Doctoral thesis submitted to
the Faculty of Behavioural and Cultural Studies
Heidelberg University
in partial fulfillment of the requirements of the degree of
Doctor of Philosophy (Dr. phil.)
in Psychology

Title of the thesis

A dynamic perspective on self-regulation and adaptive strategy:
The advantage of a regulatory shift

presented by
Peter-Samuel Arslan

year of submission
2018

Dean: Prof. Dr. Dirk Hagemann
Advisor: Prof. Dr. Klaus Fiedler

“Wandel und Wechsel liebt, wer lebt.”

Wotan in Rheingold (Wagner, 1869)

Acknowledgements

If you would have asked someone in my surrounding when I was twenty-one, that I will end up as a social psychologist in Heidelberg, no one would have ever believed you. Not even me. The past years have been the most liberating and pleasing, but also the most challenging and ambitious years of my life. I am grateful to be blessed with so many marvelous people that supported me to achieve my proficiency along this journey.

I want to thank Klaus for being the most inspiring mentor that I had in my life. You have encouraged me to think in dimensions that I would have never dreamed about. You have shaped my witty ideas into good scientific practice. You believed in my abilities even in times of doubt. Thanks to you, I have changed thoughts and ideas with great, elevating scientists from Mannheim, Cologne, Tübingen, Lisbon, Granada, Minnesota, Providence, and New York, which some of whom became good friends. You are truly a role model of a scientist and professor.

Thank you Sascha and Andi for letting me instantly distract you from your work and shifting your attention to more relevant issues. Thank you Dennis, for all the goofy social discussions at the edge of our field. Thank you Malte for being the most patient office-mate ever, and Florian for the advisory and teaching me that our knowledge can and should be applied to the real world. Nothing rolled without Ute. Thank you for keeping this crispy-circus on track. Thank you Ivan and Ulf for going through the PhD’s struggles and achievements together across departments. Also thanks to the entire research assistant team for being so reliable with my loopy and buggy experiments during data collections. Thank you all for times of being productive and entertaining together. I will miss our talks, our lunches, and the hearty laughing on the crisp-floor.

Finally, I want to thank my family for the unconditional support and the unshakable trust in my ambitions through many changes. Also thanks to my beloved nitzitum for the backup and the everlasting latschoship. Charlie my dear, thank you for your fortitude during my foolish ups and downs. Thank you for all the love and patience.

Heidelberg, CRISP, it was an honor. I will miss you.

Peter

A dynamic perspective on self-regulation and adaptive strategy:
The advantage of a regulatory shift

Table of contents

1. Introduction

The following chapter covers an outline of self-regulation on an abstract level and zooms further, on the basis of regulatory focus theory, to the detailed procedure of self-regulation circles. Additionally, the importance of a relativity approach in motivation will be discussed, and the general effects that we assume from a shifting, dynamic process in self-regulation will be presented.

1.1. A general model of self-regulation

Self-regulation models are concerned with what individuals choose to do and how they try to achieve their goals (Brown, 1998). The following framework follows the assumption that behavior is goal-directed and follows a certain purpose. Meaning that people select a goal from among various alternatives and then try to reach it. Of course, not all behavior follows this rule. Often, people act out of reflex, impulse, or habit. This type of non-purposive behavior is not covered in the following explorations.

Markus and Wurf (1987) distinguish between three components of the self-regulation process: a) goal selection, b) preparation for action and c) a cybernetic cycle of behavior. Before people can effectively regulate their behavior, they have to select a goal resp. decide what they intend to do. The probably oldest assumption about how goals arise is the hedonic principle. Freud expressed it in 1920 in a very comprehensive way: "It seems that our entire psychical activity is bent upon procuring pleasure and avoiding pain, it is automatically regulated by pleasure". Most motivational theorists agree to the hedonic principle but evaluate it as insufficient (e.g. Atkinson, 1964; Rotter, 1954; Wigfield & Eccles, 2000) and argue that goals arise not only on a value level (pleasure vs. pain) but also on people's expectancy to attain it. Thus, expectancy-value models assume that people select goals according to their expectancy of reaching them. Attaining a goal is associated with positive value, whilst not attaining with negative value. This is in line with the hedonic principle, but the extension of whether a goal is achievable or not plays a major role in that process. If, for example, you want to predict whether a mason apprentice, will adopt becoming a master as a goal, you would want to know how likely he thought it was, that he would successfully complete the master requirements and the value he places on becoming versus not becoming a master mason. In an expectancy-value model, these factors are assumed to combine in a multiplicative way. This means that we multiply the two factors together to determine the strength of an individual's motivation to engage in some behavior. This assumption has an important consequence. It means that if either value or expectancy is set at zero, the goal will not be adopted. If the mason sees no possibility that he can successfully complete the master lessons (i.e., if expectancy = 0), he will not apply to the program at craftsmen school, no matter how much he might value to become a master mason. Conversely, if he places absolutely no value on becoming a master (i.e., if value = 0), he will not apply to craftsmen school either, no matter how possible he thinks success would be.

Goals can be conceived at different levels of abstraction (Powers, 1973; Vallacher & Wegner, 1987; Trope & Liberman, 2010). Some are specific and concrete; others are broad and abstract. For example, learning a programming language may be relevant to several goals, such as "creating new experimental methods," "analyzing data more efficiently," or "understanding the logic of other programming languages". Generally speaking, goals conceived in broad terms assume greater value than goals conceived in specific terms (Vallacher & Wegner, 1987).

At the most general level, people's goals center on who they want to be or what they want to become (Brown, 1998; Markus & Nurius, 1986). For example, a person might be striving to "be independent" or even to "be a good person". Ideal goals like these are self-relevant and have been studied by numerous researchers (e.g., Emmons, 1986; Zirkel & Cantor, 1990; Higgins, 1987) and are often the most highly valued goals in life.

The second stage in the self-regulation process is the preparation for goal attainment. Here, people gather information (e.g. Fiedler & Juslin, 2006), construct scenarios regarding possible outcomes (e.g. Trope & Liberman, 2010), engage in behavioral practice (e.g. Bandura & Jeffrey, 1973) and develop different motivational strategies (e.g. Higgins, 1987). In short, they design and prepare to implement a plan to achieve their goal. Since preparation, or particularly strategy, has a significant relevance for this work, it will be discussed later on in detail. On an abstract level, goal selection and preparation are both embedded in the center of any self-regulation model: The cybernetic circle of behavior.

With the rise of computer development in the 1950s, cybernetics rivaled the dominant behaviorism theory (Skinner, 1938; Watson, 1913), which assumed that behavior is passing through a “black box” without considering cognitive processes. Later on, information processing was formally tagged with the acronym TOTE for Test-Operate-Test-Exit (Miller, Galanter & Primbam, 1986) and is still the basic principle for computational modeling techniques to create production systems with the rule: „IF...THEN“ (Eysenck & Keane, 2007).

TOTE involves four stages and is often exemplarily described by a heating thermostat: 1.) a test phase, in which a present value is compared against some relevant standard (the current temperature in the room is compared with the desired temperature). 2.) an operate stage, in which an action is undertaken to bring the present value in line with the standard (the heat comes on if the room temperature is below the standard). 3.) another test phase, in which the new value is compared with the standard (the new room temperature is compared with the desired temperature); and 4.) an exit, or quit-stage, which occurs when the desired goal is reached (the heater shuts off when the room reaches the selected temperature).

This sequence can be extended to the complexities of human behavior (Figure 1). It begins after a person has selected a goal and has prepared to attain it. For illustration purposes, imagine that a basketball player has adopted the goal of making 10 hits from the 3-point line in one game. After spending some time practicing (preparing), the player heads for the game. There, the player initiates his behavior (shot from the 3-point line), observes it (hit or miss), and compares it against the adopted goal (10 hits). So far, the sequence is not different than what was described with the thermostat. The complexities of human behavior enter into the analysis in the next two steps that are labeled as expectancy and emotional reaction in Figure 1.

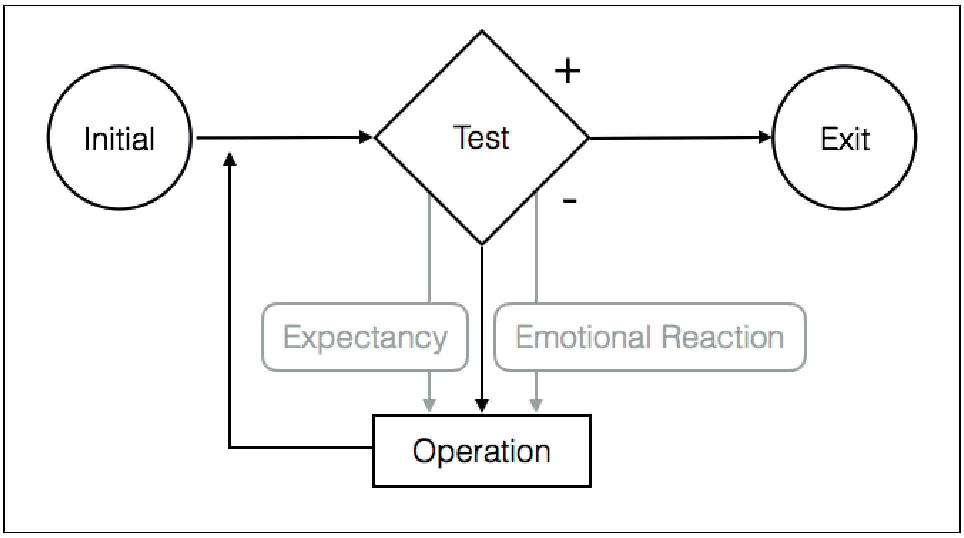

Figure 1. A general model of self-regulation. Paths illustrate the TOTE (test-operate-test-exit) regulation sequence with expectancy and emotional reaction as additional human complexities.

Let us assume that the player has fallen short of his goal (i.e., the defense was strong and he has made 6 instead of 10 hits). The player then expects the likelihood that the gap between his performance and the goal can be reduced. Let us treat this expectancy as a binary decision. That is, the player has either a favorable or unfavorable expectation of being able to close the gap. At the same time, the player is forming an emotional reaction to his performance. These emotional reactions can take many forms, ranging from positive emotions of pride and self-satisfaction to negative emotions of disappointment and despair (Higgins, 1987). Based on the expectancies he has formed and the emotion he is experiencing, the player will readjust his behavior. If his expectancies of success are high and his emotional reaction is positive, he will probably continue working towards his goal (i.e. 10 hits). If his expectancies of success are low and his emotional reaction is largely negative, he may give up the goal altogether (i.e. rather 2-point attempts).

The source of these feelings and the role they play in guiding behavior is since the school of Athena and perhaps even before, the subject of debate. From an expectancy-value perspective, the perceived distance from a goal is the critical determinant of emotion. Positive emotion arises when goals are judged to be within reach; negative emotion arises when goals are judged to be out of reach (Atkinson, 1964; Brown, 1998; Vroom, 1964). Carver and Scheier (1990) have offered an intriguing modification of this position. They have argued that the perceived rate of progress toward the goal is a more important determinant of emotion compared to the absolute distance from the goal. Positive emotion arises when people believe they are making adequate progress toward their goals; negative emotion arises when people believe they are not making adequate progress toward their goals. Thus, people can still feel good when they are far from their goals as long as they perceive that they are making progress.

The basketball player for instance, may score 8 out of 10 shots in his next game and feels great about it, because it signifies that he is on a good way to reach his goal, without actually reaching it. Thus, both factors (i.e., distance from the goal and progress toward it) influence the emotional reaction (Hsee, Salovey, & Abelson, 1994, Carver & Sheier, 1991).

Another issue is the extent to which the emotional reaction (whether it be determined by distance from the goal or rate of progress) guides behavioral adjustment. Duval and Wicklund

(1972) proposed that negative emotion arises whenever people become aware of a discrepancy between their current state and a relevant standard, and that this negative emotion is the main force that drives further attempts at discrepancy reduction. These arguments are based on Festinger's (1962) theory of cognitive dissonance in which the distance from the standard is valued as a disharmonic state.

Bandura (1986) has also argued that emotions play a critical role in the behavioral regulation process. In addition to discussing the role of negative emotions, he emphasizes that positive emotions, such as pride and self-satisfaction, motivate behavior by virtue of their capacity to function as positive reinforcements. The idea is that people are motivated to experience these positive emotions and that they regulate their behavior in an attempt to maximize these feelings of self-worth. For Bandura, these feelings, not information, govern people's behavior.

