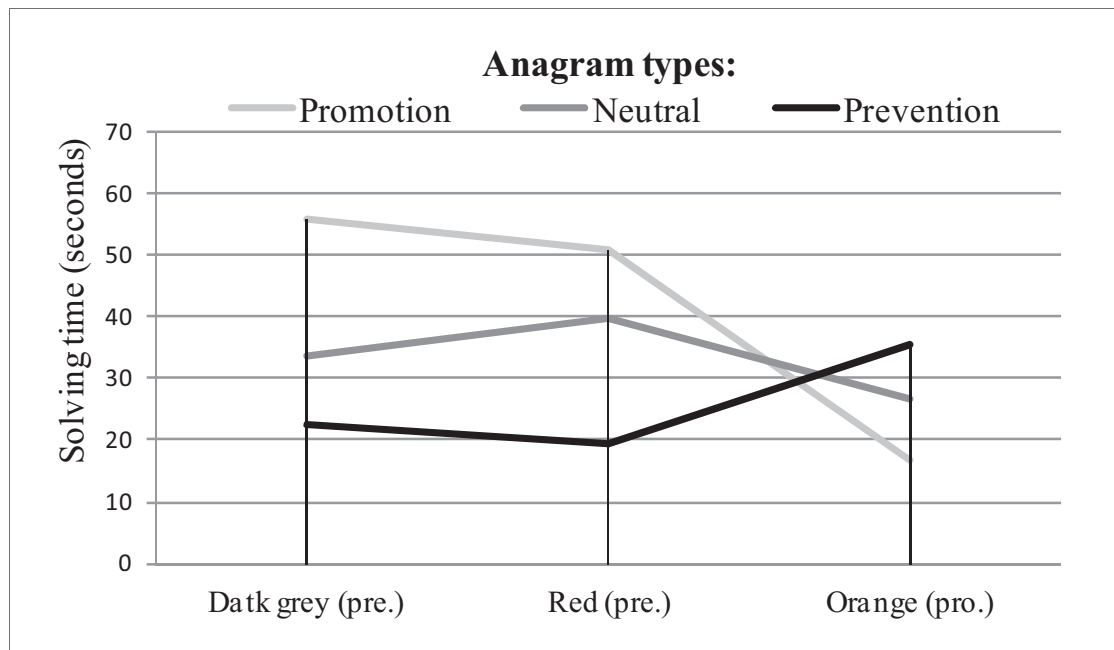


Figure 9: Significant differences in solving times depending on anagrams' type and the background stimulus.

| Hypothesized effects | Stimuli | Type of anagrams | | |
|----------------------------|-------------------|-------------------|---------------|------------------|
| | | Prevention framed | Neutral | Promotion framed |
| Prevention inducing | Red* | 19.24 (5.72) | 39.67 (25.98) | 50.84 (18.42) |
| | Dark grey* | 22.48 (6.83) | 33.56 (22.54) | 55.02 (25.56) |
| Promotion inducing | Blue | 27.55 (29.91) | 32.25 (23.72) | 29.99 (17.98) |
| | Green | 26.62 (27.82) | 37.66 (40.53) | 28.12 (26.59) |
| | Orange* | 35.41 (6.79) | 26.79 (15.97) | 16.74 (10.39) |
| Neutral | Light grey | 29.61 (22.70) | 31.67 (17.87) | 27.61 (22.02) |
| Undetermined | Purple | 14.75 (6.24) | 31.71 (28.35) | 24.19 (20.94) |

Note: Stimuli associated to significant differences in solving promotion and prevention anagrams are marked with an asterisk. Standard deviations are provided in parentheses.

Table 3: Mean anagram solving times in seconds depending on anagram type and stimuli.

Overall, these results confirm some of our hypotheses: The expected prevention inducing colors red and dark grey were indeed associated to faster solving of prevention oriented anagrams while promotion anagram solving time was impaired in comparison. In other words, prevention relevant vocabulary seemed more accessible than promotion one, that is why argue that these items are activating a vigilant

prevention orientation. Conversely, the orange color was associated to faster solving of promotion anagrams and slower solving of prevention ones. This means that promotion vocabulary was more accessible than prevention one. Thus, we conclude that the color orange activates a progress oriented promotion focus. Regarding the other items, no such effect was statistically significant. The relatively low number of participants might be insufficient to bring out potential effects that might be highly subtle.

Beyond the results associated to each specific item, our study also demonstrates that priming effects are not restricted to the colors blue and red. Indeed, other colors, dark grey and orange, are also influencing people's regulatory orientations. Furthermore, contrarily to classic color-related research, our study used stimuli that were not uniform but rather composed of a color family (i.e., lighter and darker shades of a same color). This choice was motivated by the hypothesis that specific priming effects are likely to be related to a family of shades rather than to a single and unique color. In fact, we assume that these associations are learned by repeated encounters with specific combinations of colors and events or information (e.g., red pen ink and errors, blue colors and information about cleanness). For example, we believe that there is not one unique shade of red that comes in our mind when thinking about warnings but rather a family of red colors. Our results strengthened that assumption since our heterogeneous stimuli could be linked to changes in participants' regulatory foci. In other words, the vigilance or progress related associations underlying the priming effect seem to be linked to a family or group of colors rather than to single shades. This finding is especially interesting regarding the fact that in an ecological context, people are usually exposed to a large and heterogeneous panel of shades. Thus, the color-priming principles we demonstrated should be easily transferable in concrete and ecologic contexts. Obviously, we do not pretend to cover the multitude of shades people encounter in real life. However, we provide a larger sample than Mehta and Zhu (2008) which also makes the findings more suitable for concrete applications.

3.3 Study 1B: Forms as primes

Our second point of interest concerns visual elements' shape (i.e., contours) which might be especially relevant regarding a safety concerned prevention focus. As mentioned in chapter 1 | Implicit Cues and RF, contours are mostly distinguished in terms of sharpness versus roundness which are hypothesized to be processed as cues for stimuli's harmful or harmless character (Bar & Neta, 2006, 2007). On this same line, our preliminary study reported in chapter 2 explored associations linked to different form elements. Remember that these meaningless form patterns only differed in the sharpness of their angles and the degree of curvature of their lines. The preliminary study demonstrated that despite minimal differences, tested items were categorized quite differently. Especially the items edgy strait, slightly round and highly round were interesting: While their differences were minimal and only concerned angle sharpness, they were classified very differently. This makes them especially relevant regarding a potential use in a context of user interface mediated interaction since they usually build on "clean" shapes (which exclude "star"- or "cloud"-shaped items as well as concave or convex lines). Thus, the present main study was only conducted on these three items. We expected the sharp edged form (i.e., edgy strait) to have potential to transmit the idea of danger and threat and thus to induce a state of vigilance (i.e., prevention focus). Conversely, the highly round item was expected to induce a progress oriented promotion focus. Regarding the slightly round form, it was hypothesized to be neutral and thus no effect was expected on participants' regulatory focus.

3.3.1 Methods

The method used in this second experiment was identical to the one used in experiment 1A, which is detailed in chapter 2 | Study 1A. However, participants were presented with form items as stimuli instead of color items.

3.3.1.1 Participants

Sixty-three persons took part in the study (i.e., forty were female; five did not inform this criterion). The age ranged from 19 to 51 with a mean age of 25.7 years (SD = 7.29). Most of them were students participating for course credits. None of them was involved in the color experiment (Study 1A) or in the preliminary study. It is to note

that participants were mostly chronically promotion focused (six were prevention focused; three tended neither to a promotion nor to a prevention focus and were thus considered as having a neutral regulation).

3.3.1.2 *Material*

Based on the preliminary study (chapter 2 | Preliminary study 1), we selected three form items for this study. Stimuli were composed of a pattern of plain grey forms on a white background. It is to note that these form items were presented in the light grey shade that study 1A identified as having no effect on people’s regulatory orientation. Figure 10 presents the three forms items used in this study 1B. As visible on this visualization, the anagrams were displayed on a white fond in the middle of each background. Regarding the anagrams, experiment 1B was based on the same selection of target words than those used in experiment 1A.

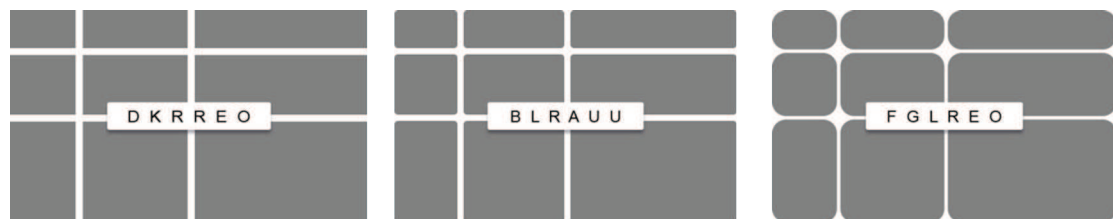


Figure 10: Anagrams presented on background variants “strait edgy” (left), “slightly round” (middle) and “highly round” (right).

3.3.1.3 *Procedure*

The procedure was identical to the one used in the experiment 1A. In other words, participants were guided through the test identifying their chronic focus, the practice tasks and the main tasks. All details about-target word selection and experimental procedure are presented in Chapter 2: Study 1A. In addition, figure 11 shows procedure’s details.

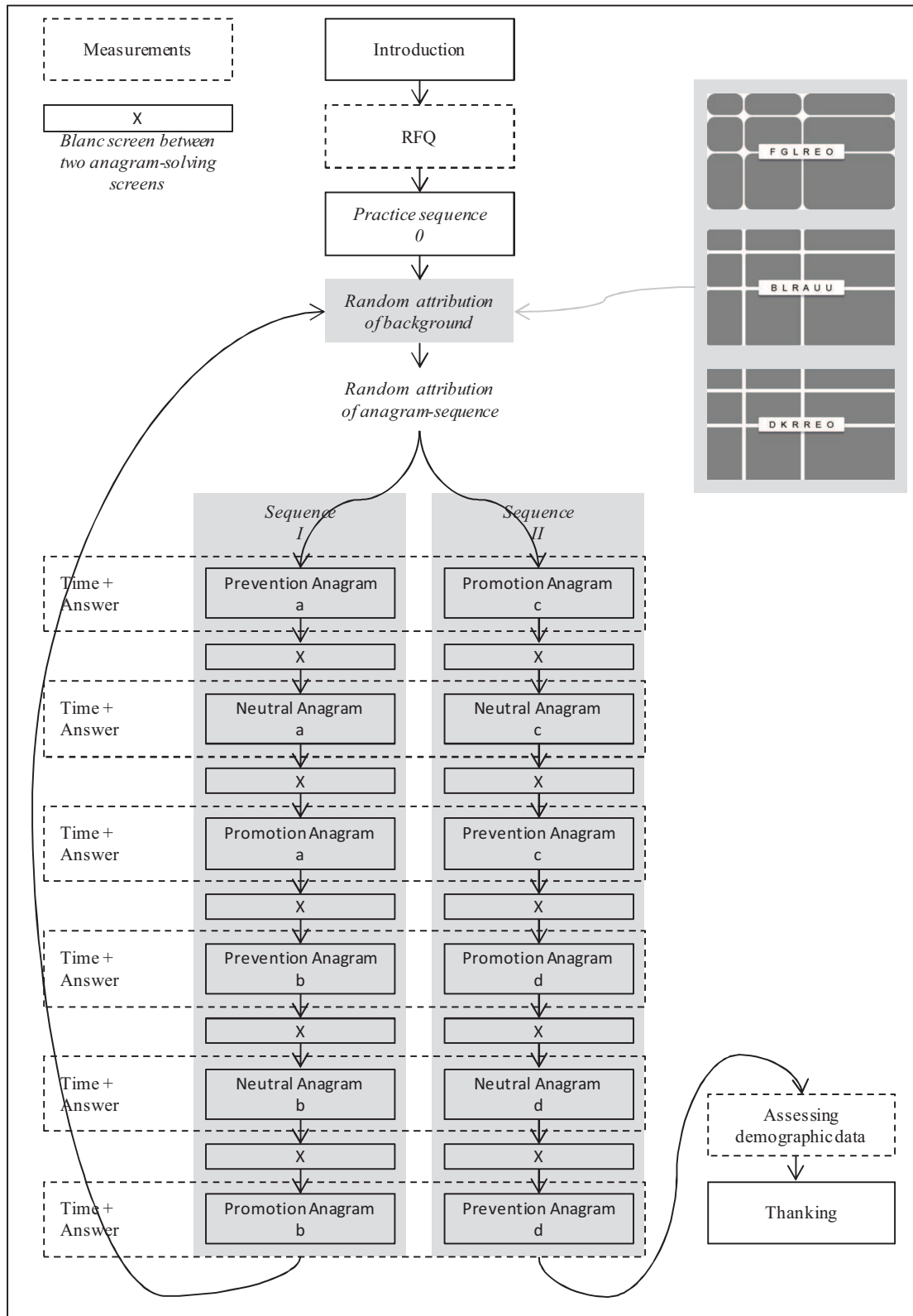


Figure 11: detailed overview of study 1b's procedure.

3.3.2 Results and Interpretation

An analysis of variance was performed with type of anagrams (prevention, neutral,

promotion) as within factor and form (edgy strait, slightly round, highly round) as between factor. No main effect was detected but the interaction between both factors was significant: $F(12, 409) = 15.77, p < .001$. As we expected, post hoc analysis showed that the edgy form facilitated solving prevention anagrams ($p < .001$, prevention anagrams were solved faster than promotion ones). Conversely, round forms facilitated solving promotion framed anagrams ($p < .001$, promotion anagrams were solved faster than prevention ones). Finally, it is to note that participant's chronic focus did not influence solving times. Table 1 presents a detailed overview of these results.

| Hypothesized effects | Stimuli | Type of anagrams | | |
|----------------------------|-----------------------|-------------------|---------------|------------------|
| | | Prevention framed | Neutral | Promotion framed |
| Prevention inducing | Strait edgy* | 19.94 (12.84) | 27.55 (23.79) | 46.78 (30.03) |
| Promotion inducing | Highly round* | 48.54 (36.99) | 29.74 (20.58) | 21.84 (16.18) |
| Neutral | Slightly round | 28.02 (21.54) | 29.31 (19.92) | 29.33 (17.37) |

Note: Stimuli associated to significant differences for solving promotion and prevention anagrams are marked with an asterisk. Standard deviations are given in parentheses.

Table 4: Mean anagram solving times in seconds depending on the type of anagram (prevention, promotion, neutral) and stimulus (edgy, slightly round, highly round).

These results confirmed our hypotheses: First and as expected, the strait edgy form was associated to a facilitated solving of prevention framed target-words which were identified faster than promotion ones. In other words, prevention relevant vocabulary was more accessible than promotion vocabulary, which is why we argue that this form may activate a vigilant prevention orientation. Conversely, promotion target words were identified faster than prevention ones when they were presented in association with highly round forms. This effect demonstrates that highly round forms make progress related vocabulary more accessible than vigilance related one. In other words, the highly round form we tested seems to activate a progress oriented promotion focus.

The slightly round forms were not associated to any differences in vocabulary accessibility which was consistent with our hypotheses. Since this stimulus did not generate a situational induced focus, we would have expected participants' chronic

focus to influence their performance. This was not the case. It is to notice that very few participants were chronically neutral or prevention oriented. This fact might explain the absence of any statistical effect.

Globally, the results indicate that a minimal difference in a form's shape (e.g., completely sharp angles versus slightly round ones) can have a maximal effect on individuals' motivational orientation and thus may influence related information processing, decision taking and behavior generating.

3.4 Discussion

The present study aimed to link visual characteristics to cognitive orientations influencing task-solving. While research traditionally focuses on global aesthetic or preference judgments, we choose to explore effects associated to distinct and separated visual items.

First, a preliminary study (Chapter 2 | Preliminary study 1) was able to demonstrate that specific color and form items (e.g., red, dark-grey, edgy and/or pointy forms) can be linked to prevention relevant vocabulary (e.g., threat, pragmatic) and ratings (e.g., high aggressivity, negativity). Other items (e.g., blue, green, orange, round shaped forms) were globally associated to promotion relevant vocabulary (e.g., comfort, warmth) and ratings (e.g., harmlessness, positivity).

The second experimental part deepened these findings by exploring color and form items' influence on performance related variables (Chapter 2 | study 1A & 1B). Results confirmed the hypothesized relationship between form and color items and cognitive regulation: The colors red and dark grey as well as the sharp contoured form facilitated solving of prevention framed target-words which were identified faster than promotion framed ones. Conversely, the items orange color and round form facilitated solving promotion target-words which were identified faster than prevention framed ones.