Carver and Scheier (1981) disagreed with this position. They maintain that informational factors, not emotional ones, guide the self-regulation process. If people believe that further efforts at discrepancy reduction will be successful, they continue; if people do not believe that further efforts at discrepancy reduction will be successful, they withdraw and quit. People may also experience various emotions when making these decisions, but the emotions themselves play no role in guiding behavior. The more important factor to consider, according to Carver and Scheier, is the relative distance, rather than the absolute distance to the goal, nor the simultaneously occurring emotions.

Allied with this assumption that emotions are not the primary guiding forces for human behavior, is the theoretical framework on self-regulation from Higgins (1987; 1997; 2017). As described above, the hedonic principle (avoiding pain vs. approaching pleasure) served a long time for an understanding of motivated behavior but suffered from simplicity. On an abstract level, research on value-expectancy has identified that goal-distance and emotional feedback play a crucial role in the self-regulation process. However, that does not clarify how people react to different kind of goals, and which strategies they prefer to reach them in particular. In terms of TOTE (Figure 1) it remains unclear, what is happening between initiating an action and testing it. What kind of behavior is beneficial to achieve a goal and how does it change in the adjustment process? The Regulatory Focus Theory (Higgins, 1997) attempts to solve these issues on a more detailed level.

1.2. Regulatory Focus Theory

Now, that we have outlined a general model of self-regulation, we will zoom into the processes that drive people towards different goals. Regulatory Focus Theory (RFT; Higgins, 1997) provides a coherent approach to shed more light into the "blackbox" of self-regulation. Higgins defined RFT in his milestone paper "beyond pleasure and pain" as the following: "Regulatory focus distinguishes self-regulation with a promotion focus (accomplishments and aspirations) from self-regulation with a prevention focus (safety and responsibilities). This principle is used to reconsider the fundamental nature of approach-avoidance, expectancy-value relations, and emotional and evaluative sensitivities (Higgins, 1997, p.1280)."

Thus, regulatory focus serves as an explanation for motivated behavior by a bilateral distinction of strategies and goal-types: Nurturance versus security; ideal (hopes) versus ought (duties) self-guides; presence and absence of positive outcomes versus absence and presence of negative outcomes; approaching matches to a desired end-state versus avoiding mismatches to a desired end-state; eager for "hits" versus vigilant against "errors of commission"; speed versus accuracy; global/abstract versus local/concrete; intuitions versus reasons (Higgins, 1987; Higgins, 1997; Higgins, 2017).

Higgins assumes that the hedonic principle should operate differently when serving fundamentally different needs; specifically, the distinct survival needs of nurturance (e.g., nourishment from breastfeeding) and security (e.g., protection from predators). As the hedonic principle suggests, children must learn how to behave with caretakers in order to approach pleasure and avoid pain. What is learned about regulating pleasure and pain differs for nurturance and security needs. Nurturance is about encouraging growth and development. Security is about being free from danger or threat. Taking this caretaker-child interaction into account, he assumes an increased likelihood that children will acquire specific kinds of goals and standards used in self-regulation, namely distinct self-guides (Self-Discrepancy Theory; Higgins, 1987).

These self-guides represent either a.) their own and significant others' hopes, wishes, and aspirations for them— ideals; or b.) their own and significant others' beliefs about their duties, obligations, and responsibilities—oughts. Regulatory focus theory proposes that self-regulation in relation to ideals versus oughts differs in the regulatory focus. Self-regulation in relation to ideal self-guides involves a promotion focus. Self-regulation in relation to ought self-guides involves a prevention focus.

Moreover, different pleasure and pain experiences represent another promotion-prevention distinction: the psychological difference between experiencing the presence and absence of positive outcomes versus the absence and presence of negative outcomes (Higgins, 1991). Let us first consider promotion focused caretaker-child interactions. For instance, when caretakers hug and kiss the child for behaving in a desired manner, they encourage it to overcome difficulties, or they set up opportunities for it to engage in rewarding activities. On the other hand the child will experience pain of the absence of positive outcomes when caretakers, for example, end a meal when it throws food all over the place, or they might take away a toy when it refuses to share it. In these cases, the child attains accomplishments or gets hopes and aspirations fulfilled in the first place, but it is communicated in reference to a state of the child that does or does not attain the desired end-state either "This is what I would ideally like you to do" or "This is not what I would ideally like you to do". In terms of regulatory focus, it is promotion — a concern with advancement, growth, and accomplishment.

These concerns differ when we consider a prevention focus in the caretaker-child interaction. For the child, it is the pleasure of the absence of negative outcomes when caretakers, for example, “child-proof” the house, train the child to behave safely, or teach the child to “mind your manners”. On the other hand, the child will experience the pain of the presence of negative outcomes when caretakers, for example, yell at it when it does not listen, criticize it when it makes mistakes, or punish it for being irresponsible. In these cases, the caretaker's message to the child is insuring safety, being responsible, and meeting obligations, but it is communicated in reference to a state of the child that does or does not attain the desired end-state either “This is what I believe you ought to do” or “This is not what I believe you ought to do.” In terms of regulatory focus, it is prevention—a concern with protection, safety, and responsibility.

Another important, and central distinction between promotion self-regulation and prevention self-regulation are the strategies, which are used in the pursuit of a goal. People can have the same general goal, such as getting excellent grades in school, but pursue that goal in different ways depending on whether they have a promotion or a prevention focus regarding that goal. For individuals with a promotion focus, getting excellent grades is an ideal hope or aspiration. For individuals with a prevention focus, getting the excellent grades is an ought duty or obligation. According to RFT, individuals pursuing an ideal emphasize taking actions that approach matches to that desired end-state, whereas individuals pursuing an ought emphasize taking actions that avoid mismatches to the desired end-state.

In a study by Higgins, Roney, Crowe, & Hymes, (1994), participants were asked to report either on how their hopes and goals have changed over time (priming promotion focus ideals) or on how their sense of duty and obligation has changed over time (priming prevention focus oughts). The participants then read about several episodes that occurred over a few days in the life of another student. In each of the episodes the goal was trying to experience a desired end-state and used either the strategy of approaching a match or the strategy of avoiding a mismatch, as in the following examples: a.) "Because I wanted to be at school for the beginning of my 8:30 psychology class which is usually excellent, I woke up early this morning." (approaching a match to a desired end-state); and b.) "I wanted to take an online-course in programming, so I didn't register for an online-course in learning Italian, because I do not have enough time." (avoiding a mismatch to a desired end-state). When a promotion (vs. prevention) focus was induced, the participants remembered the approaching desired end-states episodes better than the avoiding mismatch episodes, whereas the opposite was true when a prevention (vs. promotion) focus was induced.

To interim conclude, when engaged in a promotion-focused self-regulatory process, people's growth and development motivates them to bring themselves into alignment with their ideal selves, thereby heightening the presence or absence of positive outcomes. In contrast, when engaged in a prevention-focused self-regulatory process, people's security prompts them to bring themselves into alignment with their ought selves, thereby increasing the absence or presence of negative outcomes. Now that we have identified the differences between the promotion and prevention focus, let us investigate how the bilateral nature of the regulatory focus relates to the expectancy-value model.

Regulatory focus and expectancy-value model. Shah and Higgins (1997) argue that expectancy-value theories have failed to specify the conditions that influence the interaction of expectancy and value on goal commitment. They assume that the interactive effect of expectancy and value varies according to the regulatory focus involved in goal attainment; that is, whether the goal is construed as an accomplishment or aspiration (promotion focus) versus whether it is construed as a duty or responsibility (prevention focus).

In one study for instance, Shah and Higgins manipulated regulatory focus by framing a choice situation in terms of either prevention or promotion. Student participants were asked to rate the likelihood whether they would take a certain class in their major. They were also asked to rate the expectancy that they would do well and the value of doing well. The regulatory focus manipulation contained an application scenario of their major's honor society, and that their class performance will influence the chances of admission. In promotion framing they should maximize the chances of acceptance. In prevention framing they should minimize their chances of being rejected. The results support the assumption that regulatory focus interacts with expectancy and value. The direction of the interaction indicates that the effect of expectancy and value on choice is significantly more positive when the task information is framed with a promotion focus than with a prevention focus. Shah and Higgins (1997) replicated this significant three-way interaction among regulatory focus, expectancy, and value on goal commitment in three additional studies. Again, the direction of these interactions indicates that the positive interactive influence of expectancy and value on goal commitment increases when the goal was construed as an accomplishment or aspiration (promotion focus) but decreases when it is viewed as an obligation or necessity (prevention focus). In sum, only promotion-focused individuals behaved as predicted by expectancy-valence theory, while prevention-focused individuals did not.

However, the study of Shah and Higgins (1997) lacked from additional affective boundary controls. Brockner & Higgins (2001) argue that the nature and magnitude of people's emotional reactions depend on regulatory focus processes. More specifically, the nature of their emotional reactions is dictated by whether they are promotion focused or prevention focused. When promotion focused, people's emotional experience varies along a cheerful–dejected dimension. Positive feedback (high expectancy) raises cheerful reactions, whereas negative feedback (low expectancy) elicits dejection and disappointment. When prevention focused, their emotional reactions vary along a quiescence–agitation dimension. Positive feedback leads to quiescence (e.g., happiness and pride) while negative feedback elicits agitation (e.g., anger and fear).

Even though the nature and magnitude of people's emotional experiences does not rely on regulatory focus alone. Brockner & Higgins argue that motivation strength and feedback may play an additional role as well. Given that expectancies and values influence people's motivation strength, those conditions in which expectancies and values give rise to higher levels of motivation should be associated with more positive emotions when they succeed and more negative emotions when they fail. Therefore, emotions should vary on a cheerful–disappointed dimension when people are in promotion focus and on a quiescence–agitated dimension when they are in a prevention focus. Interestingly, the combination of low expectancy and high value is the only instance in which regulatory focus influences people's motivation strength such as that motivation is greater when people are in a prevention focus than in a promotion focus. An intriguing implication of this finding is that when people maintain low outcome expectancies and high outcome values, their emotions will differ as a function of their regulatory focus both in nature and in magnitude. Given the higher motivation exhibited by prevention-focused individuals with low expectancies and high valences, they should experience relatively strong quiescence when they succeed and relatively strong agitation when they fail. Given the lower motivation exhibited by promotion-focused individuals with low expectancies and high valences, they should experience relatively mild cheerfulness when they happen to succeed and mild disappointment when they happen to fail (Brockner & Higgins, 2001).

An important determinant of the magnitude of the emotions experienced within each type of regulatory focus is the extent to which people's actual self falls short of their goal or standard (negative discrepancy). The more negative the discrepancy, the more likely are people to experience negative emotional reactions (dejection in the case of a promotion focus and agitation in the case of a prevention focus). To test this hypothesis, Strauman (1989) assessed the magnitude of the negative discrepancies between people's actual/ideal self and their actual/ought self. Two months later, participants completed various measures of emotionality. Factor analysis of the latter measures revealed two dimensions: disappointment/dissatisfaction (e.g., "disappointed in yourself") and fear/restlessness (e.g., "feeling you are or will be punished"). The relationship between the magnitude of the actual/ideal self-discrepancy and disappointment/dissatisfaction was significant, but there was no relationship to fear/restlessness. Moreover, the relationship between actual/ought self-discrepancy and fear/restlessness was significant, but there was no relationship to disappointment/dissatisfaction. Although, the results reveal insights about the quality and magnitude of emotions, they have only been assessed on an absolute discrepancy level. Progress was not considered in that study.

To recapitulate, promotion focus fits to the expectancy-value model in the matter that the more people desire a goal (e.g. nurturance) and expect to succeed, the higher is their motivation to pursue it, compared to a low motivation if both desirability and expectancy are low. This activates feelings of cheerfulness when they succeed and dejection when they fail. Prevention focus on the other hand, does not fully fit in that model. People's motivation with a highly desired goal (e.g. safety) remains high, even if their expectation to succeed is low. This activates feelings of quiescence when they succeed and agitation when they fail.

Let us now zoom out again to the abstract level of the cybernetic circle. We have enriched the TOTE-process by the bilateral nature of the regulatory focus theory. Regulatory focus serves as a reasonable explanation for how an initiated action leads to the attainment of different goals, relativates the role of expectancy in accordance to the motivational strength, and specifies the emotional reaction as a consequence for promotion and prevention focus. However, even if RFT has a strong explanatory power regarding a bilateral path from initiated action to success or failure, it reveals little about the adjustment of self-regulated behavior. More specifically, it remains unclear what is happening when the strategy to attain a goal changes. To address this issue, we will consider theories about psychological relativity with the intention to transform our "black box" into a more "transparent box" of self-regulation.

1.3. Relativity in Self-Regulation

In this section, we will take a closer look at processes behind behavioral adjustments in the cybernetic circle. Since the Regulatory Focus Theory (Higgins, 1997) rationally explains what happens between different action styles (promotion focus vs. prevention focus) during goal attainment, it lacks from clarification regarding changes within these styles.

As noted earlier, Carver & Sheier (1991) argued that the relative distance to the goal is more important than the absolute distance. To get a better picture from that statement, we need an idea of the hierarchical nature of their self-regulation model. In 1981, Carver & Scheier developed the control theory of self-regulation, which is also based upon a cyclic feedback process. It consists of the cycling of three basic stages: attending to the self, comparing the self to a standard, and attempting to reduce the discrepancy between the way one is behaving and the way one wants to behave. So far, it does not differ from the TOTE-circle, but beyond that, it elaborates into an interconnected hierarchy of control systems, each at a progressively higher level of abstraction.

For example, at the very highest level of control, a person is concerned with fulfilling self-motives such as self-enrichment; at the next highest level, the person may be concerned with becoming a PhD; at the next level, the person is concerned with publishing an article, and, five levels later, the person is engaged in the various muscle movements involved in typing on a keyboard to write a manuscript. Control theory posits an interconnecting hierarchy of self-regulatory processes, rather than a single system.

With this multilevel-hierarchy in mind, the relativity of goal motivation becomes obvious. As people try to reduce the discrepancy between the current (initial) and desired state (exit), they stop intermittently and self-focus (test) to assess the progress. Based on this assessment, they make adjustments (operate) in behavior that are aimed at more efficiently reducing this discrepancy and they continue the pursuit. In order to predict people`s reactions to goal attainment, one must not just consider whether the goal was reached or not, but also people's progress toward goal completion as compared to their expectations, rate of progress, and whether the rate of progress is accelerating or decelerating (Carver, Lawrence, & Sheier, 1996).

People may consider sufficient progress toward a goal without having actually reached it. If this progress exceeds expectations, they experience positive affect. In contrast, when people do not make sufficient progress toward a goal, they fall short of the expectations and they experience negative affect. For instance, if a single woman who wants to be married meets an interested and well-settled potential partner at a friend's dinner party, she has not attained her higher goal. But she is likely to see her goal closer at hand than it was before the dinner. Therefore, she will be satisfied with her progress towards her goal.

Another interesting consideration is that the progress rate towards the goal is accelerating as people approach goal attainment, or whether it is decelerating. If the rate of progress increases, as people get closer to reaching a goal, they experience more positive affect than if the if the rate of progress decreases, as they approach goal attainment (Hsee & Abelson, 1991). In the example of the marriage-willing woman, her happiness might flourish when her meanwhile boyfriend would make a proposal. But why is this the case? What gives the relative distance to the goal so much weight? To find an appropriate answer to this question we must dig deeper into the cognitive process of relativity.

Models of psychological relativity. Parducci's (1965; 1968) psychological explanation of relativity is built on the range-frequency principle. According to this approach, psychophysical judgments are relative to the distribution of all stimuli in a reference set. That means, in a right-skewed distribution of mostly negative experiences (e.g. failing one's goals), the same experience gets more value than in a left-skewed distribution of mostly positive experiences (e.g. succeeding one's goals). Thus, the relativity of value is a natural consequence of the Weber-Fechner-Law (see Hecht, 1924). Just as a discrimination threshold, or just-noticeable difference, in weight, loudness, brightness or any other sensory dimensions increases with the absolute level of the magnitude in question, the threshold for pleasure (e.g. gain) or displeasure (e.g. loss) is relative to the current status quo, or comparison standard. Therefore, the reward value of an experience is not determined by the stimulus itself; it rather lies in the eye of the beholder.

To illustrate that, imagine a roulette player in a casino who is running into bad luck. He lost almost all of his money in four attempts, since all his bets on black resulted in red. He was about to quit, but in his last try he won 20 Euros, and was very happy about it. Now imagine a lucky devil that won five Euros four times in a row, only his last trial failed. On the bottom line, both received the same payout from the cashier. Who do you think was happier about the win? The bad luck guy, for sure. Another example of range-relativity is the average performance of a student relative to the class' performance. In classes of excellent students, professors will judge good students only as average, but in classes of average students, professors will judge the same good students as excellent, due to their subjective judgment range.

The relative distance to an outcome is an almost necessary consequence of natural regulation processes (Fiedler & Arslan, 2017). Rich people live in more exclusive and privileged neighborhoods, successful sports teams rise into a higher league, and so their comparison standards and expectation rise accordingly. The natural consequence of such regulation is the big-fish-little pond effect (Marsh, 1987). The same achievement is worth much less in an elite environment than in an average environment, and this may affect not only the person' self-concept, but also the evaluations of others (Moore, Swift, Sharek & Gino, 2010).

Another highly relevant case of the relativity principle in the domain of motivation is deprivation. Even in hunger, the relativity of the standard's range matters, as impressively shown by an experiment with monkeys on inequality (Brosnan & Bshary, 2016). Hungry capuchins, that would generally not refuse cucumbers as a reward, refuse it if neighboring animals get more delicious grapes.

Below the comparison of a stimulus range, whenever behavioral goals depend on drives, such as hunger, curiosity, or sexuality, the strength of the drive increases with increasing deprivation, like a strained bow. In other words, the negative deprivation experience creates the potential for positive motivation and satisfying goal attainment. Conversely, saturation after excessive goal consumption (e.g., over-eating, excessive exploration, frequent sexual activities) reduces motivation and the pleasure resulting from goal attainment (Fiedler & Arslan, 2017).

This dialectic of deprivation and fulfillment lies at the heart of many existential conflicts. In tradition of Festinger's (1962) theory of cognitive dissonance, strong intrinsic motivation and positive attitudes towards an activity often originate in a lack of external reinforcement, creating a state of under-justification. In contrast, abundant reinforcement and frequent prior satisfaction cause over-justification and thereby undermine the resulting intrinsic motivation and attitude towards the action goal (Frey & Gallus, 2016). Thus, providing strong rewards to perform activities that we already enjoy may undermine motivation, due to over-justification. In contrast, people will be strongly motivated and develop the most positive attitude toward those goals and activities when they had to wait and struggle over a long time, that is, after under-justified effort expenditure.

To enrich the self-regulatory circle, let us interim conclude that the relative distance to the goal is determined by the progress towards a goal. The progress refers to the comparison of the range and frequency of the desired end states. The closer a person gets to it, the stronger is the attraction, depending on whether the previous effort and attitude towards the goal were intrinsically reinforced. On an abstract level, all these indications provide a reasonable consideration for a relativity approach in goal attainment. Regulatory Focus Theory claims that different goals call for different strategies, but the relative relationship of these strategies has been neglected. The bilateral approach (promotion vs. prevention) does not consider a range-frequency account for the relative dependency of promotion and prevention focus in goal attainment. Since RFT claims that both regulation-styles are within the option-range of a goal, meaning that both regulatory foci can lead to the same goal, the relative dependence *between and within* the regulatory focus should be considered. In other words, it remains unclear what happens when prevention-regulation is changed to promotion-regulation and vice versa. That raises the legitimate question about the function of a dynamic, inter-changeable regulatory focus and what we can expect from it.

Regulatory Shift. So far, we have identified the determinants of relativity in self-regulation on a theoretical level. Let us now link these assumptions with empirical evidence on relativity-effects, which support a rethinking of a new designed regulatory focus.

As noted by Wänke and Hansen (2015) in a remarkable paper on relative fluency, the subjective ease, or fluency, that is experienced during the cognitive processing of information depends rather on a relative change in the fluency-level than on the absolute fluency level. For instance, a study by Whittlesea and Williams (1998) showed that feelings of familiarity emerged most strongly for stimuli that were processed more fluently than expected. Participants were asked to read aloud the items on a list of natural words (e.g., *bottle*) and non-words (e.g., *tlamnic*) and to indicate which of the stimuli had been shown before. Words are visually more fluent than non-words when merely read. However, some of the visually disfluent non-words were surprisingly easy to pronounce and sounded like real words when read aloud (e.g., *phrawg*, which sounds like *frog*). Although processing latencies indicated that such pseudo-homophones were less fluently processed than natural words, they were more likely to be falsely "recognized" as having been encountered previously in the experiment than natural words. Apparently, it was not just high fluency that indicated high familiarity but fluency that was relatively higher than expected based on spelling.

Several more findings in judgment formation, such as familiarity (Whittlesea & Williams, 2000), attitude judgments (Bornstein, 1989), truth judgments (Reber & Schwarz, 1999), and moral judgments (Hansen, Dechêne, & Wänke, 2008) support the relativity-assumption, that it's rather a discrepancy between the actually experienced state and a standard that informs (social) judgments. Wänke and Hansen (2015) argue that the context does not necessarily determine the *intensity* of fluency (or disfluency) like hot water makes lukewarm water feel cold by comparison. Rather, they propose that the context determines the *diagnostic value* of the experience. A change in the experiential state is usually more diagnostic than the current level of the experiential state.

According to Bless and Burger (2016), most behavioral research confounds the two aspects relative change and absolute level in experimental manipulations. In an attempt to induce a high or low level on an independent variable, researchers inadvertently manipulate a change of the level that existed prior to the experimental treatment (Arslan & Fiedler, 2017). Typically, the manipulation of a high X is confounded with a positive △X change, whereas a low level of X is confounded with a negative △X change. It is therefore unclear whether an effect in the dependent variable Y reflects either the influence of the absolute level (i.e., zero order function X) or of the relative change (i.e., first derivative △X). Indicating that behavioral effects often reflect the impact of relative changes rather than absolute levels on the manipulated influence variable. This is in line with Fischoff, Slovic and Lichtenstein's Sensitivity Analyses (1979). Thus, a within-subject contrast of the manipulation enhances the sensitivity for the manipulation state. Imagine a baker for instance, who works in his bakery with comfortable 21° Celsius. He might not be aware of how convenient his room temperature is until he needs to clear up the deep-freezer. After five minutes of tidying he hurries, since his hands begin to freeze, and as soon as he finishes, he rushes back to the pleasant warmth of his bakery, sensible for the current temperature, which he was not aware of before.

Moreover, Hsee and Abelson (1991) claim that the change in discrepancy between standards or goals has not only a diagnostic value, but it also creates a certain velocity (acceleration-deceleration). In one study, they focus on a specific sort of affect: satisfaction with a desired outcome. Participants read hypothetical descriptions of paired outcome scenarios and indicate which outcome they would find more satisfying. For example, participants chose whether they would be more satisfied, if their class standing had risen from the 30th percentile to the 70th percentile over the past six weeks, or if it had done so over the past three weeks. Each participant answered seven questions that paired different outcome scenarios. The questions tested the role of final outcome, distance changes, velocity, and direction of change as influences on satisfaction. For the present purpose, the role of velocity is of the greatest interest. As Hsee and Abelson (1991) predicted, participants preferred improving to a high final outcome rather than having a constant high outcome; they preferred a fast improvement to a slow one; and they preferred a fast small improvement to a slower but greater improvement. When the change was negative (e.g., when salaries got worse) participants were more satisfied with a constant low salary than with a salary that started high and fell to that level; they preferred slow falls (downward velocity) to fast falls; and they preferred large slow falls to small fast falls.

A second study (Hsee & Abelson, 1991) was designed to have participants experience a change in time by watching hypothetical outcomes that changed in the form of a graph on a computer screen. The computer displayed a bar that moved vertically along a scale portraying changes in outcome (e.g., the price of a stock in which the participant had invested). Unlike the first study, in which outcome scenarios were paired and the participant picked which would be more satisfying, participants had a reference scenario that they were told to assume was a satisfaction level of 5 on a 9-point scale. They were asked to make rate of satisfaction in comparison to the reference scenario. In this study, distance change was held constant, while direction, final outcome, and velocity were varied. The second study replicated a very strong velocity effect. Participants preferred a fast rate of change when the outcome was improving and a slow rate of change when the outcome was falling.