In other words, distinct color and form characteristics are able to influence information processing and solving performance in absence of any aesthetical or

preference judgment. Obviously, these findings lack of ecological validity. However, they represent, in our opinion, the first step towards more contextualized and natural researches on one hand, and a base for actual design procedures on the other hand. In fact, knowing these trends about color's and form's impacts, designers might reconsider the concrete use of these characteristics in the context of graphic user interfaces. Beside of being aesthetically appealing, graphic compositions might indeed benefit from being considered in dependence of the actual context of use: For example, a graphical layout related to a task that can globally be categorized as demanding precision and accuracy can be designed in a way that better supports users if applying the present study's results. Clearly defined forms and angles as well as sober and dark color schemes should favor a cognitive orientation that matches the task's nature. In addition, when confronted to different options for a specific design case, our research might provide an alternative evaluating grit to the classic instinct and preference based criterions.

We also propose to link our study to classic color researches that have, to this day, failed to provide consensual dependencies between specific colors and performance (Elliot et al., 2007; Skinner, 2001). While many different settings were used, the nature of the tasks to solve was globally not taken into account. Contrary to the general assumption, we believe that colors' facilitating or hindering impact on performance is unlikely to be linear (e.g., some authors argue that red color systematically impairs efficiency in task solving; Elliot et al., 2007). We argue that an interaction between a color-induced impact on cognition and tasks' creative or accuracy oriented nature can be considered as a more plausible explanation as well as a path worth exploring.

Overall, the present research provides an alternative approach for understanding the relationship between visual characteristics and their impact on cognition. The results are suitable to be integrate in concrete design procedures and aim to inspire further researches in relates domains.

4 Chapter 3 – Study 2: Categorizing tasks

According to regulatory focus theory and as reported more in detail in chapter 1, regulatory fit occurs when people's regulatory orientation is sustained by contextual requirements (Higgins, 2005). In other words, regulatory fit situations usually involve a) people's specific orientation (i.e., prevention focus, promotion focus) and b) situation's or tasks' framing characteristics (e.g., accuracy framing versus creativity framing). While methods to induce specific regulatory orientation (a) have been widely explored, no methodology has been proposed to either categorize existent tasks' framing or to help constructing tasks involving a specific framing (b). To avoid this problematic, relevant studies involving solving-paradigms mostly use tasks whose content is related to promotion or prevention topics. For example, some studies, including the one we presented in Chapter 2, explored implications related to regulatory focus by proposing anagram solving tasks which involved differently framed target-words (Förster et al., 1998; Higgins et al., 1997; Mehta & Zhu, 2009). Furthermore, some studies are based on tasks known to be "creative" (Crowe & Higgins, 1997; Friedman & Förster, 2001, 2005; Higgins, 1997; Mehta & Zhu, 2009) or to be "detail-oriented" (Förster, Higgins, & Bianco, 2003; Friedman & Förster, 2005; Higgins, 2000; Werth & Foerster, 2007).

In the context of Human-Computer-Interaction (HCI), people are dealing with predefined work environments and handling assigned tasks. Thus, a regulatory fit situation can only be supported if it is possible to adapt people's regulatory orientation to tasks' framing. As a consequence, this second experimental part aims to establish a methodology suitable to determine if simple HCI tasks are promotion or prevention framed. More precisely, we will propose and test criterions, which can be used to qualify simple interactive tasks. Tasks were qualified as simple if their mean solving time did not exceed 15 minutes and if their structure does not involve more than n-3 levels.

Depending on the resulting classifications, we expect to identify tasks which either benefit from being handled with promotion or with prevention solving strategies. Concretely, we will attempt in a first part to select aspects that have been related to promotion oriented or prevention oriented strategies in relevant literature. In a second

part, we will evaluate the potential importance of these aspects to successfully handle a selection of simple tasks.

4.1 Selecting promotion and prevention relevant aspects

A throughout review of relevant literature allowed us to identify general aspects which have been related to promotion or prevention regulation (see table 5). Globally, prevention-related aspects involve precision, error-detection or a tendency to favor maintenance and stability rather than a progress or evolution of the situation. Conversely, promotion aspects are related to a flexible and creative cognition as well as a risky bias and a focus on progress. We argue that tasks whose solving is supported by either promotion or prevention relevant aspects can be classified as promotion or prevention framed. For example, a task that is supported by a tendency to focus on errors, is proposed to belong in the category prevention framed.

The next section reports the different aspects we identified and suggest to take into account to qualify the tasks. Depending on their orientation, these aspects are proposed to be usable to define either promotion framed tasks or prevention framed tasks.

First, Förster et al. (2003) demonstrated that prevention regulation's strategic vigilance triggers a high focus on accuracy (reported as pre.1 in table 5) at the expense of speed related performance (reported as pro.7 in table 5). Conversely, promotion regulation's eager strategies are associated to enhanced speed performance and diminished accuracy. In that line, we argue that tasks necessitating accuracy can be considered as prevention framed while a necessity for fast solving indicates a promotion framing. Additional literature on accuracy or performance focus is reported in table 5.

In Mehta and Zhu (2009), prevention regulated participants performed better on detail-oriented (reported as pre.2 in table 5) tasks (e.g., proofreading) than promotion regulated ones. Thus, we argue that tasks benefitting from detail-orientation, can be classified as prevention framed. Additional literature dealing with detail-orientation is reported in table 5.

Error-avoidance is discussed by Higgins (1997) or by Förster et al. (2003): Prevention regulated people's state of vigilance is argued to help ensuring against mistakes as well as correct detecting of errors (reported as pre.3 in table 5) in order to avoid them. In that line, tasks benefitting from a focus on error-avoidance are proposed to be prevention framed. Additional literature on error-avoidance is reported in table 5.

Hamstra, Bolderdijk, and Veldstra (2011) exposed that a promotion regulation comes along with a risky bias: Promotion oriented people tend to take risks more eagerly (reported as pro.1 in table 5) than prevention oriented ones who tend to more conservative behavior (reported as pre.4 in table 5). Thus, tasks benefitting from risky strategies are proposed to be promotion framed while those benefitting from risk-averse strategies are argued to be prevention framed. Additional literature on risk-taking or -avoiding is reported in table 5.

Maddox, Baldwin, and Markman (2008) demonstrated that promotion oriented individuals have higher cognitive flexibility and hence tend to try strategic changes if given the opportunity. Conversely, prevention oriented people are not using possible options and tend to keep with the initial procedure. Consequently, tasks offering multiple options to be solved (reported as pro.2 in table 5) and benefitting from trial strategies (reported as pro.3 and pro.5 in table 5) are argued to be promotion framed while tasks with only limited choice of options are suggested to be prevention framed (reported as pre.5 in table 5). Furthermore, tasks requiring flexibility better fit with a promotion orientation and consequently are suggested to be promotion framed (reported as pro.4 in table 5). Additional literature on flexibility and availability of different options is reported in table 5.

As stated in de Vries, Holland, Chenier, Starr, and Winkielman (2010), familiarity (reported as pre.6 in table 5) is processed as a cue for the absence of risk. Thus, this aspect is mostly relevant for risk-focused prevention regulation. Tasks with a high degree of familiarity are hence argued to be prevention framed. Additional literature on familiarity is reported in table 5.

Some studies suggested that information overview is helpful to handle creative tasks while accuracy task tend to be supported by memorization (Dijksterhuis, 2004; Kirchler, Hoelzl, & Huber, 2010). Therefore, it is suggested that tasks requiring a

global view of relevant information (reported as pro.6 in table 5) will be better handled by individuals in a promotion focus. Conversely, tasks necessitating high memorization performance (reported as pre.7 in table 5) would be better handled with a prevention approach and are thus suggested to be prevention framed. Additional literature on familiarity is reported in table 5.

Finally, some studies suggest that promotion focused individuals tend to strive for high performance (Higgins, 2000). Thus, we argue that tasks benefitting especially from high performance (reported as pro.7 in table 5) can be categorized as promotion framed.

| Aspects | Items | Items used in the questionnaire | Potential indicators for: | Related literature |
|---------------------------------|-------|---|---------------------------|--|
| Accuracy and Detail-Orientation | Pre.1 | “How important is accuracy?” | Prevention framing | (Förster et al., 2003) (Higgins, 2000) (Mehta & Zhu, 2009) (Förster et al., 2007) (Friedman & Förster, 2005) |
| | Pre.2 | “How advantageous is it to focus on details?” | Prevention framing | (Friedman & Förster, 2005) (Kirchler et al., 2010) (Mehta & Zhu, 2009) |
| Risk & Error Handling | Pre.3 | “How important is it to avoid errors?” | Prevention framing | (Friedman & Förster, 2005) (Förster et al., 2003) (Higgins, 1997) (Scholer, Stroessner, & Higgins, 2008) (Crowe & Higgins, 1997) |
| | Pre.4 | “How advantageous is it to avoid actions or strategies with not completely predictable consequences?” | Prevention framing | (Scholer et al., 2008) (Förster et al., 2007) (Kirchler et al., 2010) (Camacho et al., 2003) |
| | Pro.1 | “How advantageous is it to propose risky actions or solutions?” | Promotion framing | (Hamstra et al., 2011) (Lee & Aaker, 2003) (Förster et al., 2003) (Werth & Foerster, 2007) (Hamstra et al., 2011) (Uskul, Sherman, & Fitzgibbon, 2008) (Higgins, 2000) |
| Options and constraints | Pro.2 | “How advantageous is it to be proposed different options and possibilities for achieving a task?” | Promotion framing | (Maddox et al., 2008) (Cavallo, Fitzsimons, & Holmes, 2010) (Lee, Aaker, & Gardner, 2000) |
| | Pre.5 | “How advantageous is it to follow a strict process?” | Prevention framing | (Aaker & Lee, 2002) (Chernev, 2004) |

| | | | | (Florea, 2003) |
|------------------------|-------|--|--------------------|--|
| Flexibility and trying | Pro.3 | “How advantageous is it to try different actions or solutions?” | Promotion framing | (Maddox et al., 2008) (Förster et al., 2007) |
| | Pro.4 | “How advantageous is it to approach the task with flexibility?” | Promotion framing | (Lee & Aaker, 2003) (Scholer et al., 2008) |
| | Pro.5 | “How probable is it to reach a satisfying result by trying different options?” | Promotion framing | (Camacho et al., 2003) (Cesario & Higgins, 2008) |
| Familiarity | Pre.6 | “How advantageous is it to be familiar to context and options?” | Prevention framing | (de Vries et al., 2010) (Freitas et al., 2005) (Lee & Aaker, 2003) |
| Global view | Pro.6 | “How advantageous is it to have a global view over all information?” | Promotion framing | (Kirchler et al., 2010) (Cavallo et al., 2010) |
| Memorization | Pre.7 | “How advantageous is it to memorize information?” | Prevention framing | (Dijksterhuis, 2004) (Higgins et al., 1997) |
| Performance focus | Pro.7 | “How advantageous is it to aim for high performance?” | Promotion framing | (Higgins, 2000) (Förster et al., 2003) |

Table 5: Questionnaire based on potentially promotion or prevention related indicators

We transformed the different aspects enlisted in the above into a 14-item questionnaire. For example, the aspect “detail orientation” has been transformed into the item “How advantageous is it to focus on details to successfully handle this task?” (see table 5). The items were presented on a 5-point scale from (1) “*very advantageous*”/ “*very helpful*” to (5) “*not advantageous*”/ “*not helpful*”. As pointed out above, the aspects and thus the items are argued to be relevant in the context of a specific regulation or not. Consequently, a high rating (tending to 5, “*very advantageous*”/ “*very helpful*”) would cue for a high relevance of the concerned regulatory orientation. For example, a high score on the just mentioned item would signal that the considered task benefits from prevention relevant aspects (see figure 12 for a visualization of this principle).

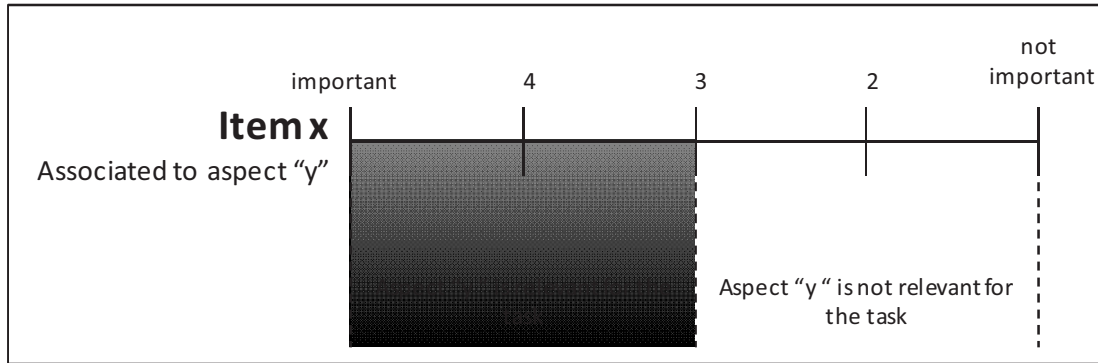


Figure 12: Scores associated to a specific item signal a task’s fitting or not in the considered framing.

To determine if a specific task can be considered as prevention or promotion framed, a promotion score and a prevention score will be computed: The promotion score (Mpro) is computed with the seven promotion items mean values and is thus a score with maximal 35 points. The prevention score (Mpre) is calculated on the same base using the seven prevention items. By subtracting the prevention score from the promotion score, we are able to provide a framing index (If). A positive framing index cues for tasks’ promotion framing while a negative framing index signals a prevention framing. Figure 13 shows the formula to compute tasks’ framing index (If) as well as its interpretation.

$$If = Mpro - Mpre$$

with $Mpro = (Pro.1 + Pro.2 + Pro.3 + Pro.4 + Pro.5 + Pro.6 + Pro.7)$
and $Mpre = (Pre.1 + Pre.2 + Pre.3 + Pre.4 + Pre.5 + Pre.6 + Pre.7)$

If > 0 → promotion framing
If < 0 → prevention framing

Figure 13: Framing index formula and interpretation

4.2 Task rating using framing questionnaire

4.2.1 Method

4.2.1.1 *Material*

As our focus is the applicability in the domain of UI-mediated tasks, we tested the framing questionnaire on a selection of simple computer-mediated tasks. These tasks were obtained by asking 10 persons who reported frequent computer use, to list some simple and frequently handled UI-processes which either fit in the description of a prevention framing (i.e., “based on error-detection and detail-orientation”) or, on the contrary, in the description of a promotion framing (i.e., “based on creativity and flexible handling”). Globally, the tasks proposed as being prevention framed demanded precise data-input or verification and involved choice-making that implied relatively weighty consequences (e.g., software-installation processes, handling critical data, filling in forms). The promotion tasks, on the other hand, were mostly based on content generating and information exploring or re-arranging (e.g., searching a solving strategy or information about a topic, creating graphical or verbal items). Table 6 lists the six prevention and the six promotion framed tasks.

| Prevention framed tasks | Promotion framed tasks |
|--------------------------------|-------------------------------|
| saving data | personal configurations |
| loading new program | online research/exploration |
| filling in online form | trying new program |
| performing configurations | researching for purchase |
| programming application | preparing visual presentation |
| transforming data | creating text/picture |

Table 6: Prevention and promotion framed tasks used to test the questionnaire

4.2.1.2 *Participants*

Twenty-one participants rated the twelve tasks using the framing questionnaire (i.e., mean age = 23.71, SD = 4.0).

4.2.1.3 Procedure

Participants were randomly presented a one-line description of a task (i.e., Loading program: “you are installing a program you need on your computer”) and were asked to give an extensive description of their understanding about this task. They were also asked to list some concrete examples of this type of task. This description was used to identify participants’ personal understanding of these tasks. Then, participants were asked to rate the task using the framing questionnaire. They were then presented with the next task.

For the six promotion tasks, we hypothesized strong scores on the promotion items (M_{pro}) and low scores on the prevention items (M_{pre}) and thus a positive framing index (If). Conversely, the six prevention framed tasks were expected to score highly on the prevention items (M_{pre}) and low on the promotion items (M_{pro}), leading to a negative framing index (If). This pattern of result would confirm that our questionnaire is able to predict tasks’ promotion and prevention framing.