The findings of Hsee and Abelson (1991) are valuable, but an important limitation of that work, however, is that the outcomes participants experienced were hypothetical. Although participants were asked to imagine themselves experiencing the outcomes, the credibility of the findings depends in part on the assumption that they actually experienced the outcomes as having personal relevance. In part for this reason, Lawrence, Carver and Scheier (2002) felt that further research was needed. In their studies, people were placed in a situation with a behavioral goal: performing well at a task that was portrayed as being relevant to a valuable skill. The perceived rate of movement toward that goal across trials was experimentally varied. It was predicted that participants in slower moving groups would experience affect that was negative relative to their previous baseline and that those in faster moving groups would experience affect that was more positive than their baseline.

One study used a situation in which feedback of progress toward a desired goal could be plausibly manipulated over an extended period of time. The session was disguised as a study of social intuition, in which participants made a lengthy series of judgments about ambiguous stimuli. Each block of ten judgments was followed by performance feedback for that block. Mood was assessed before the task began, and again at the end of the sixth block, which participants believed was partway through the session, but actually ended the session. This phenomenon is subject to an important constraint, which stems from the relations among starting value, ending value, number of trial blocks, and velocity. Specifically, these variables are not fully independent. If one varies velocity, one cannot hold constant all three other factors, as one of them must also vary. In the study reported here, they chose to keep the number of trial blocks and the ending value constant and they varied velocity by varying the starting value.

Participants received one of five patterns of performance feedback, converging such that scores on Block six were identical for all participants at 50% correct. Participants in a neutral condition had 50% on the first and last block, and 50% on average across all blocks (thus a zero slope overall). Others started with low scores and gradually moved upward to 50% (thus an upward slope; faster progress despite a worse starting point). Other participants started with high scores and fell to 50% (thus a downward slope; slower progress despite an advantageous starting point). They expected the upward-slope (higher velocity) groups to shift toward more positive affect, the downward-slope (lower velocity) groups to shift toward more negative affect, and the level-slope group (intermediate velocity) to have little or no change in affect. Finally, they expected the affect changes to be more pronounced in groups with more extreme slopes than in groups with less extreme slopes. Their findings join with the previous evidence from Hsee & Abelson (1991) in suggesting that the subjective experience of affect reflects a velocity function. Specifically, affect appears to reflect the rate of the person's movement toward (or away from) a salient goal. In this way, affect ties the goal-related aspect of motivation to the dimension of time. Affect is an indicator that the subjective experience of the now derives not solely from the present moment, but partly from relations between the present and a broader temporal span (Lawrence, Carver & Scheier, 2002).

To summarize, all these evidences suggest that we should rather consider the relativity of a change than an absolute level as a causal factor for the effectiveness of a manipulation. Additionally, we can argue that the velocity serves as a function for emotional reaction (Hsee and Abelson, 1991, Carver & Scheier, 2002), and thus as a diagnostic source for information (Bless & Fiedler, & Forgas, 2006; Fiedler & Bless, 2001; Schwarz & Clore, 1996) towards goal adjustments. In terms of the self-regulatory circle, we need to consider the action from initial behavior to goal attainment (Regulatory Focus Theory; Higgins, 1997) as relative, due to change and velocity toward the goal. Regulatory Focus Theory did not integrate these important factors in its bilateral approach of motivated behavior. Previous manipulation attempts of the regulatory focus (promotion vs. prevention) have neglected the role of a within-subject contrast. As shown by a large body of literature (e.g. Baas, De Dreu, Nijstad, 2008; Maddox, Baldwin, & Markman, 2006; Summerville & Roese, 2007) the effects of an absolute manipulation level (state) of regulatory focus were mostly tied to several other confounds. We argue that a change in regulatory focus (from prevention to promotion, and vice versa) would be beneficial to face this crux. We will discuss these methodological issues later more precisely, based on empirical findings on particular shift effects. At this point, let us capture that the strong theoretical and empirical evidence for a relative account in self-regulation endorses the consideration of a *regulatory shift* (a change from promotion to prevention focus and vice versa), to enhance the diagnostic power of the motivation strategy, within the self-regulation circle.

1.4. Adaptive Strategy

So far, we have identified the determinants of relativity in self-regulation with the call for a regulatory shift to strengthen goal attainment strategies. Let us now analyze what kind of goals or effects we can expect from a dynamic regulatory shift. Thus, we need to take a closer look at the cognitive processes, which get affected by motivated behavior.

On a very rudimentary level, we can distinguish between different processing directions. Historically, bottom-up processing evolved as the first comprehensive way to understand cognition (Eysenck & Keane, 2000). According to the bottom-up version, processing is directly affected by the stimulus input (or goal). Additionally, it was assumed that one process occurs at any given moment in time, also known as serial processing, meaning that one process needs to be completed before the next begins.

The counterpart direction, namely top-down processing, is influenced by the individual's knowledge and expectations rather than simply by the stimulus itself. To illustrate top-down processing, take a look at Figure 2. Based on *Gestalt* principles (Prägnanz; cf. Koffka,1935; Wertheimer, 1959) we perceive a football instead of only the sum of differently shaped and distinct pentagons. Since most people have seen a football before, our previous knowledge interpolates the wholeness of an object.

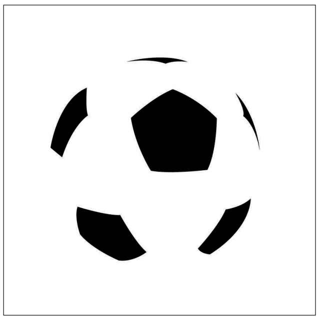

Fig. 2. Illustration of top-down processing. Instead of perceiving six distinct shapes, the visual system interpolates the *Gestalt* of a football, based on previous knowledge.

Most human cognition involves a mixture of bottom up and top-down processing. For example, Bruner, Postman, and Rodrigues (1951) conducted a study in which participants expected to see conventional playing cards presented very briefly. When black hearts were presented, some of them claimed to have seen purple or brown hearts. This is an almost literal blending of the black color stemming from bottom-up processing, and of the red color, stemming from top-down processing (i.e., the expectation that hearts will be red).

Processing in which some or all of the processes involved in a cognitive task occur at the same time is known as parallel processing. A common form is the processing-cascade, in which later processes begin even before some of the earlier processes have been completed. It occurs mainly when people are highly skilled and practiced in performing a task than when they first encounter it (Eysenck & Keane, 2000). In basketball for instance, a player is not allowed to keep the ball in both hands while he is running, that is why the ball is bounced during runs. A professional basketball player can focus on the defense, his team players, distance to the basket, and many other stimuli, without stopping to bounce the ball. However, parallel processing is, on the first hand also determined by either the environment (bottom-up) or the knowledge (top-down). It means that during a game, players need to deal with external factors like time-pressure (bottom-up), but also with internal operations like passing strategy (top-down).

To understand which important role these two processing styles play within our self-regulation circle, we need to consider a more generous theoretical framework from Fiedler (2001; 2003; 2014) that combines the regulation of information processing with mood and behavior. Central for understanding this interaction between affect and cognition is the analysis of adaptive behavior in terms of two distinct adaptive functions, *accommodation and assimilation*, with the terms borrowed from Piaget's (1954) theory of cognitive development. According to Fiedler (2001), accommodation refers to adaptive adjustments of the individual's internal representations to the external constraints imposed by the stimulus environment. Assimilation refers to the complementary process of adjusting (i.e., assimilating) the external world to the individual's internal structures. More specifically, accommodation can be characterized as a stimulus-driven, bottom-up process that aims at reacting as sensitively as possible to new environmental data—that is, to the signals, threats, and challenges of ongoing adaptation tasks. In contrast, assimilation is a knowledge-driven, top-down process whereby the individual relies on his or her own theories in going beyond the given stimulus data to predict, explain, and control the external world. In other words, accommodation is essentially reproductive and conservative whereas assimilation is productive and generative (Fiedler, 2001).

Both functions are not mutually exclusive processing styles but complementary aspects that are jointly involved in all adaptive behavior. Every social or intellectual action calls for some degree of adherence to the constraints of the situation and the stimulus input (accommodation) but also some creative transformation of the given input into some new output, or solution, based on the individual's internalized knowledge, motives, and behavioral repertoire (assimilation). For instance, to solve a mathematical task means to keep the task instructions and the input text and data in memory, as a precondition for any reasonable response that might transform the input task into some creative output solution. Even a seemingly reproductive task as reading involves both stimulus-driven decoding of written text and knowledge-driven inference making and hypothesis testing (Fiedler, 2003).

However, while both adaptive functions are universal and mutually complement and constrain each other, the relative contribution of accommodation and assimilation can vary considerably across tasks. When conservative or reproductive tasks call for careful bottom-up assessment of all stimulus details, sticking to externally given facts and refraining from uncertain inferences, the emphasis is on accommodation. In contrast, success on creative or productive tasks depends on innovative interpretations, constructive top-down inferences, and creative enrichment of the information given, thus relying heavily on assimilation (Fiedler, 2001; Beier & Fiedler, 2014). A task to infer the meaning of an incompletely presented word calls for assimilation for instance, whereas a task to read a completely presented word correctly involves accommodation.

This dual-force approach provides an integrative account for many empirical findings on affect and cognition. The first assumption, that positive mood facilitates assimilation and negative mood accommodation, is directly applicable to explaining numerous mood influences on cognitive-processing style. In particular, enhanced assimilation explains that good mood increases creativity (Isen, Johnson, Mertz, & Robinson, 1985), productive problem solving (Isen, Daubman, & Nowicki, 1987), cognitive flexibility (Hertel & Fiedler, 1994), and different knowledge-driven functions such as priming (Bless & Fiedler, 1995), stereotyping (Bodenhausen, Kramer, & Susser, 1994), and constructive memory effects (Fiedler, Asbeck, & Nickel, 1991). Conversely, accommodation explains that negative mood leads to more careful stimulus assessment (Clore & Storbeck, 2006), decisions based on more piecemeal information search (Schwarz, 1990), attitudes that are more predictable from a systematic count of stimulus arguments (Worth & Mackie, 1987), and a reduction of intransitive preferences (Fiedler, 1988). Moreover, the framework implies that positive and negative affective states have similar influences as other factors that trigger assimilation and accommodation, such as high versus low construal level (Trope & Liberman, 2010), familiar versus novel environments (Bischof, 1975), and promotion versus prevention focus (Higgins, 1997). It therefore facilitates the theoretical interpretation and integration of the affect-cognition link within a comprehensive meta-theoretical framework.

In summary, we can conclude that positive states rather evoke cognitive processes of the assimilation type; meaning more productive and generative, top-down processing, while negative states rather evoke cognitive processes of the accommodation type; meaning more careful and reproductive, bottom-up processing. Since we know that positive and negative affect is influenced by the motivation of goal attainment (see chapter 1.2.) we can translate the adaptive strategies of assimilation and accommodation to the bilateral nature of regulatory focus. This can be interpreted as follows: When the focus is on promotion or approach, people should place more weight on assimilation, and less weight on accommodation, than when the focus is on prevention or avoidance.

This assumption is partially supported by evidence from regulatory focus studies on abstract vs. concrete relations. Semin, Higgins, Gil de Montes, Estourget, & Valencia (2005) for instance, showed that promotion-oriented individuals were more persuaded by messages constructed with abstract word-predicates involving adjectives (assimilation), whereas prevention-oriented individuals were more persuaded by messages constructed with concrete word-predicates (accommodation) involving verbs. Keller, Lee and Sternthal (2006) found that advertising messages that address high-level, desirability concerns (assimilation) lead to more favorable attitudes among those with a promotion focus, whereas messages that address low-level, feasibility concerns (accommodation) lead to more favorable attitudes among those with a prevention focus.

Another study by Keller (2006) supports the premise that a person's regulatory focus determines the salience of self-efficacy or response efficacy in health behavior. Self-efficacy is the extent to which people believe they are capable (top-down/assimilative) of performing specific behaviors in order to attain certain goals (Bandura, 2001), while response efficacy is describes as the extent people believe a recommended response (bottom-up/accommodative) effectively deters or alleviates goal-directed behavior (Witte, 1994). The findings indicate higher intentions to perform advocated behaviors when self-efficacy features are paired with promotion focus and when response efficacy features are paired with prevention focus. Thus, self-efficacy (assimilation) is weighed more than response efficacy (accommodation) when the regulatory focus is promotion, whereas the reverse is true in prevention regulatory focus.

Another reasonable overlap of regulatory focus effects on adaptive cognitive processing styles can be derivesd from creativity research. As creativity is by definition an act of knowledge-driven, generative processing (Amabile, 1996; Guilford, 1967; Isen, 1987) it can be interpreted as the pure product of an assimilative mindset. More evidence for this integrative account of regulatory focus into the mood-cognition framework derives from a large body of literature (e.g. Batey, 2012; Baas, DeDreu and Nijstad, 2008; Fiedler, 2001; Friedman & Förster, 2001; Isen, Daubman, & Nowicki, 1987). A meta-analysis by Baas, DeDreu and Nijstad (2008) synthesized

102 effect sizes that reflected the relation between (specific) moods, regulatory focus and creativity. Accordingly, creativity is enhanced by positive mood states with an approach motivation and promotion focus, rather than negative mood states that are associated with an avoidance motivation and prevention focus.

In decision-making literature on the other hand, the accommodative processing style is the dominant mindset to make more accurate choices (e.g. Crowe & Higgins, 1997; Fiedler & Hütter, 2013; Fiedler, Nickel, Muehlfriedel, & Unkelbach, 2001; Liberman, Idson, Camacho, & Higgins,1999). Generally speaking, a prevention focus, just as negative mood, leads to a more careful, accurate decision style (accommodation), while promotion focus, just as positive mood, leads to a more sloppy, biased decision style (assimilation). Again, the parallels between regulatory focus and mood effects on decision-making are just as indisputable as those in creativity research.

To summarize, when we take all this evidence into account, a consideration of regulatory focus as an independent variable for the activation of adaptive strategy in terms of assimilation-accommodation seems reasonable. Thus, a promotion focus is associated with assimilation (top-down, productive and generative), while a prevention focus is associated with accommodation (bottom-up, reproductive and sensitive). Let us now get back to the relativity principle. All listed effects above, describing how regulatory focus affects adaptive strategies are based on the premise of absolute conditions. It means that every investigation, irrespective of mood or regulatory focus, consideres the conditions as *either* promotion *or* prevention. Here is where the consideration of a regulatory shift starts to play a major role. As we have reasoned before, based on the range-frequency principle (see chapter 1.3.), a change in the experiential state should be more diagnostical than the absolute level of the experiential state. Additionally, we have identified many reasons to link the bilateral nature of regulatory focus to the adaptive strategy of the mood-cognition framework.

Just as this framework implies (abstraction is rather associated with assimilation than with accommodation) the previous chapters collected arguments that speak supportive for the consideration of a relative approach in self-regulation, positively speaking. The following empirical evidence will identify more precise arguments that speak against the premise of an absolute (state) approach. In reflection of accommodation, we will discuss the limitations of the absolute approach in more detail on a methodological level within the experimental sections. Furthermore, we will provide evidence from four experiments that support the consideration of a regulatory shift as the more efficient determinant in adaptive strategies, compared to a mere state manipulation. These investigations are concerned with creativity, ranges of judgments and decision-making, with the main emphasis on generative vs. conservative processing. On a global level, derived from a strong consistency in self-regulation and adaptive cognition literature, we finally define the aims of this work, condensed in the following general assumptions:

1.5. General Assumptions

The aim of this work is to capture the influence of regulatory shifts on adaptive strategies. Instead of relying on an absolute manipulation level (state), we rather encourage a relative change (shift) as the more relevant causal factor for an effect. Thus, we assume that a regulatory shift enhances adaptive strategies in the following matter: A promotion shift (change from prevention to promotion) should result in stronger generative effects, as reflected by high creativity, more liberal decisions, and broad cognitive flexibility, compared to a mere state manipulation of promotion focus. A prevention shift (change from promotion to prevention) should result in stronger conservative effects, as reflected by low creativity, more conservative decisions, and narrow cognitive flexibility, compared to a mere state manipulation of prevention focus.

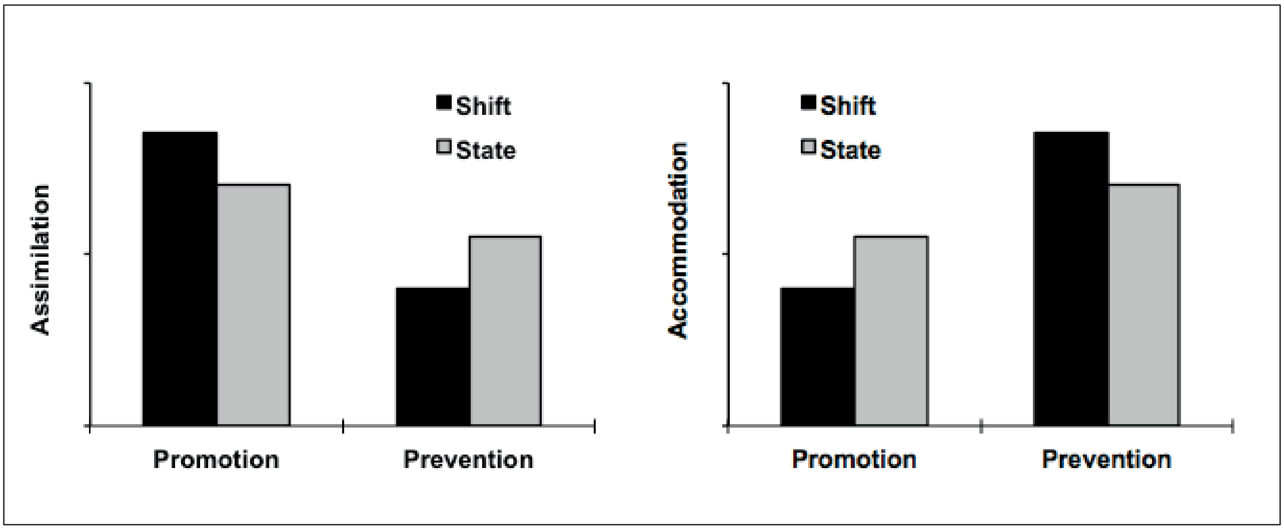

Figure 3. The charts are intended to illustrate the three-way interaction of regulatory focus and shift on adaptive strategy. The left chart shows an idealized pattern for assimilative tasks; the right chart shows an idealized pattern for accommodative tasks.

2. Empirical Evidence

In this chapter, we will first address the limitations of regulatory focus practices on a methodological level, and present the materials for a more reliable and objective manipulation measure. Also, the general procedure for the shift vs. state framing will be introduced and finally we will enter the empirical evidence that supports the main assumptions of this work with quantitative data derived from four experiments, concerned with the impact of regulatory shifts on adaptive strategy.

Limitations of regulatory focus measures. Despite the generality and utility of the Regulatory Focus Theory (Higgins, 1997), open questions remain about both this construct and its measurement. Conceptually, the seminal statement of regulatory focus presented two distinct conceptualizations of regulatory focus: the self-guide definition, based on whether goals are derived from an attention to desires (achieving personally important aspirations, ideals, and ambitions) versus obligations (fulfilling duties, obligations, and responsibilities), and the reference-point definition, based on the end-state to which current goal progress is compared.

Summerville and Rose (2008) raised the legitimate question, whether these definitions in fact represent a single or unitary construct. Methodologically, two distinct measures of regulatory focus have been mostly used in previous studies: the regulatory focus questionnaire (RFQ, Higgins et al., 2001) and the general regulatory focus measure (GRFM, Lockwood, Jordan, & Kunda, 2002). These two scales were used in a variety of investigations, but with little apparent overlap in topic area. The RFQ has been shown to predict emotional outcomes, such as guilt and coping (Camacho, Higgins, & Luger, 2003), cognitive outcomes, such as persuasion and language use (Semin et al., 2005), and health outcomes (Strauman et al., 2006). The GRFM, in contrast, has primarily been used in investigations examining role models (Lockwood, Jordan, & Kunda, 2002), and in applied consumer research (Yeo & Park, 2006). Summerville and Rose (2008) examined the items of these two measures and assume that the RFQ primarily centers on the self-guide conceptualization of ideals versus obligations, with a significant portion of items dealing with parental interaction and other past self-guide experiences capturing the obligation aspect of prevention focus. In contrast, the GRFM follows the reference-point definition, with items emphasizing achievements. Findings from a principal components analysis of these scales, including bordering conditions, show distinct factors. Thus, rather than being orthogonal to approach and avoidance (measured with the BIS/BAS scale; Carver & White, 1994), the reference-point definition seemed to overlap it. Additionally, when defined in terms of reference-points, as in the GRFM, promotion focus was associated with positive affectivity, whereas prevention focus was associated with negative affectivity (measured with the PANAS; Watson, Clark, & Tellegen, 1988). Above that, both scales share the general limitation of self-report measures. They are limited by the degree to which participants possess insight into their own motivational state and experiences. Besides, these scales represent the dominant approach to measure regulatory focus rather on a trait level (a "chronic" regulatory focus orientation). They have nevertheless been primarily used in manipulation studies as an assessment for state manipulations of regulatory focus with moderate success and a large inconsistency in several studies (Baas et al., 2008; Haws, Dholakia, & Bearden, 2010).

2.1. General procedure and design

In this work, we address the previously mentioned, methodological issues by developing new ways of treatments *and* measures for the regulatory focus. Rather than relying on self-reports we applied implicit measures to strengthen the manipulation checks' objectivity. To do so, we firstly pre-tested a set of promotion-related and prevention-related words for their associative power on both dimensions. The resulting six promotion-related (hope, dreams, goals, prospect, silver lining, ideals) and six prevention-related words (force, command, order, obligation, skepticism, commitment) have been hidden as horizontal or vertical strings in a 16 x 16 letter grid. This anagram puzzle was operationalized, as a measure of relative accessibility (Bower 1981; Fazio, 1986), and was implemented as a manipulation check in three studies of the present work. Since the GRFM, as a self-report on a goal-orientation, cannot successfully disentangle affectivity from regulatory focus, due to mood-oriented items, we assume that our accessibility approach will solve this problem. Also the RFQ is mainly concerned with regulatory focus on a trait-level. Thus, we assume that our manipulation measure of regulatory focus should be more diagnostic for the situational context. Especially, when addressing the main hypotheses of state versus shift effects. The fourth experiment covers an even more sophisticated attempt to do so. We developed a treatment that does not just trust people's subjective statements of goal-orientation, but rather calls for immediate goal approach-avoidance behavior on an explicit level, and simultaneously checks the manipulation on an implicit level by applying a signal detection approach. However, let us first introduce the general procedure for the next three experiments. The aim of experiment 1 is the situational manipulation of regulatory focus and shift on creativity. In experiment 2, we will examine those context effects on price-ranges and price-estimations of own vs. other products (endowment effect). Experiment 3 focuses on the relation between regulatory shift and over-estimations, reflected by the hot-hand fallacy and gambler's fallacy. All three experiments follow the same manipulation procedure (Fig.4). Only experiment 4 differs from the following treatment since it introduces a new combination of treatment and manipulation check of regulatory focus within one task.

In the following experiments, participants were first asked to complete two brief essay-writing tasks, which were adopted from Freitas and Higgins (2002) and have been prominently used in previous studies to induce regulatory focus (e.g. Lee & Aaker, 2004; Friedman & Förster, 2001; Cesario, Grant, Higgins, 2004). To induce a prevention focus, they were asked to write a short essay about obligations, requirements and duties of their past and present. To induce a promotion focus, they were asked to write about hopes, desires, and dreams of their past and present. An additional neutral-focus task was administered to the regulatory-focus state conditions in which participants had to write a short essay about the route they took to the department (cf. Friedman, Förster, & Denzler, 2007).

Promotion-focus state and prevention-focus state conditions were first asked to write a neutral essay and then, after a short filler task (“connect-the-dot”), to write an essay intended to induce a promotion focus or a prevention focus, respectively. In the promotion-focus and prevention-focus shift conditions, participants were first asked to write an essay with an opposite regulatory focus before they completed the essay intended to induce a promotion focus shift or a prevention focus shift. The filler task between the two essay-writing tasks involved numerical combination and lasted around three minutes.