In addition, we wanted to determine if each item indeed measures a promotion or a prevention aspect (M ≠). To do so, we compared individually items’ mean score for the prevention tasks (M ≠ pre) to the mean scores for the promotion tasks (M ≠ pro). Similar scores signal that an item is not related to promotion or prevention relevant aspects. Items that are not rated differently for promotion and prevention framed tasks will be excluded from the questionnaire. Figure 14 shows how to compute items’ mean difference as well as results interpretation.

| |
|--|
| <p>Mean \neq between promotion and prevention tasks per item:</p> <p>(Mean \neq) = (M \neq Pro) – (M \neq Pre)</p> <p>with (M \neq Pro) = (TPro.1 + TPro.2 + TPro. 3 + TPro.4 + TPro.5 + TPro. 6)</p> <p>and (M \neq Pre) = (TPre.1 + TPre.2 + TPre. 3 + TPre.4 + TPre.5 + TPre. 6)</p> <p>(Mean \neq) > 0 → item is measuring promotion aspects</p> <p>(Mean \neq) < 0 → item is measuring prevention aspects</p> <p>(Mean \neq) \approx 0 → items is not measuring regulation related aspects</p> |
|--|

Figure 14: Formula to compute and interpret items' mean differences

4.2.2 Results

Table 22 reports mean scores per questionnaire item and per task. In addition, the table shows the difference (Mean \neq) between the mean scores attributed to the six prevention tasks and those attributed to the six promotion tasks. As mentioned above, a high difference between the ratings signals that the item is either measuring aspects relevant for promotion tasks (Mean \neq > 0) or for prevention tasks (Mean \neq < 0). Conversely, a low difference signals that the item does not measure aspects related to regulation.

The results showed that the promotion and prevention tasks are not rated differently on the items Pre.7 (i.e., memorizing information) and Pro.6 (i.e., global view). Thus we argue that these aspects are not relevant for a specific regulatory orientation. This is also true for the items Pre.6 (i.e., familiarity) and Pro.7 (i.e., performance). In addition, contrarily to what we expected, Pre.6's mean difference indicates a promotion relevance (Mean \neq > 0) while Pro.7' mean difference indicates a prevention relevance (Mean \neq < 0).

Therefore, these four items were excluded from the questionnaire and all further analyses were performed on the remaining 10 items. A corrected version of the formula is presented in figure 15. Since the calculation is based on 10 items, promotion and prevention scores can reach a maximum of 25 points.

| |
|--|
| <p>If = Mpro – Mpre</p> <p><i>with</i> Mpro = (Pro.1 + Pro.2 + Pro.3 + Pro.4 + Pro.5)</p> <p><i>and</i> Mpre = (Pre.1 + Pre.2 + Pre.3 + Pre.4 + Pre.5)</p> <p>If > 0 → promotion framing</p> <p>If < 0 → prevention framing</p> |
|--|

Figure 15: Corrected formula to compute framing index

We computed each task’s framing index (If) based on the corrected formula mentioned above. Figure 16 gives an overview about each item’s contribution to tasks’ framing index. In addition, tasks are ranked from the lowest framing index (i.e., filling in online form) to the highest framing index (i.e., trying new program).

As expected, prevention framed tasks had negative framing indices which ranged between -4.1 and -10.8. Most of the promotion framed tasks had positive framing indices which were comprised between 1.8 and 8.5. Only the task “performing personal configuration” presented an index that was not conform to our expectations since it pointed out a prevention framing rather than a promotion framing (If = -1.6). Participants’ individual understanding of the task might explain this effect. In fact, nearly half of them (i.e., 10 out of 21) mentioned security related aspects (e.g., password-definition, firewall-configuration, backup-configuration) as part of the task. Thus, it seems logical that participants’ overall ratings reflected more a prevention framing than a promotion framing.

Overall, the results point out that the aspects we selected are suitable to predict tasks’ promotion or prevention framing. Obviously, the questionnaire cannot be generalized without statistical analysis of each item’s contribution strength on the framing index score. This would necessitate the usage of a higher number of ratings as well as a larger pool of tasks. Nonetheless, the results ensures a throughout understanding about the main criterions which underlay and indicate a task’s framing. Finally, this exploration also provides us with a choice of promotion and prevention framed tasks to use in the next study (chapter 4).

| Items | Prevention framed tasks | | | | | | Promotion framed tasks | | | | | | Mean \neq | |
|-------|---|---------------------|------------------------|---------------------------|-------------------------|-------------------|-------------------------|-----------------------------|--------------------|--------------------------|-------------------------------|-----------------------|----------------|--------------|
| | saving data | loading new program | filling in online form | performing configurations | programming application | transforming data | personal configurations | online research/exploration | trying new program | researching for purchase | preparing visual presentation | creating text/picture | | |
| Pre.1 | “How important is accuracy?” | 3.33 (0.84) | 3.10 (1.06) | 3.38 (0.65) | 3.53 (0.61) | 3.65 (0.68) | 3.59 (0.60) | 2.76 (0.97) | 2.76 (0.81) | 1.86 (1.21) | 2.82 (0.86) | 2.53 (0.70) | 2.06 (1.26) | -5.78 |
| Pre.2 | “How advantageous is it to focus on details?” | 3.00 (0.93) | 3.05 (1.00) | 3.67 (0.47) | 3.47 (0.78) | 3.60 (0.71) | 3.29 (0.67) | 2.65 (1.01) | 2.86 (0.77) | 2.38 (1.09) | 3.53 (0.61) | 2.47 (0.70) | 2.24 (1.11) | -3.96 |
| Pre.3 | “How important is it to avoid errors?” | 3.48 (0.79) | 3.19 (0.96) | 3.62 (0.65) | 3.76 (0.55) | 3.65 (0.68) | 3.35 (0.90) | 2.55 (0.92) | 1.71 (1.08) | 0.95 (1.00) | 1.82 (1.20) | 2.41 (1.09) | 2.35 (0.90) | -9.25 |
| Pre.4 | “How advantageous is it to avoid actions or strategies with not completely predictable consequences?” | 3.19 (1.01) | 3.48 (0.66) | 3.24 (1.06) | 3.18 (0.92) | 2.65 (1.13) | 2.82 (0.86) | 2.52 (1.10) | 1.52 (1.14) | 1.14 (0.89) | 1.71 (0.96) | 1.76 (1.06) | 1.53 (0.61) | -8.36 |
| Pre.5 | “How advantageous is it to follow a strict process?” | 3.05 (0.90) | 3.33 (0.84) | 2.95 (1.09) | 3.00 (1.03) | 3.06 (1.06) | 3.12 (0.58) | 2.10 (0.58) | 1.38 (1.25) | 1.76 (1.15) | 1.29 (0.82) | 2.29 (0.89) | 1.82 (1.04) | -7.86 |
| Pre.6 | “How advantageous is it to be familiar to context and options?” | 3.43 (0.85) | 2.90 (0.92) | 2.90 (1.27) | 3.76 (0.55) | 3.65 (0.68) | 3.88 (0.32) | 3.43 (1.00) | 3.19 (0.73) | 3.48 (0.73) | 2.35 (1.28) | 3.65 (0.48) | 3.12 (0.83) | -1.32 |
| Pre.7 | “How advantageous is it to memorize information?” | 2.43 (1.05) | 1.81 (1.33) | 2.19 (1.18) | 2.53 (1.24) | 2.88 (0.96) | 2.41 (0.91) | 2.19 (0.85) | 3.24 (1.15) | 3.19 (0.91) | 3.00 (2.54) | 2.29 (0.82) | 1.53 (1.04) | 1.19 |
| Pro.1 | “How advantageous is it to propose risky actions or solutions?” | 0.29 (0.45) | 0.48 (0.73) | 0.43 (0.73) | 0.53 (0.85) | 2.00 (1.19) | 1.29 (1.13) | 0.90 (0.97) | 2.19 (1.22) | 2.67 (1.13) | 1.35 (1.23) | 1.76 (1.23) | 1.59 (1.09) | 5.45 |
| Pro.2 | “How advantageous is it to be proposed different options and possibilities for achieving a task?” | 2.10 (0.81) | 1.81 (1.22) | 0.95 (1.05) | 2.35 (1.08) | 2.65 (0.90) | 2.82 (0.86) | 2.71 (0.98) | 3.43 (0.85) | 3.38 (0.79) | 3.00 (1.08) | 3.06 (0.80) | 3.24 (0.94) | 6.14 |
| Pro.3 | “How advantageous is it to try different actions or solutions?” | 1.10 (1.27) | 1.57 (1.05) | 1.00 (1.14) | 1.53 (1.33) | 2.94 (0.80) | 2.18 (0.92) | 2.43 (0.95) | 3.57 (0.79) | 3.76 (0.68) | 3.06 (1.00) | 2.82 (0.78) | 3.00 (1.17) | 8.33 |
| Pro.4 | “How advantageous is it to approach the task with flexibility?” | 2.14 (1.04) | 2.05 (1.21) | 1.57 (1.18) | 2.12 (1.13) | 2.88 (1.02) | 2.41 (0.97) | 2.24 (1.34) | 3.81 (0.39) | 3.57 (0.58) | 3.12 (0.96) | 3.06 (0.94) | 3.47 (0.61) | 6.09 |
| Pro.5 | “How probable is it to reach a satisfying result by trying different options?” | 1.95 (1.09) | 1.90 (1.15) | 2.10 (1.41) | 1.59 (0.91) | 2.00 (1.08) | 1.82 (0.98) | 2.71 (1.12) | 3.14 (0.89) | 3.24 (0.75) | 2.41 (1.33) | 2.88 (0.68) | 3.47 (0.61) | 6.50 |
| Pro.6 | “How advantageous is it to have a global view over all information?” | 3.00 (0.76) | 2.57 (1.26) | 2.57 (1.14) | 3.24 (0.73) | 3.29 (0.75) | 3.06 (0.80) | 2.76 (0.97) | 3.43 (0.73) | 3.05 (0.84) | 3.00 (0.91) | 3.47 (0.70) | 2.94 (0.94) | 0.92 |
| Pro.7 | “How advantageous is it to aim for high performance?” | 2.57 (1.37) | 2.10 (1.54) | 2.24 (1.41) | 3.00 (1.14) | 3.41 (0.69) | 2.88 (0.83) | 1.95 (1.21) | 2.29 (1.03) | 1.52 (1.33) | 2.18 (0.78) | 3.12 (0.83) | 2.53 (0.92) | -2.61 |

Note: Mean values tending to 5 signal an agreement with the item. Standard deviation is given in parentheses. The items excluded from further analyses are marked in light grey.

Table 7: Mean ratings per task and questionnaire item

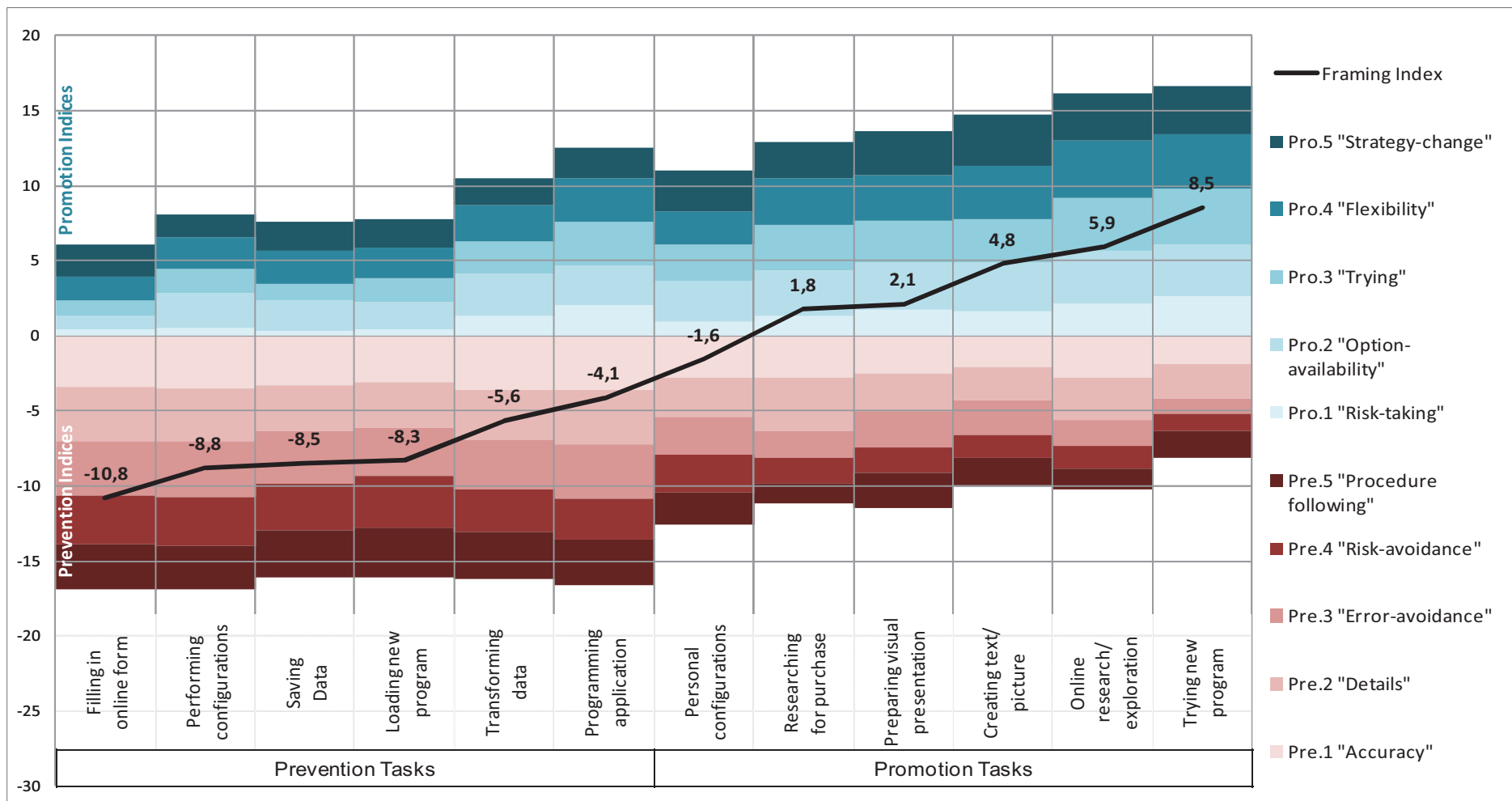


Figure 16: Items' contribution to tasks' framing indices

5 Chapter 4 - Study 3: Regulatory Fit when using a GUI

5.1 Introduction and hypothesis

The global purpose of the present research was to investigate how basic graphic interface characteristics can be used in order to support users to approach tasks in the most favorable cognitive state. A first exploration (i.e., Study 1, chapter 2) was able to demonstrate that graphic characteristics such as color and form are indeed able to induce either a promotion focus or a prevention focus. Furthermore, a second investigation (i.e., Study 2, chapter 3) demonstrated that some simple everyday tasks can be classified as promotion or prevention framed. On this base, this final study will explore the feasibility of transferring these principles to actual system interaction situations as well as the benefits resulting from this transfer.

Furthermore, one main goal being to explore solutions that are applicable in ecological contexts, this study will especially focus on close-to-nature material. This way, we expect to close the gap between fundamental research and applied real system interaction situations, and thus provide funded and usable approach to support users during task-solving.

In that line, this last part will explore following issues:

- a) Can the Study 1's findings be reported on an actual task-solving context? In other words, is color and form's effect on people's regulation still happening when the primes are integrated in tasks' visual layout and when an interaction takes place?
- b) Are there measurable differences when people's induced regulation fits tasks' framing compared to a situation of non-fit? In other words, is there a difference between solving prevention and promotion framed tasks when a prevention regulation (respectively promotion regulation) is triggered?
- c) Which kind of variables are affected when people's induced regulation matches handled tasks' framing or when it mismatches it? More precisely, are objective variables like performance affected? Or are more subjective variables like satisfaction influenced by these match or mismatch situations?

Globally, and in accordance to regulatory fit principle (Cesario et al., 2008), we expect an advantage for the fit situation where people’s induced regulation matches tasks’ framing over the non-fit situation where people’s regulation mismatches tasks’ framing. To be more precise, we expect the fit situation to be associated to higher or better performance as well as more positive subjective experience compared to the non-fit situation (see figure 17).