The second essay-writing task was supposed to determine the effective regulatory focus (promotion vs. prevention) that should affect the subsequent dependent variables. The sequential context (shift vs. state) was manipulated by having the final regulatory focus either follow an initial opposite focus (shift) or an initial neutral focus (state). The manipulation phase lasted between 10 to 15 minutes.

Immediately after the regulatory focus manipulation, participants were instructed to solve an anagram puzzle, which served as a manipulation check. Six promotion-related (hope, dreams, goals, prospect, silver lining, ideals) and six prevention-related words (force, command, order, obligation, skepticism, commitment) were hidden as horizontal or vertical strings in a 16 x 16 letter grid. An input text-field right next to the puzzle served to register the discovered words. Participants were instructed to identify as many words as possible within one minute. Only words with more than three letters were guilty registered. Finally, and before starting with the dependent assimilation-accommodation test measures, they completed in about two minutes the self-assessment manikin test for mood and arousal (SAM; Bradley & Lang, 1994) to control for affective side effects of the manipulation.

The complete procedure for the next three experiments is illustrated in Figure 4.

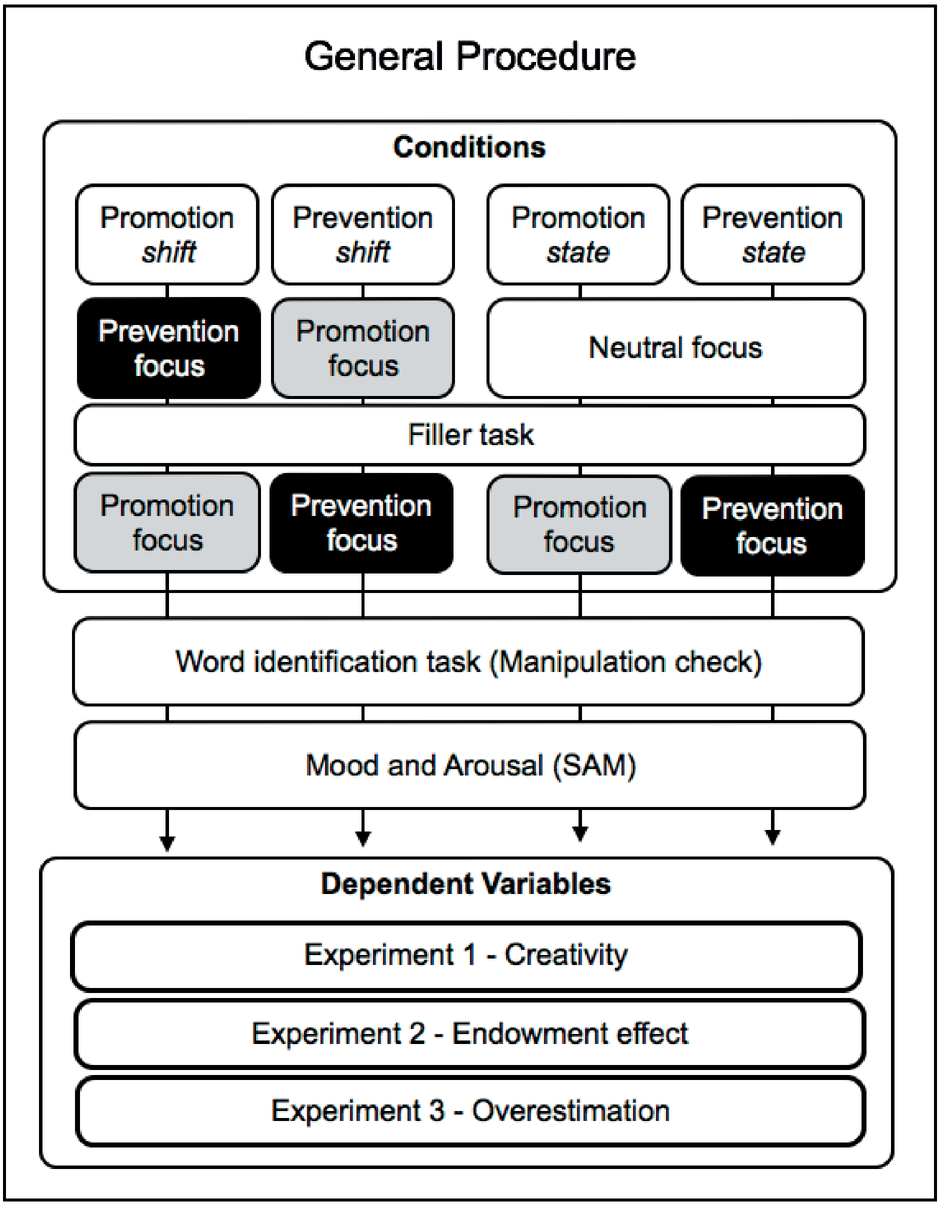

Figure 4. Schematic overview of the procedure from four experimental groups (conditions) in a two by two factorial manipulation design (shift vs. state x regulatory focus). Manipulation checks are implemented as word identification task and self-assessment manikins to cover mood and arousal. Dependent variables for each experiment (creativity, endowment effect, and overestimation) are listed below.

2.2. Regulatory Shift and Creativity

Most cognition and emotion researchers agree consistently about that creativity depends on regulatory focus (Baas, DeDreu, Nijstad, 2008). Creative performance is expected to be higher under promotion focus than under prevention focus. Being concerned with one's hopes and desires, in such emotional states as elation or disappointment, should facilitate creative functions more than being concerned with threats and obligations in states of agitation or anxiety. In a broader theoretical frame, a promotion focus should facilitate generative thinking of the assimilation type, liberated from the dictate of immediate stimuli and common norms. Conversely, a prevention focus should support adaptive functions of the accommodative type, like reproductive thinking and careful responding to stimulus and task demands (Arslan & Fiedler, 2017).

However, only a few published articles lend partial support to this prediction (Friedman & Förster, 2001; Zabelina, Felps & Blanton, 2013). In some studies, an empirical proof remained indirect and qualified by other variables. Sacramento, Fay, and West (2013) found, for instance, that promotion focus functions as a catalyst for a positive influence of challenge stressors on creativity, whereas prevention focus reversed the sign of this influence. Henker, Sonnentag, and Unger (2015) showed that promotion focus mediated the relation between transformational leadership and employee creativity. Studies by Herman and Reiter-Palmon (2011) indicate that the impact of regulatory focus on creativity was confined to an idea generation phase, as distinguished from an idea-evaluation phase.

Still, whether regulatory focus is assigned the role of a causal variable or merely the role of an enabling condition or catalyst of another causal influence, it is mostly a focus on promotion rather than on prevention that facilitates creativity. Very few seemingly divergent results can be reconciled with this general rule. For instance, unfulfilled prevention tasks may instigate creativity because they leave the individual in a generative mindset (Baas, De Dreu & Nijstad, 2011). Or, the tendency to imitate and rehearse creative exemplars under promotion focus may reduce creativity because they prevent participants from creating their own new exemplars (Rook & van Knippenberg, 2011).

Taking these issues into account, we consider an important differentiation in the generative dimension of creativity for two reasons: First, within our theoretical framework (Bless & Fiedler, 1996; Fiedler, 2001; Fiedler & Hütter, 2013), promotion (vs. prevention) focus is conceived as fostering adaptive functions of the assimilation (vs. accommodation) type. If so, regulatory focus should exert a stronger influence on generative tasks, which rely on more elaborate assimilation functions (i.e., knowledge-driven inferences beyond the conservation of the information given) than non-generative tasks. This prediction is consistent with numerous other findings showing that creativity increases under task conditions that trigger assimilation (rather than accommodation). Creativity has been shown to increase in elated mood (Isen, Daubman & Nowicki, 1987), high level of construal (Liberman, Polack, Hameiri & Blumenfeld, 2012), low need for closure (Chirumbolo, Livi, Mannetti, Pierro & Kruglanski, 2004), or dopamine (Chermahini & Hommel, 2010). Creativity belongs to the most intensively researched area of mood and cognition and the majority of evidence suggests that tasks with a pronounced generative component profit most from assimilative mindsets (Fiedler, Nickel, Asbeck & Pagel, 2003; Fiedler, Nickel, Muehlfriedel & Unkelbach, 2001; Forgas, 1995).

Second, a successful experimental manipulation will plausibly affect the online performance on a presently performed generative task. It can hardly affect the past creative history that may underlie a person's unusual associations or preferences on non-generative tasks. However, the possibility should not be dismissed that an assimilative rather than accommodative mindset (i.e., promotion rather than prevention focus) can trigger selective memory or self-presentation strategies that favor creative responses even on non-generative tests. Still, the impact of an experimentally induced mindset is more likely to affect the online performance on a novel creative inference task performed in the present experimental session.

To test these considerations at the highest level of reliability, we developed some experimental improvements. First, we included a more implicit manipulation check (see chapter 2.1.) to rule out that regulatory focus is not induced effectively, or maybe overshadowed by other uncontrolled context influences. Secondly, as described in chapter 1.3, we manipulate changes and levels of regulatory focus orthogonally, in an attempt to provide effective evidence for an enhanced influence of regulatory focus shift, consistent with Bless and Burger's (2016) argument and with Fischhoff, Slovic, and Lichtenstein's (1979) notion of sensitivity training. Within participants, changes in regulatory focus – from prevention to promotion focus and vice versa – should sensitize participants to the intended aspect of a complex experimental treatment.

Hypotheses. We expect convergent support for the facilitative influence of promotion focus on creativity, provided that the independent variable (regulatory focus) is manipulated effectively and the dependent variable (creativity) is measured reliably. The causally effective variable should be a change in regulatory focus, rather than a static level. The impact of regulatory focus should be more pronounced for generative than for non-generative creativity.

2.2.1. Method

Participants and design. *N*=98 students recruited from the *Studientportal* platform (Bock, Nicklisch, Baetge 2012), 78 females and 20 males, mean age = 23, SD = 5.64, were randomly assigned to four conditions resulting from the orthogonal manipulation of two between-participants factors, regulatory focus (promotion vs. prevention) and context (shift vs. state) with four creativity tests as dependent variables.

Materials and procedures. The experiment was fully implemented in an online-environment (Leiner, 2014; SoSci Survey, Version 2.5.00-i). Participants were recruited for a 30-minute experiment on “The validation of a new creativity test battery”. They were seated in front of a computer desk on which they found a questionnaire that guided them through the regulatory-focus manipulations as described above in the general procedure section (pp.8). Upon completion of the manipulation check, four computerized creativity tests were administered in counterbalanced order.

First, in the brick task (BT), participants were given three minutes to generate as many uses for a brick as they could think of. Deviating from the Friedman and Förster (2001) instructions, we also counted common uses of a brick in this highly generative measure of creativity, but participants were instructed to refrain from listing unrealistic or impossible uses. The final measure of creativity was the overall number of different uses generated by each participant. The second test of the battery was a computerized German version of the Remote Association Test (RAT; Mednick, 1962). The stimuli were German translations of ten word triads taken from a study by Bowers, Regehr, Balthazard, and Parker (1990). Participants were presented with word-triads (e.g., *magic, plush, floor*) and asked to generate a forth, often hard to identify word that bears a semantic relationship to all three words in the triad (i.e., *carpet*). Given the remote nature of the correct solution and the elaborate memory search required to establish correspondent semantic attributes and relations to all three provided stimulus words, the RAT can be classified as a generative measure of creativity or creative insights (Bolte, Goschke & Kuhl, 2003). The final test score was the number of correct responses provided within 15 seconds. As a third generative task, we created another word identification puzzle (WIP) using a 21 x 21 letter grid. Six words from each out of four categories (furniture, fruits, music instruments, stimulants) from Mannhaupt's (1983) association norms (24 words in total) were hidden in a grid to encourage an active discovery process. Thus, the WIP also offers an online processing tool that calls for an on-demand creative problem solving.