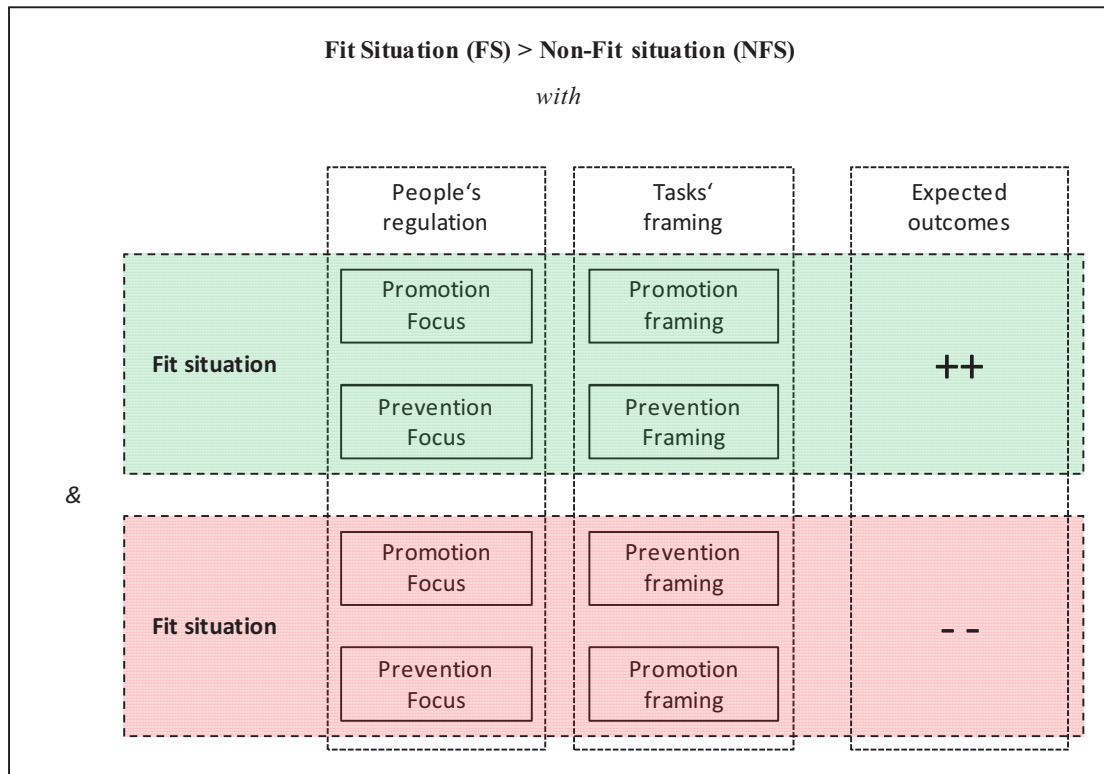


Figure 17: Visualization of this studies’ hypotheses.

5.1.1 Methods

5.1.1.1 Participants

One hundred and four students took part in the study in return for 15€ or course credit (40 male, 64 female, mean age = 25 years). Participants performed randomly one of the prevention framed tasks plus one of the promotion framed tasks, both being presented in the same design variant (i.e., either prevention design or promotion design).

5.1.1.2 *Material*

Our material was based both on study 1 (chapter 2) and study 2 (chapter 3).

5.1.1.2.1 Tasks

First, we selected four tasks, whose framing indices were particularly high (i.e., promotion framing) or low (i.e., prevention framing) and which could easily be transformed in interactive prototypes. Thus, the prevention tasks “application installation process” (If = -10.8) and “filling in online form” (If = -8.3) were selected for their prevention framing. In addition, the tasks “generating a text document” (If = 4.8) and “exploring a site” (If = 5.9) were selected for their promotion framing.

More precisely, the tasks were operationalized through interactive high-fidelity HTML prototypes running classic desktop computers:

- Application installation process: Participants were asked to install a new program in a free version first, in a premium version in a second time. Participants were provided with some instructions regarding choices (e.g., restrained or open access) or information to fill in (e.g., name of administrative contact person). Annex II | Figure II shows this tasks’ architecture.
- Filling in online form: Participants were asked to make an online application for a travel visa. They were provided with necessary information such as a passport or travel dates. Annex II | Figure III shows this tasks’ architecture.
- Generating a text document: Participants were asked to write a creative invitation for a birthday party. They were provided with some information that was asked to be integrated in the invitation text (e.g., date, party should have a theme). Annex II | Figure IIII shows this tasks’ architecture.
- Exploring a website: Participants were asked to spend some time on a website about psychological methods. Annex II | Figure IV shows this tasks’ architecture.

The prototypes were built in a way that enabled us to register participants actions (e.g., change of page, validating an input), information input (e.g., text input) as well as the time they spend to perform the tasks.

5.1.1.2.2 Graphic design

Study 1 demonstrated that the colors red and dark grey as well as sharp edged forms are able to activate a safety oriented prevention focus. It also showed that the color orange as well as round shaped forms activated a progress oriented promotion focus. Based on these findings, each prototype was created in two design variants: The first one was expected to activate a prevention orientation since it combined sharp-edged forms, a dark-grey overall shade as well as some red-colored elements. The second design was based on colors and forms that were linked to a promotion orientation (i.e., orange colored elements, round shaped contours). The designs have been created by a professional user interface designer. See figure 18 for a visualization of these designs. Additional screenshots are provided in Annex III.

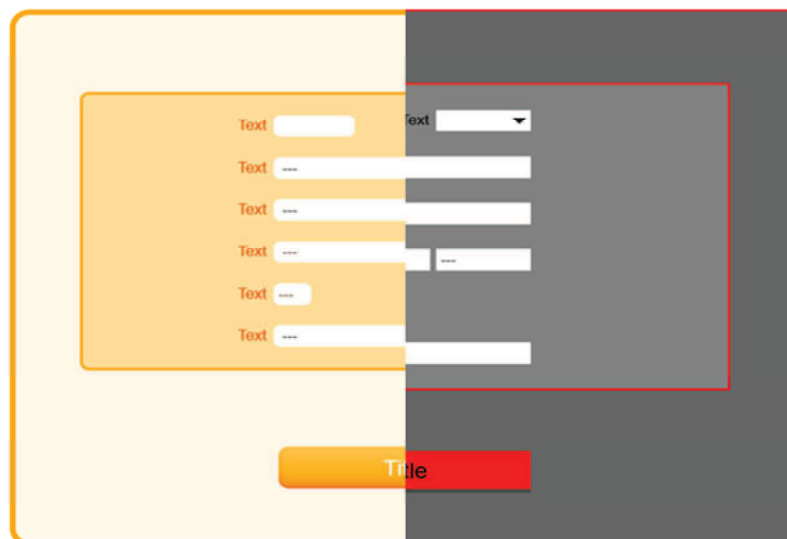


Figure 18: Screenshots of the expected promotion (left) and the expected promotion priming prototype variant (right).

5.1.1.2.3 Variables

One goal of the present study was to investigate which variables are or are not impacted by regulatory fit. To this end, we integrated a relatively wide selection of variables so as to detect which aspects might or might not depend on regulatory fit.

Regarding both prevention tasks, performance was assessed through two variables. First, we assessed task execution time by stopping time between the beginning and the ending of the execution. This data was automatically collected by the HTML prototypes and could be extracted from their scripts. Then, participants' responses were compared to the references they were handed out (e.g., which setting to chose, names or phone numbers to enter). Each deviation from these references was rated as an error. An error score was attributed to each participant having performed the task.

For the promotion task "generating a text document", performance was assessed via a creativity evaluation of participants' text productions. We used a 7-point creativity rating performed in a blind procedure by four evaluators. Evaluators' inter-reliability was computed during data-analysis and provided a Cronbachs alpha of .78. In addition, we assessed the time necessary to execute the task as well as the number of words participants used in their texts.

Finally, for the promotion task "exploring site", we assessed information recall which was evaluated on the basis of the amount of site-related information participants were able to write down after exploring the website. Two evaluators rated this recall on a scale from 1 (no recalled information) to 7 (high amount of recalled information). Their inter-reliability was computed during data-analysis and provided a Cronbachs alpha of .86. In addition, we assessed the amount and type of pages participants opened during the site exploration.

Participants' subjective experience was evaluated through following variables:

- Satisfaction and fun. These variables were assessed using two single item scales from 1, standing for a low level of satisfaction or fun, to 7, standing for a high level;
- flow (Rheinberg, Vollmeyer, & Engeser, 2003). A positive flow experience occurs when one is fully immersed in the process of fulfilling a

task. In other words, a high flow experience score signals that participants are positively focused on the task they currently handle ; and

- felt effort (SMEQ, Zijlstra, & van Doorn,1985). The SMEQ scale assesses participants’ subjective feeling of effort associated to the currently fulfilled task. A high felt effort signals that participants are experienced the task as difficult to handle.

Since visual design has often been linked to halo effects attributed to aesthetic appraisal (Angeli, Sutcliffe, & Hartmann, 2006; Tractinsky, Katz, & Ikar, 2000), we also evaluated this variable through the VisAWI questionnaire (Moshagen & Thielsch, 2012). Finally, participants’ chronic regulatory orientation was determined using the RFQ (Higgins et al., 2001). Table 8 lists variables assessed for each task.

| Variables | | Generating Text | Exploring Website | Filling Form | Installation Process |
|------------|---|--------------------|----------------------|-----------------|-------------------------|
| Subjective | Chronic regulatory orientation | x | x | x | x |
| | Flow (7-item scales) | x | x | x | x |
| | Satisfaction (7-item scales) | x | x | x | x |
| | Fun (7-item scales) | x | x | x | x |
| | Visual appraisal (7-item scales) | x | x | x | x |
| | Felt effort (0 to 220 points) | x | x | x | x |
| Objective | Solving time (seconds) | x | | x | x |
| | Error rate (compared to reference) | | | x | x |
| | Creativity (7-item rating) | x | | | |
| | Information restitution (7-item rating) | | x | | |
| | Opened pages/ Use of navigation page | | x | | |

Table 8: Overview of Dependent Variables

5.1.1.3 Procedure

In a first step, participants were asked to fill in the RFQ (Higgins et al., 2001) on a paper form. Then, they had to perform the first task which was presented on a personal computer. Information input had to be given via mouse and keyboard. After finishing a task, participants were asked to fill in the paper questionnaires assessing their subjective experience (described in the previous section). In a second time, participants were randomly attributed a second task. After solving it, they were asked to fill in the paper questionnaires assessing their subjective experience. Each task was

presented in each design variant so that at least twenty-five subjects performed it. See figure 19 for an overview of the procedure.

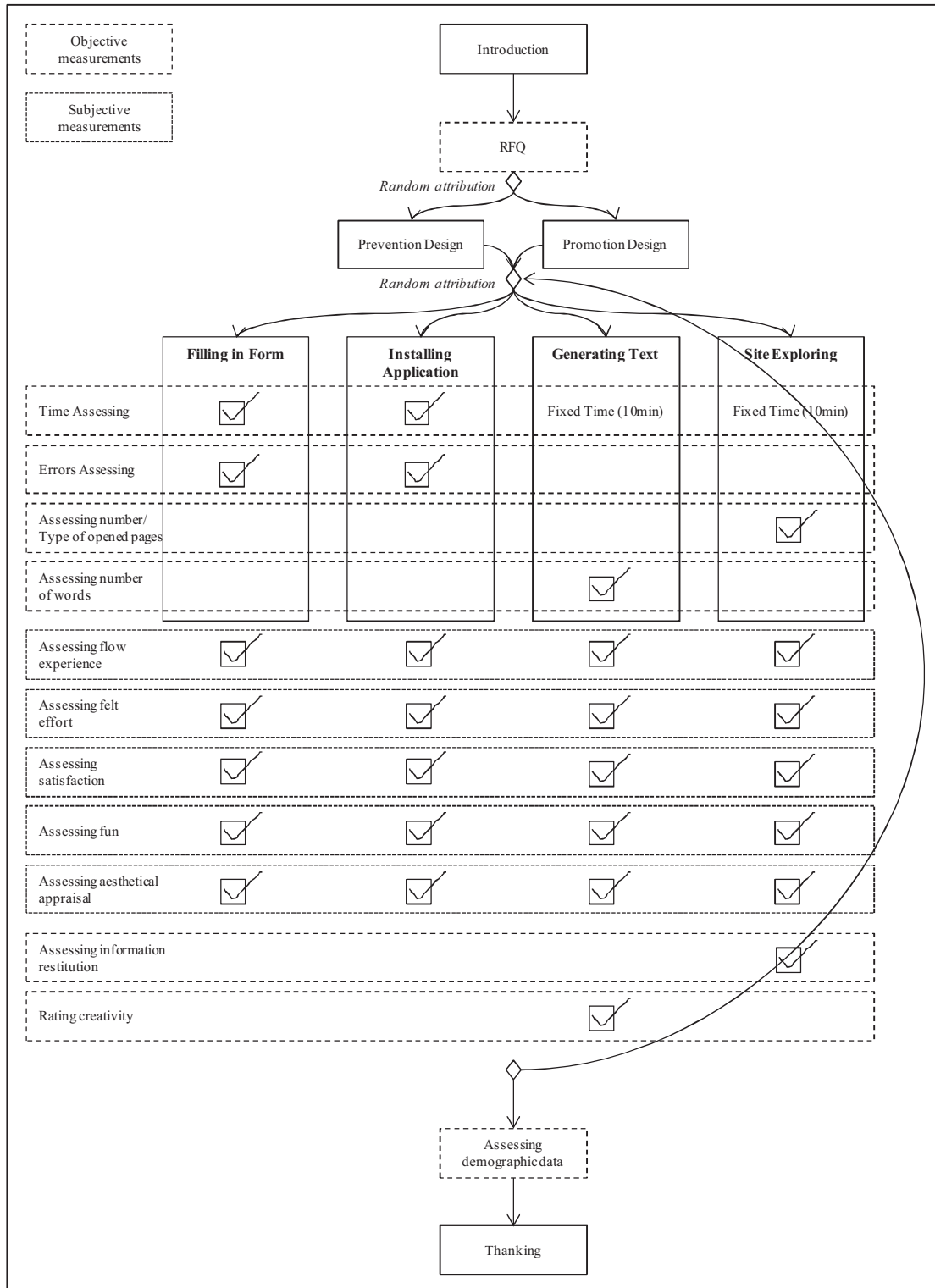


Figure 19: Schematic description of study procedure

5.1.2 Results

An analysis of variance was performed for each task (2 design variants x 7 or 8 dependent variables) in order to compare its execution as a function of the two design variants (i.e., promotion inducing design vs. prevention inducing design). These analyses aimed to detect effects related to the factor design.

In addition, an analysis of variance (4 Tasks x 2 design variants) was performed on the subjective variables which were identical for each task handling (i.e., visual appraisal, flow, felt effort, satisfaction and fun). This analysis aimed to detect global trends (main effects) as well as effects relative to participants' chronic regulatory tendency.

5.1.2.1 Chronic Focus

Participants' chronic regulatory tendency (CF) was assessed using the regulatory focus questionnaire (RFQ; (Higgins et al., 2001)). The questionnaire's output is a prevention tendency score on 24 points as well as a promotion tendency score which is also on 24 points. A positive difference between the scores ($(pro\ score) - (pre\ score) = CF$) is seen as a chronic tendency to use promotion strategies whereas a negative one is interpreted as a chronic prevention tendency. These scores were used as an additional independent variable in order to determine if participants' chronic focus affects the dependent variables. The analysis showed no such influence, which speaks for a successful visual priming overruling people's chronic focus.

It is to note that over 75% amongst participants are tending to a chronic promotion focus. This prevailing of the promotion focus concords with Uskul, Sherman and Fitzgibbon (2009) who hypothesized that the western culture promotes individualistic values which favor a self-achievement oriented promotion focus, compared to more collectivistic values that are predominant in eastern cultures.

Furthermore, an independent analysis showed that male participants scored significantly higher on the RFQ scale than female ones [$F(1, 102) = 5.09, p = .03$; $M_{male} = 5.18, M_{female} = 3.09$]. In other words, male participants have a higher tendency towards chronic promotion focus than female participants. However, no sex-

related difference was detected regarding performance or subjective experience variables. See figure 20 for an overview of chronic regulation tendencies' repartition.

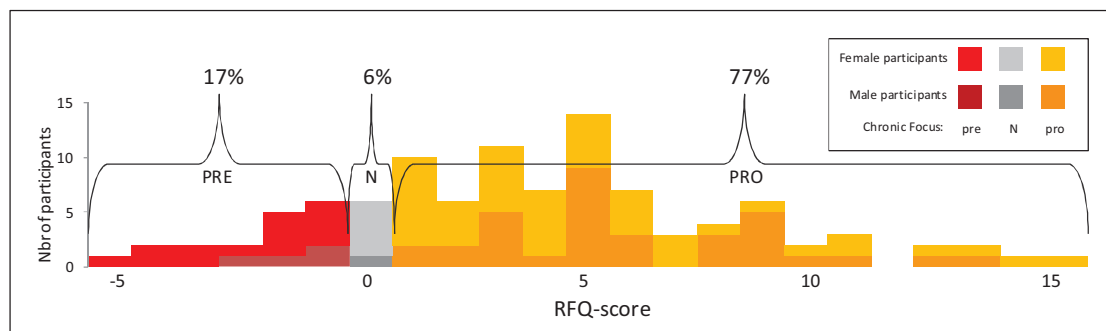


Figure 20: Repartition of participants' chronic tendencies

5.1.2.2 Subjective Experience

As we predicted, the measurable positive effects on the different subjective variables were all in favor of the fit situations (i.e., promotion tasks x promotion design, prevention tasks x prevention design) over the non-fit situations (i.e., promotion tasks x prevention design, prevention tasks x promotion design).