Finally, we draw a sharp line between generative and non-generative tests. In contrast to the previously described on-line measures of creative problem solving, we included plain questionnaires that solely assess biographic traces of *past* creativity: the German version of the Inventory of Creative Activities and Achievements (ICAA; Jauk, Benedek, & Neubauer, 2014). It comprises creative achievements and creative activities, both assessed for eight domains: literature, handcraft, music, cooking, performance art, visual art, sports and science. To illustrate, the sports category included: new tricks based on motor coordination (e.g. juggling), new tricks in winter sports (skiing, snowboard), new tricks in summer sports (bicycling, skateboard), new tricks in fighting (karate, judo), new tricks in other sports areas, and planning of varied sports program. The ordering of all four creativity tests, BT, RAT, WIP, and ICAA, was counterbalanced, such that each test appeared about equally often in all four ordinal positions. As a consequence, differences between specific measures of creativity were not confounded with a potential position effect. At the end of the session, which lasted around 25 minutes, participants were thanked, debriefed and rewarded with 7 Euros and a candy bar.

2.2.2. Results

Manipulation check. The manipulation check substantiates the intended treatment effects in all respects. An ANOVA on the difference between the number of identified promotion-related minus prevention-related words revealed a strong main effect of regulatory focus, $F(1,94) = 22.012$, $\eta^2 = .182$, $p < .001$, and an interaction, $F(1,94) = 4.585$, $\eta^2 = .038$, $p = 0.035$. Participants in the promotion-focus condition produced relatively more promotion-related minus prevention-related words ($D = 1.20$). The opposite was observed for participants in the prevention-focus condition ($D = -3.37$). This differential treatment effect was more pronounced after a shift, $D = 1.16$ vs. -2.17, $t(47) = 6.038$, $p < .001$, $d = 1.73$, than in a static context, $D = .042$ vs. -1.20, $t(47) = 1.547$, $p = .129$, $d = 0.44$. Neither the mood nor the arousal control measure was significantly affected (all Fs < 2.5).

Creativity performance. The descriptive statistics for the resulting influences of the regulatory focus manipulations on all measures of creativity are presented in Table 1. The typical pattern of results is substantiated in all important respects (Figure 5). For all creativity tasks except for the ICAA, the bar diagrams exhibit a general increase in creativity from the prevention focus to the promotion-focus condition, which is steeper for the shift than for the state condition. This pattern was most pronounced for the BT, yielding a strong regulatory-focus main effect, $F(1,97) = 16.738$, $\eta^2 = .145$ $p < .001$, and an interaction, $F(1,97) = 4.911$, $\eta^2 = .042$ $p = .029$.

Only a main effect for regulatory focus, $F(1,97) = 7.435$, $\eta^2 = .073$ $p = .008$, was obtained for the RAT, but no interaction effect, $F(1,97) = 0.837$, $\eta^2 = .008$, $p = .263$. The ANOVA for the WIP yielded only a regulatory focus main effect, $F(1,97) = 12.240$, $\eta^2 = .113$ $p < .001$. The interaction test fell short of significance, $F(1,97) = 1.932$, $\eta^2 = .018$, $p = .168$.

Two summary scores were calculated from the responses to the ICAA subscales, for reported creative activities and for creative achievements. Both measures of non-generative creative self-presentation were not affected by the experimental manipulations. That is, neither a regulatory-focus main effect nor a focus × shift interaction, respectively, were obtained in the ANOVA of activities, $F(1,97) = 0.175$, $\eta^2 = .002$ $p = .677$, and $F(1,97) = 1.068$, $\eta^2 = .011$ $p = .304$, and in the ANOVAs of achievements, $F(1,97) = 0.093$, $\eta^2 = .001$ $p = .760$, and $F(1,97) =$

1.065, $\eta^2 = .011$ $p = .305$.

Table 1: Mean creativity scores (and standard deviations) by experimental conditions

Measure	**Shift**		**State**		**Total**	
	Promotion	Prevention	Promotion	Prevention	Promotion	Prevention
BT	11.54 *(3.49)*	7.92 *(2.60)*	10.16 *(2.78)*	9.08 *(2.39)*	10.837 *(3.19)*	8.49 *(2.54)*
RAT	4.29 *(1.49)*	3.28 *(1.48)*	3.92 *(1.28)*	3.42 *(1.21)*	4.10 *(1.39)*	3.35 *(1.35)*
WIP	20.32 *(4.71)*	15.79 *(3.65)*	19.12 *(4.53)*	17.17 *(5.29)*	19.72 *(4.61)*	16.48 *(4.55)*
ICAct	13.03 *(2.907)*	13.93 *(2.496)*	13.82 *(3.139)*	13.27 *(3.162)*	13.43 *(3.05)*	13.67 *(2.98)*
ICAch	5.685 *(1.964)*	5.940 *(1.562)*	6.158 *(1.969)*	5.523 *(1.619)*	5.94 *(2.07)*	5.62 *(1.63)*

The inter-correlations between the manipulation check and the five measures of creativity are rather modest (Table 2). Clearly the strongest correlation was observed between the two non-generative IAAC indices of creative life experience, as distinguished from the online generation of creative problem solutions.

Table 2. Inter-correlations between five creativity measures and the manipulation check (MC), across all participants in Experiment 2

Measure	***MC***	**BT**	**RAT**	**WIP**	**IC Act**	**IC Ach**
BT	*.18*	1.00	.09	.25	.17	.24
RAT	*.16*		1.00	.22	–.10	.06
WIP	*.19*			1.00	.05	.14
ICAA act	*.04*				1.00	.68
ICAA ach	*.06*					1.00

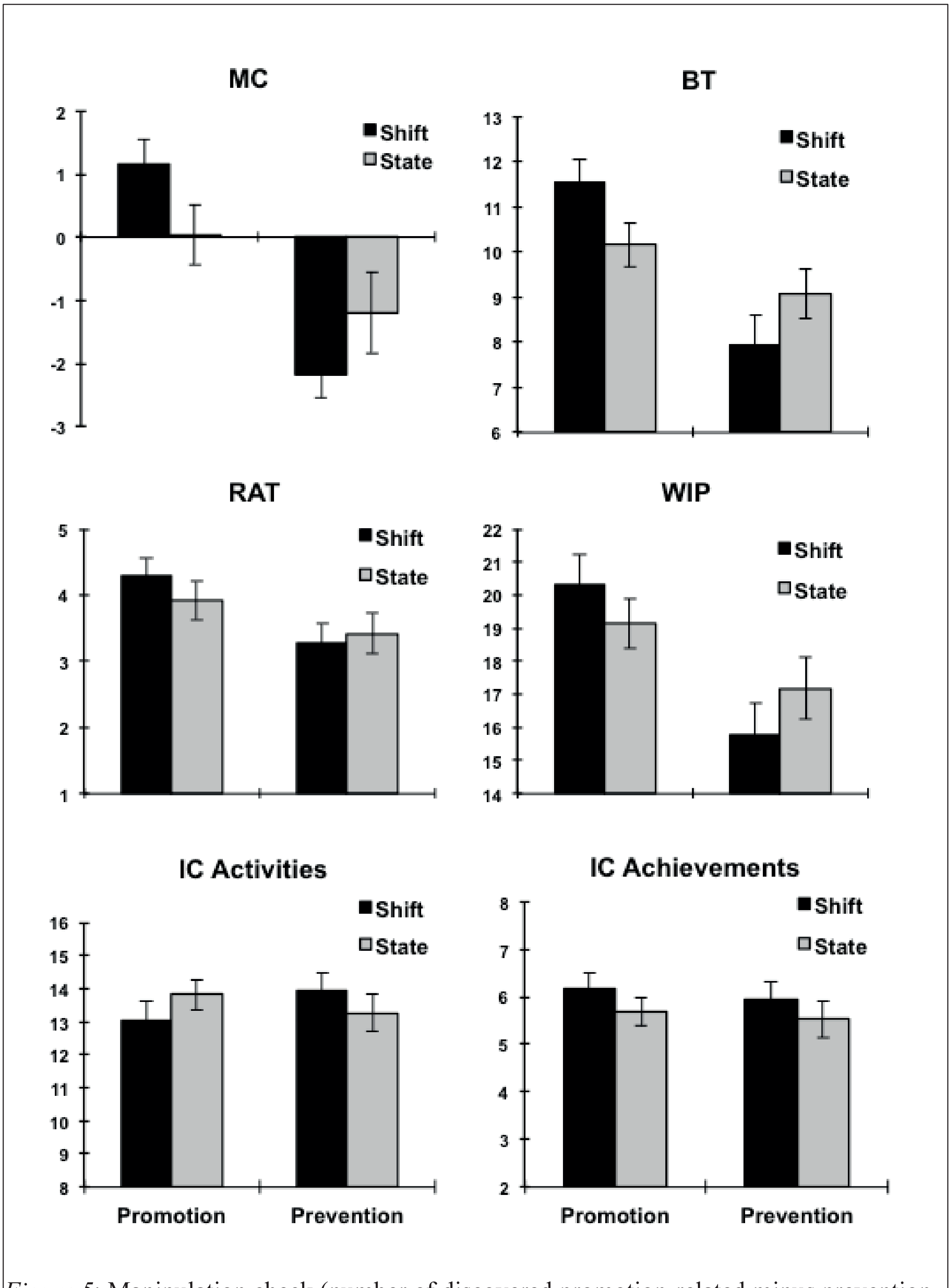

Figure 5: Manipulation check (number of discovered promotion-related minus prevention-related words) and mean creativity scores for each test as a function of regulatory focus (promotion vs. prevention), and context (shift vs. state).

To analyze the differential impact of regulatory focus on generative and non-generative measures of creativity, we computed contrast scores for each participant's total average of all five (z-standardized) creativity tests, for the mean difference of generative minus non-generative tests, and for generative and non-generative tests separately.

The ANOVA of the total average score yielded a main effect for regulatory focus, $F(1,97) = 11.400$, $\eta^2 = .105$, $p < .001$, but no interaction, $F(1,97) = 0.523$, $\eta^2 = .005$, $p = .471$. Only the ANOVA for generative creativity tasks exhibited the canonical pattern of a strong regulatory-focus main effect, $F(1,97) = 31.438$, $\eta^2 = .235$, $p < .001$, along with a significant interaction, $F(1,97) = 5.184$, $\eta^2 = .039$, $p = .025$, reflecting an enhanced effect after a shift of regulatory focus. Both effects were not obtained in the ANOVA of a combined score for both non-generative ICAA measures, $F(1,97) = 004$, $\eta^2 = .000$, $p = .951$, and $F(1,97) = 1.270$, $\eta^2 = .013$, $p = .263$, respectively.

As a consequence of these divergent results for generative versus non-generative creativity tasks, an ANOVA of the mean difference between both types of tasks exhibited a main effect for regulatory focus, $F(1,97) = 11.383$, $\eta^2 = .102$, $p < .001$, as well as a significant interaction, $F(1,97) = 5.706$, $\eta^2 = .051$, $p = .017$. Thus, both regulatory focus in general and regulatory focus shift in particular differentially affected generative creativity more than non-generative creativity.

2.2.3. Discussion

We reasoned that the appropriate operationalization of the independent variable and the dependent variable is the fundament for systematic validation. Drawing on the relativity approach, which implies that manipulations of high and low absolute levels on an independent variable are unavoidably confounded with manipulations of upward and downward changes, respectively, and based on large evidence that behavior is more sensitive to relative changes than to absolute levels, we manipulated changes (shifts) in regulatory focus orthogonally to absolute levels, promotion versus prevention focus. Moreover, we made an attempt to assess creativity at a high level of reliability by including a battery of diverse creativity tests, including both generative and non-generative tasks. Generativity as defined by an online production of novel solutions to an ongoing epistemic problem, we used the BT, RAT, and WIP as a combined measure of generative creativity, while the self-reports IC activities and IC achievements from the ICAA were not based on the online mobilization of generative action, since they constitute self-reports of people's record of creative past behavior. Although IC activities and IC achievements were detached from creative performance in current tasks, they refer to genuinely creative experiences in the past and were therefore combined and applied as a non-generative measure.