5.1.2.2.1 Satisfaction

For both prevention framed tasks, “installation process” and “filling in form”, participants gave higher satisfaction ratings in the prevention design condition compared to the promotion design condition: $F(1, 49) = 5.89, p = .02, \eta^2p = 0.11$ respectively $F(1, 51) = 7.97, p = .04, \eta^2p = 0.13$. Conversely, participants handling the promotion task “generating text” were more satisfied in the promotion design condition $F(1, 48) = 7.52, p < .01, \eta^2p = 0.13$. See figure 21 for a visualization of these results and table 9 for more details (e.g., mean values, standard deviations).

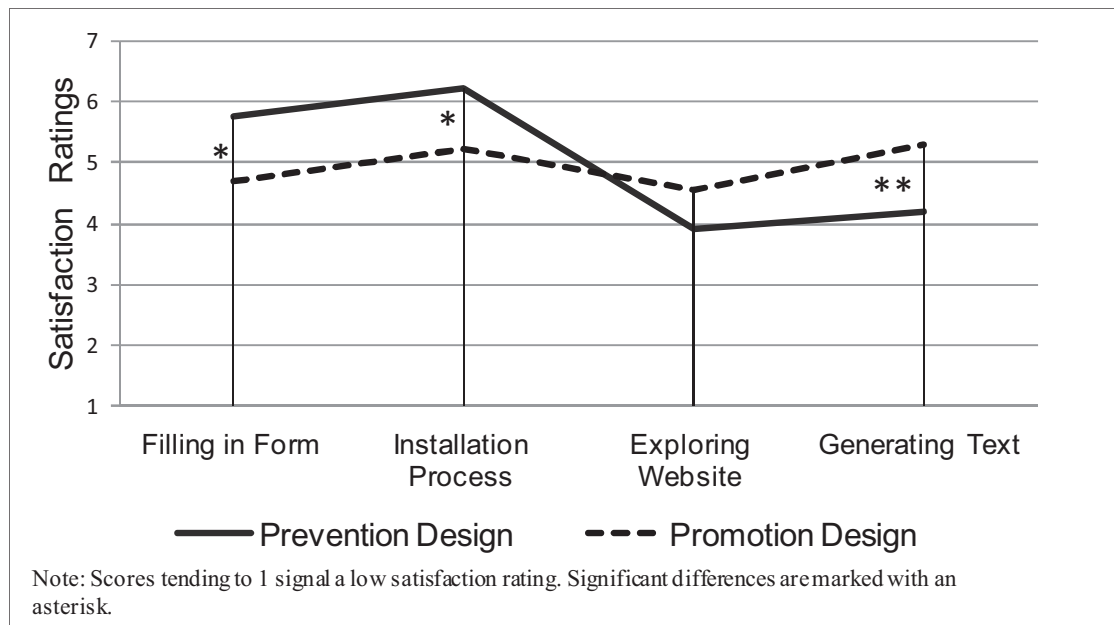


Figure 21: Satisfaction ratings depending on the factors task and design

5.1.2.2.2 Fun

Participants performing the promotion task “generating text” reported to enjoy task handling more in the promotion design condition compared to the prevention design condition: $F(1, 48) = 6.01$ $p = .02$, $\eta^2p = 0.11$. Participants performing the prevention tasks, “installation process” and “filling in form”, reported having more fun in the prevention design condition than in the promotion design condition: $F(1, 49) = 8.36$, $p < .01$, $\eta^2p = 0.15$ respectively $F(1, 51) = 7.00$, $p = .01$, $\eta^2p = 0.12$. See figure 22 for a visualization of these results and table 9 for more details (e.g., mean values, standard deviations).

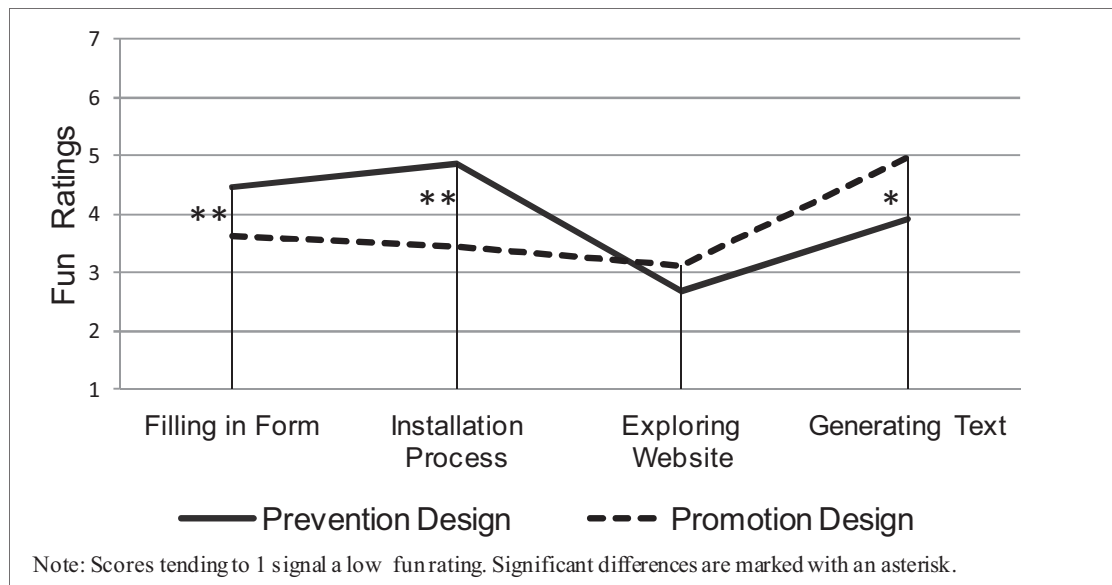


Figure 22: Fun ratings depending on the factors task and design

5.1.2.2.3 Effort

Participants performing the prevention task “filling in form” rated the effort lower in the prevention design condition than in the promotion design condition: [$F(1, 51) = 13.79, p < .01, \eta^2_p = 0.21$]. See table 9 for details.

5.1.2.2.4 Flow

Participants handling the prevention task “installation process” reported a higher flow-experience in the prevention design condition compared to the promotion design condition: [$F(1, 49) = 4.57, p = .04, \eta^2_p = 0.09$]. See table 9 for details.

5.1.2.2.5 Aesthetics

Finally, participants reported a higher aesthetic appreciation of the promotion design when they were performing the promotion tasks “generating text” and “exploring website” compared to the prevention design condition: $F(1, 48) = 14.94, p < .01, \eta^2_p = 0.24$ respectively $F(1, 48) = 11.88, p < .01, \eta^2_p = 0.20$. However, no such differences were observed regarding the two prevention tasks “installation process” and “filling in form”. An additional analysis showed that participants globally preferred the promotion design variant over the prevention one: $F(1, 196) = 21.03, p$

< .01, $\eta^2p = 0.10$. See figure 23 for a visualization of these results and table 9 for more details (e.g., mean values, standard deviations).

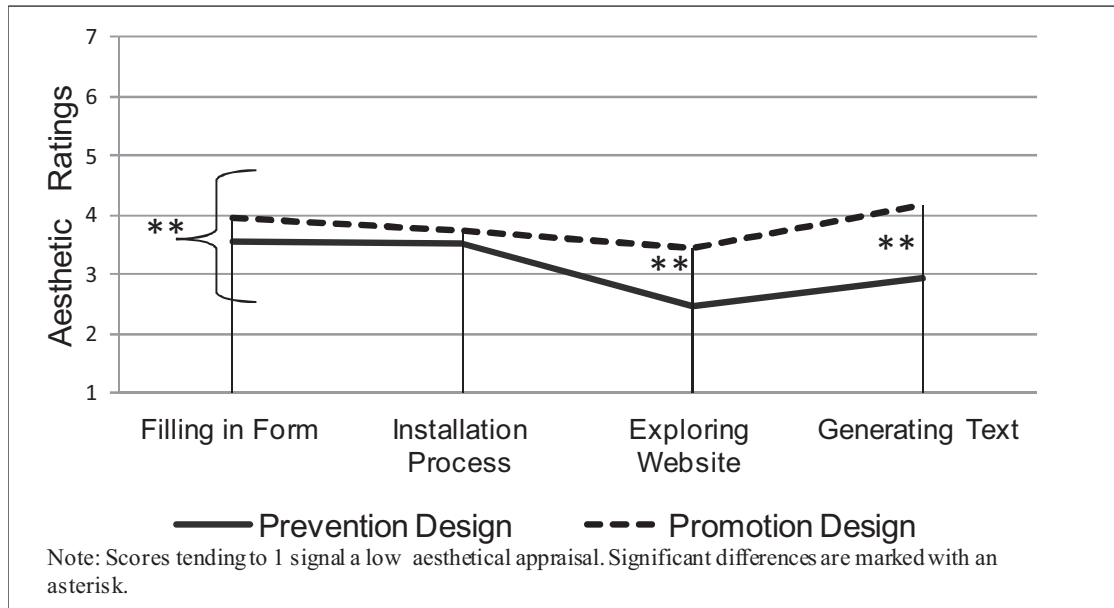


Figure 23: Visual appraisal ratings depending on the factors task and design

5.1.2.2.6 Performance

As predicted, performance measurements showed an advantage of the fit situations (i.e., promotion tasks x promotion design, prevention tasks x prevention tasks) over the non-fit situations (i.e., promotion tasks x prevention design, prevention tasks x promotion design). More precisely, participants solved the prevention tasks “filling in form” and “installation process” faster when the prototypes were presented in the prevention design variant compared to the promotion design variant: $F(1, 51) = 11.58, p < .01, \eta^2p = 0.18$ respectively $F(1, 49) = 29.79, p < .01, \eta^2p = 0.38$. See figure 24 for a visualization of these results and table 9 for more details (e.g., mean values, standard deviations).

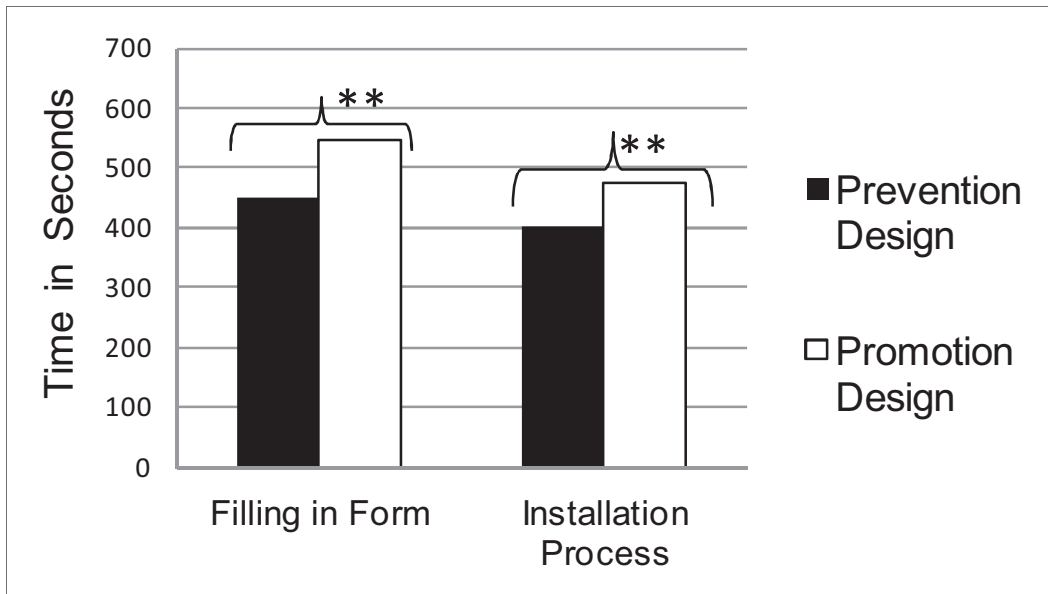


Figure 24: Solving time depending on the factor design for prevention frames tasks

Participants also made fewer errors in this same condition: $F(1, 51) = 15.43, p < .01, \eta^2p = 0.23$ respectively $F(1, 49) = 16.54, p < .01, \eta^2p = 0.25$. See figure 25 for a visualization of these results and table 9 for more details (e.g., mean values, standard deviations).

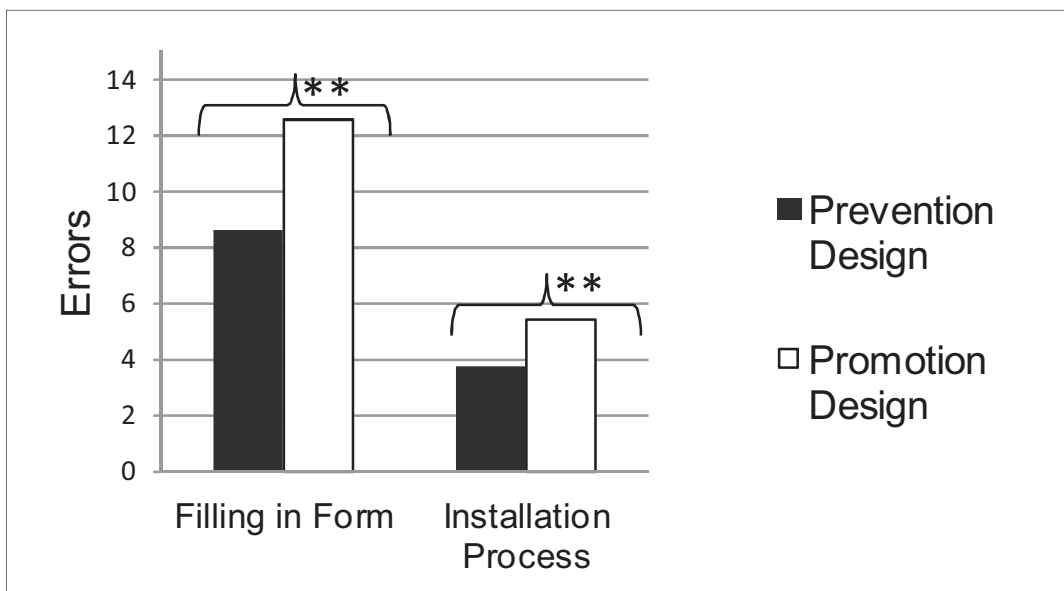


Figure 25: Error rate depending on the factor design for prevention frames tasks

Regarding the promotion task “generating text”, participants generated more creative texts when the task was presented in the promotion design variant compared to the prevention design variant $F(1, 48) = 9.76, p < .01, \eta^2p = 0.17$. No differences were observed regarding executing-time or the number of words they generated.

Finally, participants handling the promotion task “exploring website” were able to elicit more information when the task was presented in the promotion design variant compared to the prevention design variant: $F(1, 48) = 11.62, p = .001, \eta^2p = 0.19$. While no differences were detected regarding the number of pages opened, participants in the prevention design condition proportionally made a higher usage of the main page of the site $F(1, 48) = 12.98, p < .01, \eta^2p = 0.21$. It is to note that this main page presents an overview of the site-navigation, which suggests that participants using the promotion design version needed less guidance than the one using the prevention design version. See table 9 for details.

| | | Tasks | | | |
|-----------------------------|----------------------------------|--|---|---|---|
| | | Prevention framed tasks (accuracy, details) | | Promotion framed tasks (flexibility, creativity) | |
| Measured variables | | Filling in Form (FF) | Installation Process (IP) | Exploring Website (EW) | Generating Text (GT) |
| Subjective variables | Flow (7-item scales) | 5.13 ; 5.14 ^{ns} (1.22); (1.00) | 4.75 < 5.40** (1.09); (1.09) | 3.96 ; 3.52 ^{ns} (0.97); (1.08) | 5.17 ; 4.79 ^{ns} (0.89); (1.13) |
| | Satisfaction (7-item scales) | 4.70 < 5.77 * (1.32); (1.39) | 5.32 < 6.23 * (1.49); (0.99) | 4.56 ; 3.92 ^{ns} (1.69); (1.29) | 5.28 > 4.20** (1.43); (1.35) |
| | Fun (7-item scales) | 3.63 < 4.46 ** (1.08); (1.21) | 3.44 < 4.85 ** (1.36); (1.78) | 3.12 ; 2.68 ^{ns} (1.27); (1.52) | 4.96 > 3.92* (1.34); (1.63) |
| | Visual appraisal (7-item scales) | 3.96 ; 3.54 ^{ns} (1.17); (0.91) | 3.73 ; 3.51 ^{ns} (1.25); (1.34) | 3.43 > 2.46 ** (1.00); (1.11) | 4.16 > 2.94** (1.02); (1.20) |
| | Felt effort (0 to 220 points) | 60.0 > 31.7 ** (31.4); (23.3) | 40.0 ; 30.1 ^{ns} (20.9); (26.8) | 75.0 ; 95.0 ^{ns} (42.5); (46.6) | 47.4 ; 79.9 ^{ns} (28.7); (27.0) |
| | Solving time (seconds) | 546.6 > 452.2 ** (115.3); (83.5) | 474.2 > 402.5 ** (100.8); (73.45) | - | 464.7 ; 452.0 ^{ns} (137.9); (173.4) |
| Performance | Mean error rate | 12.59 > 8.62 ** (3.73); (3.63) | 5.44 > 3.69 ** (2.74); (1.54) | - | - |
| | Creativity (7-item rating) | - | - | - | 4.37 > 3.32 ** (1.10); (1.25) |
| | Number of words | - | - | - | 82.8 ; 79.9 ^{ns} (20.6); (20.2) |
| | Information restitution | - | - | 4.64 > 3.16 * (1.60); (1.46) | - |
| | Ratio of opened navigation pages | - | - | 0.16 < 0.27 ** (0.10); (0.12) | - |

Note: Mean values measured in the promotion design condition are given on the left, those in the prevention design condition on the right. Standard deviations are mentioned in parentheses.

Table 9: Detailed overview of results

5.1.3 Discussion

The main goal of this study was to propose solutions to sustain task handling in a context that does not allow additional verbal stimuli. More precisely, we evaluated how beneficial might be the pairing of prevention and promotion framed tasks with visual designs specifically created to activate matching promotion or a prevention regulatory orientations.

Globally, the results of this study supported these expectations since both objective and subjective variables pointed out a benefit associated to regulatory fit. Thus, prevention tasks “filling in form” and “installation process” were associated to faster and more accurate execution when the visual design activated a prevention focus (i.e., sharp edged forms, dark grey and red colors). Furthermore, participants’ writing was more creative when the promotion task “text generating” was presented in the promotion design condition (i.e., round forms, orange color). In this same condition, the promotion task “site exploring” was associated to higher information recall and a diminished usage of the main navigation page, which suggests a lower need for guidance. Participants executing the tasks “filling in form”, “installation process” and “text generating” also reported higher satisfaction and fun ratings in the regulatory fit situations.

Despite similar patterns of results, differences regarding participants’ flow experience and felt effort were globally not significant. We might assume that these effects are either too subtle to be detected or that these dimensions are globally not affected by regulatory fit. Furthermore, the exploration task, unlike the other tasks, was not associated with differences in fun and satisfaction ratings. It has to be mentioned that participants informally reported they globally liked neither the topic (i.e., experimental psychology) nor the task’s layout (i.e., based on a Wikipedia article). This globally negative perception of the task might have overruled regulatory fit’s positive effects on participants’ subjective experience while more objective dimensions were not negatively influenced.

Finally, results point out that the promotion variant’s (i.e., orange shades, round forms) was globally rated more aesthetical than the prevention variant (i.e., dark and red shades, sharp edged forms). However, this less appraised variant became equally

high rated when associated to regulatory fit. This effect demonstrates that despite an inherent aesthetic value, a relatively low appreciated design can be rated higher when it is part of a regulatory fit situation. In addition, the results show an absence of halo-effects (Angeli, Sutcliffe, & Hartmann, 2006; Moshagen & Thielsch, 2010; Tractinsky et al., 2000) which would have predicted a systematic better task-handling for highly appreciated designs. In other words, aesthetic value can also arise from a regulatory fit situation. Thus, not all that is beautiful necessarily works better. Further implications will be discussed in chapter 5, general discussion.

6 Chapter 5 - General discussion

6.1 Summary of the present studies

The sequence of experimentations presented in this dissertation point out the relevance as well as the benefits of considering a regulatory fit in the context of user interface mediated system interaction. It was shown that visual characteristics of color and form influence people's tendency to use either creative or accuracy oriented strategies to approach a specific task-solving situation. A match between tasks' natures ("framing") and these strategies support an efficient and satisfying system interaction ("regulatory fit").

In study 1, it was established that people's current regulatory orientation can be influenced by visual characteristics of color and form. More precisely, the color orange as well as round forms increased recognition of promotion relevant vocabulary in an anagram-solving task. These stimuli are frequently associated to promotion relevant ideas like progress or harmlessness, which can explain the priming effect. Conversely, dark and red colors as well as edgy forms share links to prevention relevant aspects like risk or errors. People exposed to these characteristics during anagram solving, recognized prevention relevant vocabulary faster than promotion relevant one. Interpreted in accordance to relevant literature (Mehta & Zhu, 2009), these results support our hypothesis, that some individual visual characteristics are able to activate specific regulatory orientations.

Study 2 proposed to classify criterions regarding their importance in the context of promotion or prevention framed tasks. A thorough review of related literature established that aspects such as a focus on details, error-avoidance or pre-defined procedures are relevant in the context of prevention framed tasks. Conversely, flexibility, creativity or availability of options, appeared to be relevant aspects in the context of promotion framed tasks. These findings were used to build a 10-item questionnaire which was supposed to identify the most relevant aspects for a specific task. Tested on some simple everyday computer tasks (e.g., application installation procedure, web-based researching), the questionnaire was indeed able to predict their promotion or prevention framing. Identifying tasks' framing was an essential step to determine the regulatory orientation that is most suitable to supports task's handling.

Study 3 was the main experimentation in this dissertation: It was hypothesized that user interface mediated tasks' solving could be supported if the visual design uses characteristics likely to trigger a regulatory orientation matching tasks' framing. In addition, the study was expected to inform about this visual priming method's applicability in ecological contexts. The results showed that people's solving strategies indeed differed in function of interface's visual design: A dark and edgy design was associated to higher accuracy while an orange and round visual design enhanced people's creativity. These strategic inclinations were more or less beneficial depending on task's framing: Prevention framed tasks were handled more efficiently when people tended to accuracy strategies while promotion framed tasks were supported by creative strategies. In addition, these regulatory fit situations seemed to have a positive impact on people's subjective experience since they reported higher satisfaction and fun ratings. Conversely, strategic inclinations mismatching tasks' framing (i.e., prevention tasks associated to creative strategies and promotion tasks associated to accuracy strategies) impaired interaction's quality regarding both performance related variables and subjective experience ratings.

6.2 Findings

Color and form elements can trigger specific regulatory orientations. Regulatory focus induction is usually based on verbal material (e.g., instructions, priming tasks, message framing, etc). Regarding non-verbal methods, they are mostly limited to gestural priming (Cesario & Higgins, 2008) and only a single publication focuses on visual priming (Mehta & Zhu, 2009). The present research was able to develop this field by proposing a relatively large panel of visual items having potential to impact people's regulation. Especially form elements are an interesting new aspect: Indeed, different studies were able to related forms to fear processing (Bar & Neta, 2006, 2007). However, no research has, at this day, established forms' impact on people's strategic orientation. In that line, Study 1 (Chapter 2) provides highly interesting findings which constitute a major progress to develop visual priming in the context of RFT.

Tasks can be classified as prevention or promotion framed. Task-solving is used in regulatory fit research to determine people's current orientation: High scores in creative tasks signal a promotion orientation while high scores in accuracy tasks cue for a prevention focus. However, there exists at this day no method to classify tasks on their framing and studies mostly rely on tasks "known as being" creative or accuracy-focused. In this line, the present research provides a valuable tool for a better and funded understanding of tasks' framing.

Regulatory fit's impact can be measured both on performance related variables and subjective experience related ones. Regulatory fit (respectively non-fit) has traditionally been associated to positive effects (respectively negative effects) on different variables. Most of them were related to persuasion and value attribution (Cesario et al., 2008; Cesario & Higgins, 2008). As for task-solving outcomes, they were used as indicator for people's regulation and rarely as an achievement for its one. The present research has investigated a large pool of variables related to task-solving and was able to show an impact both on performance related variables and on subjective related ones. These findings are particularly interesting for establishing regulatory fit principles in the domain of task-solving since its most important parameters are how well people solve a task and how positive they experienced the interaction.

Integrating specific color and form elements in actual UIs can activate promotion or prevention foci. One prominent achievement of the present research was to transfer item-based results to a close-to-nature experiment: While it was important to determine with precision which color or form items can activate a promotion or prevention focus, demonstrating their impact when used in prototype's interface was an important step towards an actual utilization of visual priming in ecological contexts. Obviously, Study 3 does not allow a differentiation of each items' contribution to the overall impact. However, it demonstrates that a combining of different items still provides strong results and ecological situations are precisely characterized by non-isolated items.

6.3 Implications

Color and form can be used to orient people's regulatory focus so as to be best adapted to tasks' framing. In fact, the main motivation of the present research was to identify visual methods suitable to orient people's regulatory focus so as to be best adapted to tasks' framing. The findings reported above suggest that such possibilities indeed exist: Simple everyday multimedia tasks can be classified depending on the strategies most suitable to solve them efficiently. This classification is proposed as criterion to choose the type of color and form characteristics to use in task's user interface: Colors and Forms triggering a promotion focus are suitable to sustain creative tasks while those activating a prevention focus support users in solving accuracy framed tasks.

Regulatory fit can improve both performance and users' subjective experience. As reported above, the benefits of regulatory fit are not limited to performance related variables. Interestingly, the impact was also measurable on more subjective variables such as satisfaction and fun. Influencing subjective variables is especially relevant regarding user experience (UX) research which focuses on how people individually experience interacting with systems, products, objects or services (Hassenzahl, Schöbel, & Trautmann, 2008; Law, Leicester, Hassenzahl, Vermeeren, & Kort, 2009). Thus, it is argued that acting on people's regulatory orientation constitutes a promising method to impact UX which becomes more and more a criterion for qualitatively outstanding products.

Color and form are both inherent UI elements and do not prompt additional cognitive load. One major concern guiding the present exploration was to propose solutions which would not impact the amount of information to process. In that line, basing regulatory focus induction on visual characteristics has the advantage of using elements naturally present in graphic user interfaces. In fact, color and form characteristics are aspects that are integrated in absence of conscious and effortful processing. By not imposing additional cognitive load, the method becomes especially suitable in situations that are often characterized by a high degree of complexity.

Priming necessarily occurs. Demonstrating the impact of visual priming also highlighted the fact that these effects are likely to occur in an unintended manner. In other words, characteristics of color and form necessarily influence people's

regulatory orientation. However, this effect is quite random and is as likely to be supportive as he can be impairing. For example, some interfaces might unintentionally trigger a regulatory orientation that misfits tasks' framing. Actively controlling them provides the chance to avoid impairing effects such as an unintended mismatch between user's regulatory orientation and task's framing (e.g., in study 3, participants made up to 30% more errors in a non-fit situation than in a fit situation).





This method can be used in ecological contexts. From the beginning on, the present research aspired to propose solutions usable in ecological contexts. To achieve this, we choose to focus on visual elements which are, as mentioned above, inherent parts of graphical user interfaces. In fact, UI are basically composed of areas (e.g., background, headers, buttons, text-fields, etc.) which differ in size, form and coloration. Coloration is a value that can be changed without major impacts on UI and thus provides a quite large choice in possible primes⁴. Form characteristics, on the other hand, are quite uniform: Most designs are based on straight parallels and perpendiculars. Only angles are likely to differ and range from right to round. However, the preliminary study reported in Chapter 2 | Preliminary Study 1, demonstrated that people associate different values and concepts to forms that only differ regarding their angles. The anagram study reported in Chapter 2 | Study 1B comforted the assumption that forms' angles are indeed sufficient to trigger opposed regulatory orientations. On this base, the proposed usage of color and form characteristics to impact people' regulation seems not only advantageous but is also suggested to be easily applicable in ecological contexts.

Aesthetics: not all that is beautiful is necessarily working better. The findings collected in this research also suggest to rethink the role traditionally attributed to UI's aesthetical value. In fact, participants rating the visual designs used in study 3 (chapter 3) globally appreciated more the promotion design variant compared to the prevention variant. However, the prevention variant became as high rated as the promotion variant when associated to a prevention framed task. This effect demonstrates that despite an inherent aesthetic value, a relatively low appreciated design can be rated higher when it is part of a regulatory fit situation. These findings stand against the overall admitted theory that "what is beautiful is usable" (Tractinsky

⁴ Obviously, some restrictions exist since specific domains are color-coded (e.g., medical domain usually uses blue coloration; ecological related domains use green colorations). Furthermore, the color red is not really usable on larger areas for inducing stress. For this reason, designs in Study 3 used red color only as highlights.

et al., 2000; Tractinsky, 2005). In this line, it is argued that not all that is beautiful is necessarily working better and aesthetic value can arise from a regulatory fit situation.

Choosing a design on regulatory fit principle is more advantageous than using aesthetical ratings. A highly interesting aspect concerns the methods and criterions used in design processes to select styles and design elements. As reported above, aesthetic values are often used as base for design choices. The main assumption underlying this method is that aesthetically appealing designs have a positive and linear correlation with interaction's quality (e.g., the higher the appreciation, the better the performance and subjective experience) and that it also might have no impact at all. In other words, design choices based on aesthetical principle are suggested to have either a positive or a neutral impact and the method is thus thought to be low-risk. However, the findings resulting from Study 3 (Chapter 4) show that design choices based on aesthetical principles can lead to impairing effects. In fact, participants globally preferred the promotion inducing design variant over the prevention variant. Consequently, a design choice based on people's ratings would logically favor the promotion variant so to satisfy the majority of participants. However, study's results point out that this choice is associated to disadvantageous outcomes in 50% of the cases: As illustrated in figure 26, favoring the promotion variant leads to a mismatch in the case of prevention/accuracy framed tasks. Conversely, applying the regulatory fit principles, that is to say choosing the design for inducing a regulation matching tasks' framing, would lead to 100% advantageous outcomes. In fact, designs would be chosen so as to favor the most adapted regulation, even if that meant to use a variant that is initially not the highest rated in aesthetical terms (e.g., prevention inducing design). Overall, this example favors a new understanding for a traditionally used method. Based on the findings presented in our dissertation, it is argued that aesthetic ratings alone might not be a sufficient base to select UI's visual designs. Also taking into account designs' potential impact on people's strategic regulation is proposed as advantageous method to support efficient and satisfying task-solving.

| Design choices based on: | | |
|--------------------------|---|---|
| | global aesthetical appraisal | regulatory fit principles |
| Type of tasks | creativity tasks  * | creativity tasks  * |
| Type of tasks | accuracy tasks  * | accuracy tasks  * |

* Note: Outcomes are classified as globally positive (green checkmark) or globally negative (red cross) in terms of performance and subjective experience.

Figure 26: Exemplary visualization of Study 3’s task-solving outcomes in dependence of the method used to chose the design

RF theory’s scope can be enlarged. The present research allows to expand RFT’s scope which is traditionally established in the domains of persuasion (Cesario et al., 2004, 2008; Cesario & Higgins, 2008), well-being (Higgins, 1997) or decision-making (Crowe & Higgins, 1997; Higgins, 2002). Indeed, study 3 was able to establish strong links to task performance dimensions and people’s utilization-related experience. These aspects are especially relevant for domains involving intensive task-handling activities.

Furthermore, non-verbal priming in general is rarely used in the context of RFT and then mostly involves gestural and behavioral stimuli (Cesario & Higgins, 2008; Cesario, 2008; Fennis & Stel, 2011). To our knowledge, visual cues are only mentioned in a single publication which exclusively compares the two colors red and blue (Mehta & Zhu, 2009). Thus, exploring of visual primes, especially novel ones like form, widens understanding of RFT.

Principle can be used as alternative explanation for some controversial result in color research. The topic of classic color research has already been aborted in this dissertation’s first part (chapter 1). However, it has to be mentioned that the findings exposed throughout this research might provide alternative explanations for the

discrepancies observed in this field. In fact, classic color researches has to this day, have failed to provide consensual dependencies between specific colors and performance (Elliot et al., 2007; Skinner, 2001; Tal et al., 2008). While lots of different settings were used, the natures of the tasks to solve were globally not taken into account. Contrarily to the broad assumption, the findings presented in this dissertation suggest that colors' facilitating or hindering impact on performance is unlikely to be linear (e.g., some authors argue that red color impairs efficiency in task solving, Elliot et al., 2007). An interaction between a color-induced impact on cognition and tasks' creative or accuracy oriented nature presents, in our opinion, a more plausible explanation as well as a path worth exploring.

For matters of completeness, a final topic has to be addressed here: In fact, a recurrent question encountered when investigating color-related fields, is the universality of observed effects. In fact, some semantic associations related to specific colors are proposed to relay on a cultural and acquired base. For example, and as mentioned in this dissertation's first chapter, it is commonly admitted that recurrent co-occurrence of a color and a context (e.g., red color and warnings) lead to associations such as the ones used to prime a vigilant-prevention focus. However, a large number of recent publications point out that colors' interpretation is probably based on evolutionary principles (Changizi, Zhang, & Shimojo, 2006; Elliot & Aarts, 2011; Elliot et al., 2010; Fetterman, Robinson, Gordon, & Elliot, 2012; Hughes, Higham, Allen, Elliot, & Hayden, 2015; King, 2005; Stephen, Oldham, Perrett, & Barton, 2012). For example, Elliot and Aarts (2011) compile findings issued from psychological, physiological and anthropological research. The authors expose that that in several primates, including humans, a red skin coloration signals attack-readiness, aggression or anger. More globally, King (2005) proposes an overview about principles underlying Human's color perception. The author argues that discriminating and interpreting colors has played a primordial role in Human's evolution: Color based codes are highly present in natural environments and are mostly mend to either attract or to signal a potential danger. For example, many plants benefit from having their seeds (e.g., fruits) distributed and have thus developed color characteristics likely to attract fruit eating animals. Conversely, some fruits as well as some animals use coloration to signal active or passive dangerousness (e.g., venomous snakes, poisonous frogs or fruits). Thus, Humans evolved in a context where color perception

mostly allowed to distinguish items of potential interest and those representing potential threat. These evolutionary associations between some colors and approach or avoidance motivations might underlie the priming effects observed in the different studies reported in this dissertation.

To sum up, the question about the universality of colors is not yet completely clarified: Some arguments point out a cultural origin of color's meanings, others support evolutionary principles. The studies reported in this dissertation have been conducted with western-cultured participants. Thus, it is advisable to treat the findings with caution if to apply in different cultures.

Further directions. Overall, this dissertation advocates a renewed focus on the bound linking UI's visual design to the type of task to handle. In fact, this kind of information is, if at all, usually reserved for a system's architectural and conceptual designing. Research on visually aesthetic interfaces in the early 2000s brought a new light on characteristics thought to be unimportant or only nice-to-have. However, visual characteristics are at this day, still considered as too subjective and the lack of reliable rules and guidelines hinders an objective and efficient usage. We hope that the findings presented in this dissertation will provide a base to rethink procedures and choices underlying user interface designing.

7 References

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Additional Material

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Summary Study 0

Motivation. This study aimed to link specific color and form items to results cueing for participants' current regulatory orientation. More precisely, we used a method developed by (Mehta & Zhu, 2009), which is based on a preference choice between two short descriptions for a same everyday objects (e.g., sofa, plant, shoes). One of the two descriptions is framed in a way to point out object's pragmatic characteristics (e.g., solid, long-lasting, security- or health-relevant) whereas the other one highlights hedonic characteristics (e.g., modern or fancy designed, progress- or development-relevant). Participants exposed to items activating a progress orientated promotion focus are hypothesized to prefer the hedonic description for matching their focus. Conversely, participants presented with items activating a vigilant prevention focus are expected to prefer pragmatic descriptions over hedonic ones.

Methods. 27 women and 10 Men took part in the study (mean age = 27). Material was composed of screens presenting two small lists of characteristics (i.e., one list was constituted by three promotion characteristics, the other one with three prevention characteristics) related to an everyday object (e.g., sofa, plant, shoes). The screens were presented with backgrounds displaying one of the form and color stimuli to test (i.e., orange, green, purple, blue, dark grey, edgy strait, slightly round and highly round form). Each stimulus was associated to two different objects and each everyday object was displayed in association with two different stimuli. See figure I for an example of material.

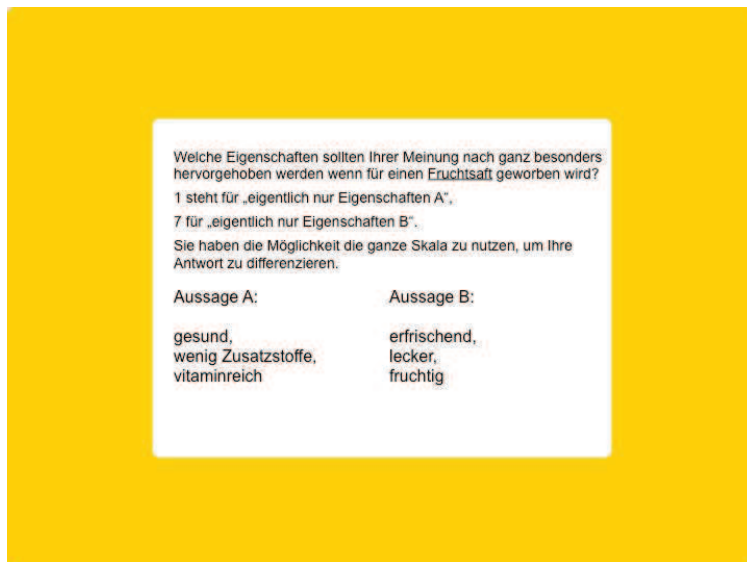


Figure I: Example of screen displaying the stimulus “Orange color”

Participants were asked in first step to inform RFQ (Higgins et al., 2001) to assess participants chronic regulatory orientation. They were then randomly presented the different screens and were asked to decide which characteristics (i.e., hedonic, pragmatic) they thought more fitting to describe the everyday object (i.e., preference scale from 1 “totally prefer characteristics A” to 7 “totally prefer characteristics B”).

Results and analysis.

The data-analysis failed to confirm our hypotheses. We assume that no effect could be identified because the objects themselves were strongly associated to either the pragmatic or the hedonic characteristics, so that no individual preference was expressed. For example, the object “Smartphone” was associated to a mean score of 5 on a scale from 1 (pragmatic characteristics) to 7 (hedonic characteristics) and this independently from the kind of stimulus presented as a background (i.e., promotion or prevention inducing). The reverse was true for the object “Coat” which had a mean score of 2.9 on the scale.

In addition, we think that stimuli were not displayed long enough in a row for influencing participants' choices: Indeed, participants informed their preference rating and quickly passed to the next screen. Consequently, they saw numerous prevention and promotion stimuli in short time. We can assume that in this situation of mixing, color and form's potential to act on people's cognitive regulation is reduced and not measurable. Based on these findings, further studies should be designed in a way so that participants are exposed continuously to a specific stimulus.

Appendix II: Prototype architecture

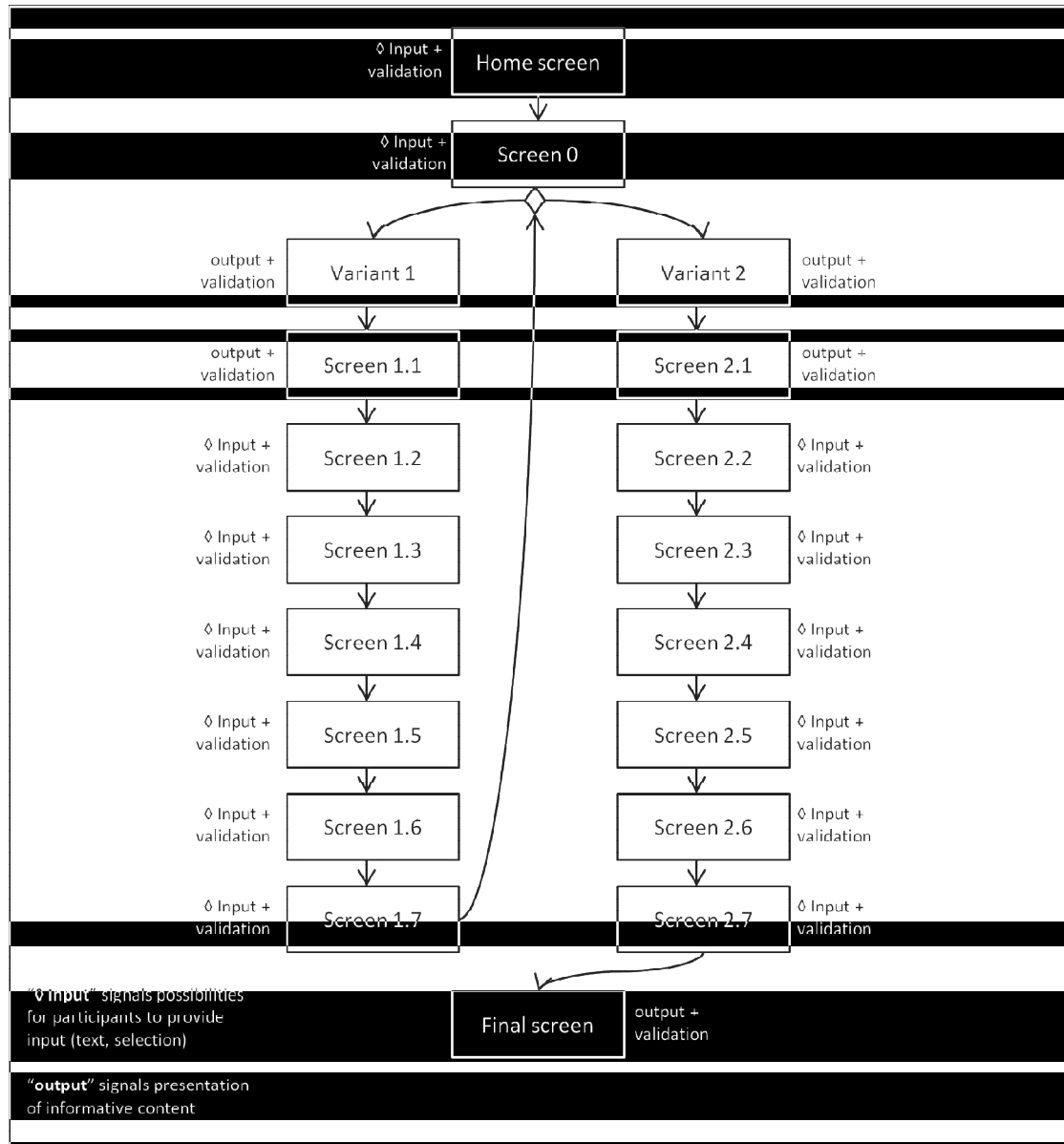


Figure II: Architecture of the prototype "installation procedure"

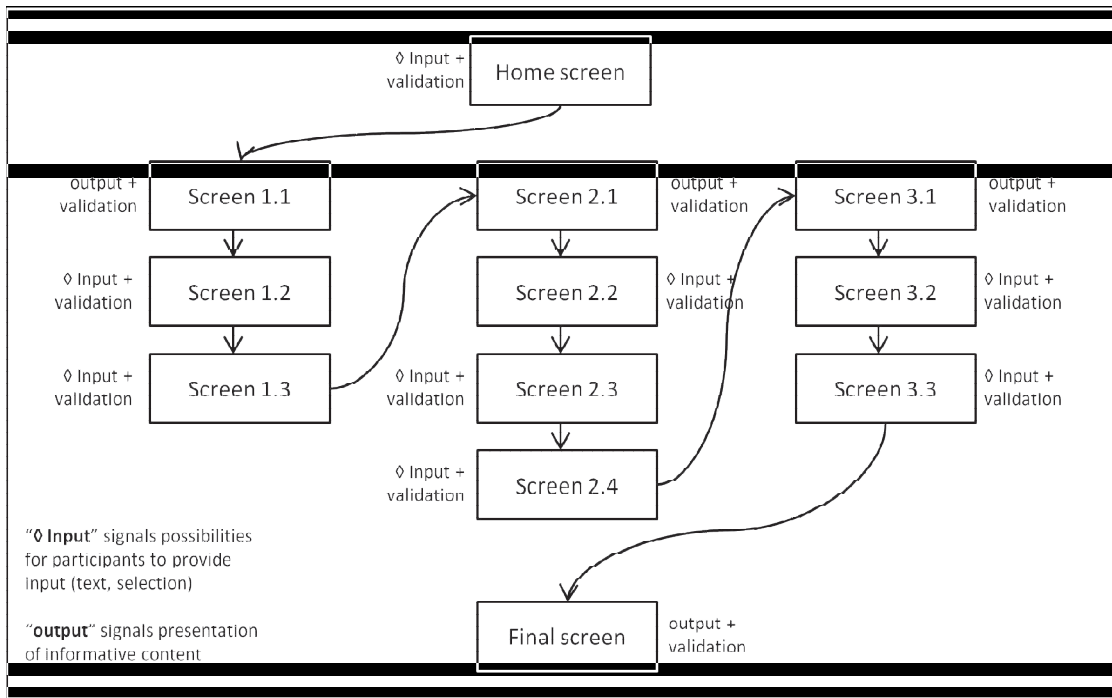


Figure III: Architecture of the prototype “filling in form”

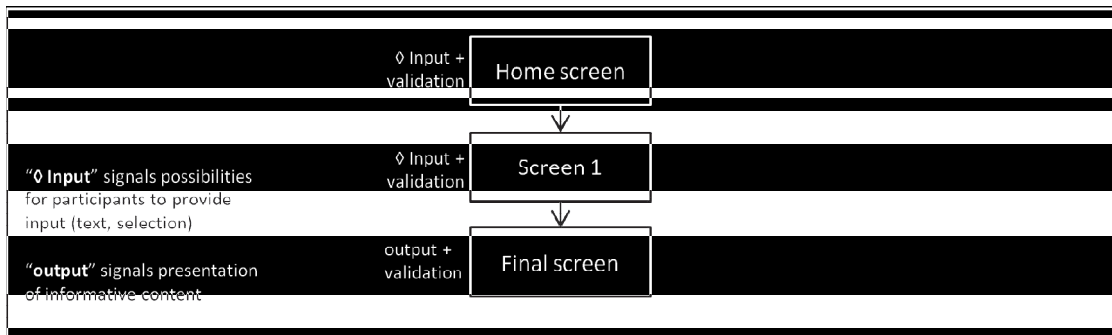


Figure III: Architecture of the prototype “generating text document”

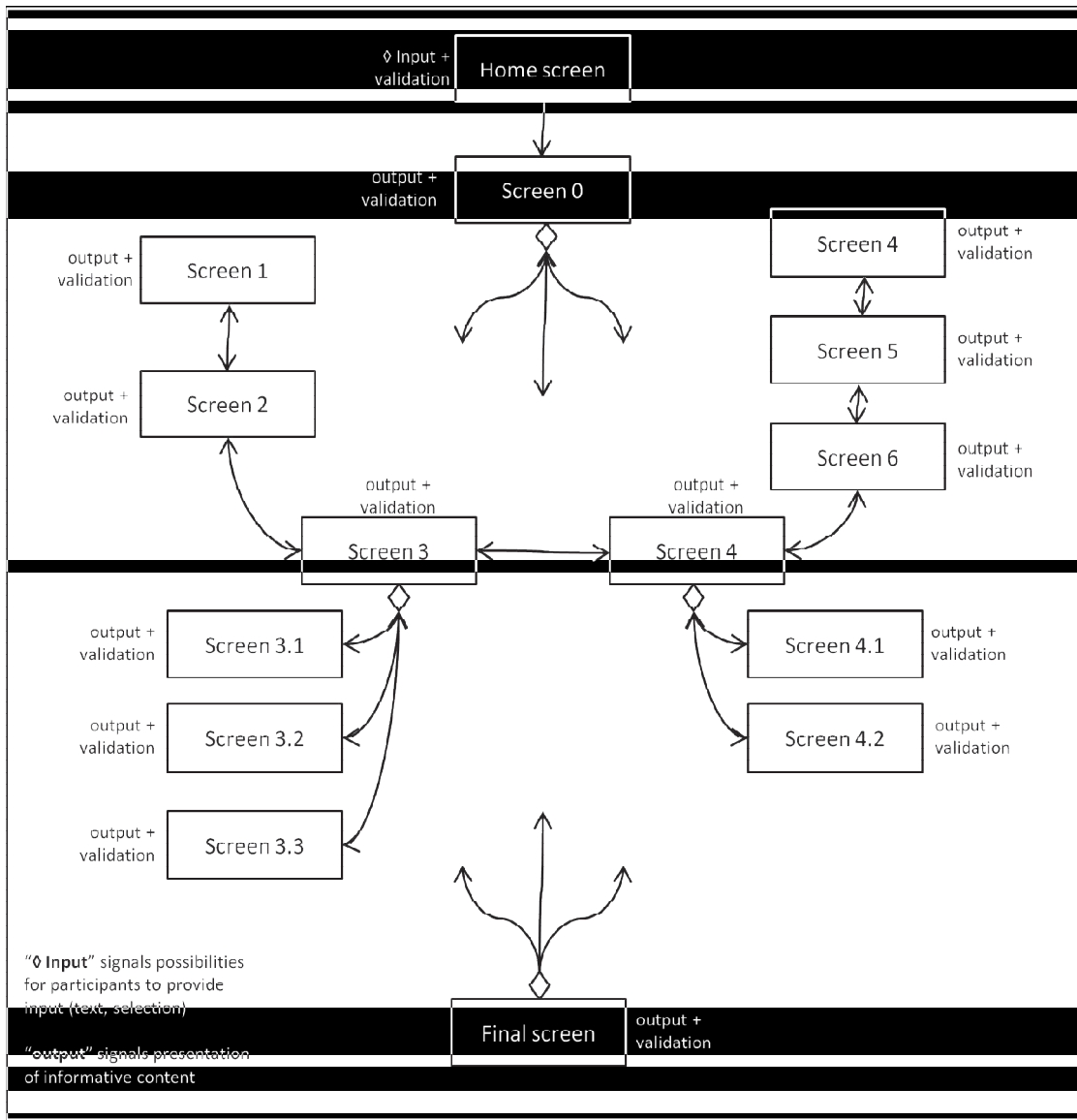


Figure IV: Architecture of the prototype “exploring website”



Figure V: Screenshots of different views from the four prototypes used in Study 3.

Interaction Homme-Machine et Théorie du Regulatory Focus :
Utilisation des Caractéristiques Graphiques des Interfaces Utilisateurs pour créer une
Concordance entre les Stratégies de Résolution et les Tâches à Résoudre

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Thèse soutenue le 17 Juillet 2015

devant le jury composé de

Nathalie Blanc, Michael Burmester, Marc Hassenzahl, Stéphanie Mailles-Viard Metz et Axel Platz

Résumé substantiel

Position du problème et objectifs de la thèse.

Le sujet de thèse se construit sur la Théorie du Regulatory Focus (Higgins, 2005, Higgins et al., 2003) qui distingue deux types de régulation métacognitive : le mode « promotion » et le mode « prevention ». Le premier se caractérise par des stratégies d'approche créatives et risquées alors que le second est caractérisé par des stratégies d'évitement familières et vigilantes. La performance, la satisfaction et l'engagement seront accrus si le mode de régulation de l'individu concorde avec les caractéristiques de la tâche ou de la situation. En se basant sur ces principes, le but de la thèse est de proposer une possibilité d'optimiser la résolution de tâches en milieu multimédia interactif (e.g., Interaction Homme-Machine) en favorisant cette concordance type de tâche/mode de régulation également appelée « regulatory fit ».

Problématique et Hypothèses.

Différentes possibilités d'induire une situation de concordance ont été démontrées au travers une multitude d'études, notamment un amorçage classique agissant sur le mode de régulation de l'individu. En effet, différentes études montrent que l'utilisation d'un vocabulaire axé sur la prévention et le risque dans le cadre

de consigne ou de descriptions permet d'induire un mode « prévention ». Au contraire, un vocabulaire orienté sur le progrès, le succès ou le jeu active une mode de cognition « promotion ».

Néanmoins, cette méthode n'est pas applicable au contexte d'utilisation d'interfaces graphiques pour trois raisons : tout d'abord, le milieu cible est un média très visuel dans lequel le contenu verbal est, en règle générale, prédéfini et donc peu compatible avec une utilisation d'amorces verbales qui risqueraient de perturber l'utilisateur. De l'autre côté, un rajout de ce type augmenterait considérablement la charge cognitive. Enfin, les contenus de type verbal ne sont pas nécessairement assimilés dans leur totalité puisque très souvent, les utilisateurs ne font que « survolent » celui-ci. Aussi, l'action d'amorces verbales nécessitant une lecture du contenu cible, un impacte réel ne peut être garanti dans un contexte écologique.

Dans cette optique, le travail de thèse propose tout d'abord d'identifier une méthode plus adaptée au contexte de résolution de tâche dans un milieu multimédia. Dans un second temps, nous avons déterminé une liste de caractéristiques permettant de catégoriser des tâches multimédia simples en fonction de leur concordance avec des stratégies de type précision et vigilance (« prévention ») ou bien de type créatif et flexible (« promotion »). La troisième partie, enfin, s'est intéressée à la validation de cette méthode dans un milieu réaliste ainsi qu'à l'évaluation de son impacte sur des facteurs de type objectif, comme par exemple la qualité de résolution de tâche, et de type subjectif tel que la satisfaction de l'utilisateur ou son appréciation de l'interface.

De manière générale, nous avons posé l'hypothèse que l'induction d'un mode spécifique de cognition, soit « promotion », soit « prévention », favorisera une augmentation de la qualité de résolution d'une tâche ainsi qu'un vécu positif de l'interaction à condition que ce mode concorde avec le type de tâche (par ex. créative ou de précision). À l'inverse, une non-concordance induirait une diminution de la qualité d'interaction et du vécu subjectif.

Partie 1 : Induire une cognition « promotion » ou « prévention »

Dans cette première partie, nous avons cherché à définir un amorçage visuel basé sur les propriétés graphiques inhérentes au médium, l'interface utilisateur. Plus particulièrement, nous proposons d'identifier des caractéristiques visuelles capables d'induire chez l'utilisateur soit un mode « promotion », soit un mode « prévention ». Ces amorces visuelles auraient l'avantage d'être facilement intégrable aux interfaces graphiques en fonction du type de tâche à réaliser.

Methodologies : Une revue de la littérature approfondie ainsi qu'une étude préliminaire ont permis d'identifier des types de stimuli visuels susceptibles de répondre à cette attente : ainsi, certaines caractéristiques de forme et de couleur semblent associées soit à l'idée de progrès et de créativité, soit à un risque de danger et d'erreur.

Une première expérience en laboratoire a permis d'établir de manière expérimentale que certains de ces aspects visuels ont bel et bien un effet d'amorçage: Cent vingt-neuf sujets ont été soumis à un paradigme de résolution d'anagramme dont les mot-cibles appartenaient soit à un vocabulaire relatif à la sécurité et la vigilance (e.g., « erreur »); au progrès et le succès (e.g., « gain »); ou encore étaient d'une nature neutre (e.g., « planète »). Les anagrammes à résoudre ont été présentées sur un fond visuel reprenant les stimuli à tester

(i.e., couleurs, formes graphiques). L'hypothèse était que le type de mots-cible concordant avec le mode de cognition induit par le stimulus serait reconnu plus rapidement que les mots appartenant à une catégorie non compatible. En d'autres mots, la résolution plus rapide d'un certain type de mots-cible permettrait de déduire l'effet d'amorçage du stimulus visuel présenté. L'absence de différences dans la rapidité de résolution des trois types de mots-cibles démontrerait quant à lui que le stimulus en question n'affecte pas (de manière décelable) le mode de cognition des participants.

Résultats obtenus. Les résultats ont montrés que certains éléments graphiques sont capables d'induire spécifiquement un mode de régulation. Ainsi, les éléments de couleur rouge, gris très sombre et de forme aux angles acérés ont été associés à une résolution plus rapide des mots-cibles de type vigilance et s'avèrent donc propices pour une utilisation en tant qu'amorce d'une cognition « prevention ». Au contraire, les éléments de couleur orange et de forme arrondi ont été associés à une résolution plus rapide des anagrammes de type progrès et sont donc utilisable en tant qu'amorce d'une cognition de type « promotion ».

Partie 2 : Classifier des tâches multimédia simples selon leur type

Cette seconde partie avait pour but d'identifier des tâches multimédias simples qui bénéficieraient soit de stratégies de résolutions de type précision (« prevention »), soit de type créatif (« promotion »). Plus précisément, il s'agissait de déterminer les caractéristiques différenciant ces deux types de tâche afin de permettre par la suite, de les assortir de manière ciblée à un type de stratégies de résolution. L'hypothèse était que le type de qualificatif associé à une tâche précise, par exemple relatif à la précision, permettrait de déduire quel type d'approche cognitive serait plus adaptée à sa résolution et donc de la classifier en tant que « tâche promotion » ou bien en tant que « tâche prevention ».

Méthodologies : Une étude approfondie de la littérature a permis d'identifier certains aspects ou idées spécifiquement associées soit à une cognition de type précision soit à une cognition de type créatif. De manière générale, la première est attribuée de qualificatifs tels que « précision », « détection », « maintien » ou encore « stabilité ». Au contraire, une cognition de type créatif est souvent associée à des caractéristiques telles que « flexibilité », « progrès », « prise de risques », « créativité » ou encore « performance ».

Ces caractéristiques ont été transformées en items d'un questionnaire qui avait pour but de déterminer l'orientation d'une tâche. Plus précisément, sept items visaient à déterminer le degré d'utilité de stratégies « promotion » pour la réalisation de la tâche en question (e.g., « *Est-il avantageux d'essayer différentes actions ou solutions ?* ») alors que sept autres devaient évaluer le degré d'utilité de stratégies « prevention » (e.g., « *Est-il avantageux d'éviter des actions ou solutions dont les conséquences sont peu prévisibles ?* »).

Dans une seconde partie, ledit questionnaire a été testé à l'aide d'une série de six tâches créatives et de six tâches de précision. 21 participants ont été priés de caractériser les tâches à l'aide du questionnaire. Les items « promotion » du questionnaire pourraient être validé s'ils étaient associés à des scores élevés pour des tâches créatives et faibles pour des tâches de précision. Des items ayant des scores similaires pour les deux types de tâches ne mesureraient pas le caractère « promotion » ou « prevention » des tâches et seraient donc écartés de questionnaire.

Résultats obtenus. Cinq items de type précision étaient, comme attendu, associés à des scores élevés pour les tâches « prévention » et faibles pour les tâches « promotion ». De plus, cinq items de type créatif étaient associés à des scores faibles pour les tâches « prévention » et élevés pour les tâches « promotion ». Ces items ont donc été jugés fiables pour prédire l'orientation « prévention » ou « promotion » des tâches. Quatre items ont été écartés du questionnaire en raison de leurs scores sensiblement similaires pour les deux types de tâches.

Partie 3 : Induire un mode de cognition en fonction du type de tâche

Cette dernière partie expérimentale avait pour but de tester la validité de l'amorçage dans une situation proche du contexte écologique. Dans un premier temps, l'étude visait à confirmer que l'utilisation ciblée d'amorces visuelles influence la résolution de tâches multimédia de type créatif ou bien de précision. Dans un second temps, il s'agissait d'identifier avec précision les variables impactées par la concordance ou l'absence de concordance entre le type de tâche et les stratégies de résolutions (« Regulatory Fit » versus « Regulatory Mis-Fit »).

Les hypothèses étaient les suivantes : l'intégration d'amorces visuelles « promotion » dans les interfaces graphiques favorise la résolution de tâches de type créatif et entrave la résolution de tâches de type précision. Au contraire, l'intégration d'amorces visuelles « prévention » dans les interfaces graphiques favorise la résolution de tâches de type précision et entrave la résolution de tâches de type créatif. Ces effets seront mesurables au travers de variables dites objectives tel que la performance de résolution de tâche ainsi qu'au travers de variables subjectives comme la satisfaction ressentie lors de la résolution de la tâche en question.

Méthodologies : Sur la base des résultats des deux premières études, deux tâches de type créatif (i.e., tâche de création de texte ; tâche de recherche et d'intégration d'information) et deux tâches de type précision (i.e., renseigner des formulaires ; procéder à l'installation d'une application) ont été présentées avec une variante d'interface graphique reprenant des amorces visuelles de type « promotion » (e.g., formes arrondies, couleurs oranges) et une variante intégrant des amorces « prévention » (e.g., formes « carrées », couleur sombres).

104 participants devaient résoudre une tâche de chaque type. Pour chaque participant, ces deux tâches étaient présentées dans la même variante variantes de design visuel. En d'autres mots, chaque participant était soit induit dans un mode cognitif « promotion » soit dans un mode de cognition « prévention ». En fonction de cet amorçage, nous nous attendions à ce que la performance de chaque participant serait meilleure lorsque la tâche concordait avec ce mode cognitif (« Regulatory Fit ») comparé aux performances associées aux tâches non-concordantes (« Regulatory Mis-Fit »).

Afin d'établir quels facteurs sont principalement impactés par la concordance ou la non-concordance entre le type de tâche et l'orientation cognitive, différentes variables ont été mesurées durant ou après la réalisation de chaque tâche. Ainsi, l'expérience subjective a été mesurée à l'aide des quatre variables « plaisir ressenti », « satisfaction », « flow ressenti », et « effort ressenti ». En fonction de la tâche, la qualité objective de résolution a été mesurée par deux facteurs parmi les suivants : « temps de résolution de la tâche », « nombre d'erreurs », « créativité », « rappel libre d'informations », « nombre et type de pages visitées ». De plus, les participants devaient évaluer le degré d'appréciation du design des interfaces graphiques.

Résultats obtenus : Conformément aux attentes, les quatre tâches étaient résolues différemment en fonction du design visuel dans lequel elles étaient présentées.

Tout d'abord, les participants reportent une satisfaction et un plaisir plus élevés lorsque les tâches « créatives » étaient présentées avec un design graphique amorçant un mode de cognition promotion que lorsqu'elles étaient présentées avec un design graphique « prévention ». Au contraire, les tâches de précision s'accompagnaient d'un sentiment de satisfaction et de plaisir plus élevé lorsqu'elles étaient présentées dans un design graphique amorçant une cognition « prévention ». En d'autres mots, la positivité ressentie par les participants ne dépendait ni du type de tâche à résoudre, ni du type de design mais, comme attendu, de la concordance entre le type tâche à résoudre et l'orientation avec laquelle un participant s'y consacre.

Un même schéma a pu être observé concernant les facteurs plus objectifs : En effet, les performances réalisées en situation de concordance (e.g., tâche créative associée à un design amorçant un mode « promotion ») étaient supérieures aux performances associées aux situations de non-concordance (e.g., tâche de précision associée à un design amorçant un mode « promotion »). Par exemple, les participants renseignaient plus rapidement tout en faisant moins d'erreurs les formulaires de l'une des tâches de précision lorsque celle-ci était présentée dans le design graphique amorçant un mode « prévention » comparé au design induisant le mode « promotion ». Au contraire, la tâche de réalisation d'un texte était accomplie avec un degré de créativité supérieur lorsqu'elle était présentée dans un design graphique amorçant un mode « promotion ».

Enfin, la mesure de l'appréciation des deux types de design permit d'observer que si les participants préféraient le design « promotion » de manière générale, le design « prévention » était tout autant apprécié lorsqu'il était montré dans une situation de concordance tâche-mode de cognition.

Partie 4 : Synthèse et Conclusions

L'ensemble des études menées dans le cadre de cette thèse soulignent l'importance à considérer le phénomène du « Regulatory Fit » dans le contexte d'interactions Homme-Machine d'autant plus que celle-ci intègre de plus en plus notre quotidien professionnel, privé et ludique. Une communication par le canal visuel y étant majoritaire, il est donc primordial de s'interroger sur les effets potentiellement bénéfiques ou handicapants que peut avoir l'utilisation de certaines caractéristiques visuelles.

Plus concrètement, il a tout d'abord été démontré que certaines caractéristiques visuelles, notamment les couleurs ou formes, amorcent bel et bien un changement du mode cognitif avec lequel les individus opèrent. Ensuite, nous avons pu confirmer que l'utilisation ciblée de ces amorces influence positivement l'expérience de plaisir et de satisfaction des utilisateurs et cela indépendamment du type de tâche ou du type de design graphique utilisé. De même, ces situations de « Regulatory Fit » contribuent à une augmentation des performances autant pour des tâches de précision que pour des tâches de créativité.

Ces résultats remettent en question l'approche traditionnelle qui associe linéairement des stimuli visuels tels que la couleur à des effets positifs ou négatifs (e.g., la couleur bleu augmenterait les performances indépendamment du contexte). De plus, les résultats montrent également que la valeur subjective qu'une personne attribue à un design ne dépend pas uniquement du caractère inhérent à celui-ci mais également à

son contexte de présentation puisqu'une interface utilisateur jugée moins attrayante est perçue comme plus plaisante lorsqu'elle s'intègre dans un contexte concordant.

D'un côté plus appliqué, ces résultats suggèrent une utilisation plus réfléchie et moins intuitive des caractéristiques visuelles dans le cadre des tâches multimédias. En effet, une utilisation ciblée de certaines amorces visuelles peut non-seulement éviter des effets négatifs non désirés mais également favoriser une résolution plus performante et plaisante.