Generative performance was markedly higher under promotion focus than under prevention focus. Moreover, going beyond previous research, an independent manipulation check – measuring the relative accessibility or promotion-related and prevention-related concepts – supported the assumption that creativity effects were most pronounced for those participants who were most sensitive to the manipulation. Thus, the creativity advantage of promotion over prevention focus was accentuated after a shift, when a promotion focus (prevention focus) manipulation was preceded by a contrastive prevention focus (promotion focus) manipulation, relative to a regulatory-focus state condition. Although the regulatory focus main effect was the strongest and most robust effect, the focus x shift interaction provides positive support for the shift manipulation, whereas the regulatory focus manipulation remains inevitably confounded with a shift. Even in the absence of a contrastive shift, promotion or prevention focus states followed a shift from a neutral state, suggesting that the basic main effect may also be due to an unknown degree to a shift on the independent variable, rather than an absolute level.

Moreover, the results show stronger regulatory-focus effects on generative tests (BT, RAT, WIP) than on non-generative tests (IC activities and achievements). However, this finding was only based on one non-generative measurement so far and has to be validated with a more comprehensive sample of non-generative tasks.

Further support for the first evidence, that generative tasks are particularly sensitive to assimilative mindsets (like promotion focus) can be found in the previous literature on regulatory focus and creativity. Friedman and Foerster (2001) attributed the influence of regulatory focus on creativity (using a brick task) to a risky, explorative processing style, which is indeed a characteristic feature of assimilative strategies (cf. Fiedler & Hütter, 2013). Also in line with the present evidence is the finding by Zabelina et al. (2013) that only the production of novel associations, but not common associations, is facilitated under promotion (vs. prevention) focus.

Also in a study by Herman and Reiter-Palmon (2011) a promotion-focus advantage was indeed obtained for the assimilative function of generation of original ideas, but not for the evaluation of the idea quality, based on the accommodative use of an evaluation rule. Thus, when it came to judgments about the generated ideas, the impact of promotion focus seems to be limited while prevention focus operates as the more accurate evaluation strategy.

In this experiment, assimilation was clearly targeted by the experimental effects on creative performance, but accommodation as the complementary adaptive strategy was not sufficiently represented by the non-generative measures. Thus, the following experiment will ask more specifically for accommodation strategies as represented by deliberated judgments.

2.3. Regulatory Shift and Endowment Effect

The field of behavioral economics, which contains the application of psychological insights to economic models, has been strongly influenced by cognitively focused research on decision making (Krueger & Kutzner, 2017) but has been largely untouched by decision researchers interest in self-regulation. The following experiment intended to fill this gap by linking regulatory shifts with the endowment effect – that is, the tendency for selling prices to exceed buying or ''choice'' prices for the same object (Kahneman, Knetsch, & Thaler, 1991). People tend to overestimate the value of goods once they become their possessions. The endowment effect is one of the most important and robust economic anomalies in behavioral economics.

A popular explanation in the literature for the endowment effect concerns the psychological variable "loss aversion", which refers to the notion that when a loss and a gain have the same monetary value, the motivation to avoid the loss is stronger than the motivation to approach the gain. The psychological variable of loss aversion, in turn, is often understood in terms of Kahneman and Tversky's (1979; 1984) "prospect theory" which proposes that the curve relating psychological value to objective value for loss outcomes is steeper than the curve for gain outcomes. Giving up an object one already possesses would entail a certain loss. From a loss aversion perspective, the motivation to avoid this painful outcome is so powerful that it overwhelms the motivation to approach a pleasant alternative (Thaler, 1980).

Only a few studies considered the potential role of self-regulation as a moderator for this robust effect (Förster and Higgins, 2005; Lerner, Deborah, Small, & Loewenstein, 2004; Liberman, Idson, Camacho, & Higgins, 1999). Liberman and colleagues, for instance, examined how regulatory focus, varying as a chronic personality variable and as an experimentally induced variable, influence the endowment effect. In each study, the participants were given an object or imagined being given an object as a gift (e.g., a pen) and then they were asked whether they wanted to exchange it for another gift of comparable monetary value. They predicted that participants' willingness to exchange the object they possessed for the alternative object, i.e., their choice to take or not to take the new alternative, would vary by regulatory focus.

According to Regulatory Focus Theory (Higgins, 1997), participants in a prevention focus would prefer vigilance means of decision-making, and vigilance involves ensuring against errors of commission. This conservative bias of vigilance should make these participants less open to change, thus producing the endowment effect. According to RFT, participants in a promotion focus would prefer eagerness means of decision making, and eagerness involves ensuring hits. This risky bias of eagerness should make these participants more open to change, thus reducing the endowment effect. All three studies found that, as predicted, a significant endowment effect was found when participants were in a prevention focus, but no endowment effect was found when participants were in a promotion focus. One of the studies also asked the participants before they made their decision how much they liked the object they had been given as a gift. Regulatory focus was not related to participants' liking of this object. Thus, regulatory focus influenced participants' decision to take or not take the new alternative despite having no influence on participants' liking for the gift object.

Another study by Förster and Higgins (2005) applied regulatory focus on the endowment effect by letting participants process information globally or locally prior to choosing between two objects. Participants were then presented with a series of global letters that were each made up of rows of closely spaced local letters and were asked to identify either the global letter (promotion focus) or the local letter (prevention focus). Then participants were instructed to choose between a mug and a pen by either thinking about what they would gain by choosing the pen or the mug (an eager strategy), or what they would lose by not choosing the pen or the mug (a vigilant strategy). The authors found that those who had just performed the local task assigned a higher price to their chosen object if they used prevention-related vigilant means to make their decision, rather than promotion-related eager means, whereas the reverse was true for those who had just completed the global task.

Evidence for the moderation of the endowment effect also arises from an emotion research perspective. Lerner, Deborah, Small, & Loewenstein (2004) demonstrate that emotions of the same valence can have opposing causal effects. They showed that disgust triggered goals to expel, reducing buying and selling prices, whereas sadness triggered the goal of changing one's circumstances, increasing buying prices but reducing selling prices. The effects were sufficiently strong that in one case (disgust) they eliminated the endowment effect, and in the other case (sadness) they reversed it. This is not surprising from a range-frequency-perspective since the range of the same valence offers different qualities (see chapter 1.3).

However, all these findings suggest that the robustness of the endowment is relatively dependent on self-regulation factors. Most of the studies concerning endowment effects also lack from reliability, since the common use of a very small sample of items (possessions), and sometimes even only one item (e.g. pen or mug). Perhaps for the sake of economic reasons and procedure efficiency. We believe that a larger dependent sample should lead to better decisions and more internally consistent results (Cronbach, 1951; Fiedler & Juslin, 2006).

Moreover, we believe that the validity of the endowment is not sufficiently illustrated by the measure of only one fixed price estimate. According to the range-frequency model (Parducci, 1965; 1968), we assume that a price range judgment would strengthen the robustness of the endowment effect and permit more insights about its nature. Thus, we suggest that a negotiation request, as recorded by a minimum and maximum price estimation would enrich the validity of the endowment effect, additionally to the classical estimation of single price values.

Considering our adaptive strategy model (Fiedler, 2001; Fiedler & Hütter, 2013), the endowment effect fosters functions of the accommodation type, since the tendency to overestimate own goods requires a predominant bottom-up state of "sticking to what is given", while an assimilation function would rather "go beyond what is given" in a top-down process of imagining what else can be gathered instead. Thus, and in the light of the previous creativity evidence, we want to add more reliability to the driving force behind the endowment effect by inducing the regulatory shift in addition to the regulatory focus state manipulation, as an enhanced sensitization for the treatment (Fischoff, Slovic & Lichtenstein, 1979), and strengthen the endowment effects validity by adding a negotiation task to the fixed price estimates. We assume that a change in regulatory focus should be a more diagnostic treatment than a mere state manipulation. Thus, a shift from promotion to prevention should lead to a stronger endowment effect. Furthermore, and since we know that promotion focus leads to higher levels of assimilation, we expect an enhanced exploration for opportunities in promotion focus compared to prevention focus, as reflected by a higher negotiation range compared to a narrow negotiation range for prevention focus.

Hypotheses. We expect convergent support for the facilitative influence of prevention focus on the endowment effect, provided that the independent variable (regulatory focus) is manipulated effectively and the dependent variable (endowment effect) is measured reliably. The causally effective variable should be a change in regulatory focus, rather than a static level. The impact of promotion focus on price estimates should be more pronounced for price ranges than for fixed prices.

2.3.1. Method

Participants and design. N=126 students were recruited from the *Studienportal* platform (Bock, Nicklisch, Baetge 2012), 105 females and 21 males, mean age = 22,53 *SD* = 6.53, were randomly assigned to the same 2 (regulatory focus) x 2 (shift) conditions as in the previous experiment and complemented with x 2 (endowment) dependent factors. The study was implemented on the SoSci-Survey online-platform (Leiner, 2014; Version 2.5.00-i).

Materials and procedures.

Participants were invited to compete in a study on price estimates of everyday products. Upon completion of the manipulation phase, participants were shown a randomly chosen set of eight products that were "reserved as your personal gift-set". The products were randomly chosen from 1-Euro-Market supplies, all with an identical price value. Participants were allowed to choose one of their reserved products as an additional gift for participation at the end of the experiment.

After considering their own product set, they were instructed to estimate a fair price for each one of their products on an analog price scale ranging from 50 cent to 10 euros in 50 cent sections. After submitting a fixed price estimate, they were asked on a following page to mark a fair minimum price and finally a fair maximum price on a similar price scale. Each product judgment followed the same order (fix, min & max price). All eight reserved products (gifts) were randomly assigned to a total set of sixteen items, which contained eight additional but unfamiliar products (non-gifts). After entering all price estimates for each product, participants were asked to fill out a demographic information form. The session lasted about 20 minutes. Participants were thanked, debriefed and rewarded with 7 Euros and one real product of their choice from their experimental set.

2.3.2. Results

Manipulation check. As in Experiment 1 the manipulation check replicated and substantiated the intended treatment effects in all respects (Figure 6). An ANOVA of the difference between the number of identified promotion-related minus prevention-related words again revealed a strong main effect for regulatory focus, $F(1,122) = 74.927$, $\eta^2 = .366$, $p < .001$, and an interaction, $F(1,122) = 7.433$, $\eta^2 = .036$, $p = .007$. Participants in the promotion-focus condition produced relatively more promotion-related minus prevention-related words (D = 3.22). The opposite was observed for participants in the prevention-focus condition (D = -1.86). This differential treatment effect was more pronounced after a shift, D = 2.09 vs. -1.25, $t(62) = -4.413$, $p < .001$, $d = -2.01$, than in a static context, D = 1.13 vs. -0.61, $t(60) = -4.541$, $p < .001$, $d = -1.09$. The SAM measure for mood and arousal was not significantly affected (all Fs < 3).

Endowment effect. A repeated measure ANOVA with 2 levels for endowment (own vs. other products) was conducted to indicate the effect of the experimental treatment on fixed price estimates. All means and standard deviations for the resulting influences of the regulatory focus treatment are listed in Table 3. A strong main effect for endowment, $F(1,122) = 56.870$, $\eta^2 = .243$ $p < .001$ and an interaction with regulatory focus, $F(1,122) = 55.202$, $\eta^2 = .236$ $p < .001$ was observed. This was clarified by a post-hoc comparison between promotion and prevention focus with the difference scores between own and other product estimates as the dependent variable. It revealed a much stronger endowment affiliation with prevention focus compared to promotion focus, $t(124) = -7.489$, $p < .001$, $d = 1.33$. Neither an endowment interaction with shift, $F(1,122) = 0.090$, $\eta^2 = .000$ $p = .765$ nor the triple interaction of endowment with regulatory focus and shift led to significance, $F(1,122) = .003$, $\eta^2 = .000$ $p = .956$. The shift treatment did not seem to have an impact on fixed price estimates (Figure 6).

The assessment of the openness to negotiate, however, led to different effects. Only the observation of the minimum prices only led to a marginal effect for endowment, $F(1,122) = 3.556$, $\eta^2 = .028$, $p = .062$, explained by prevention focus claiming higher minimum prices for owned ($M = 2.28$, $SD = .71$) compared to other products ($M = 2.12$, $SD = .60$). A followed between subject comparison for minimum prices showed a strong main effect for regulatory focus, $F(1,122) = 10.332$, $\eta^2 = .077$, $p = .002$, in the expected direction of promotion focus claiming lower prices ($M =1.86$, $SD = .62$) compared to prevention focus ($M = 2.20$, $SD = .66$). The maximum price observation on the other hand, revealed neither a general endowment effect nor any interactions with the manipulations at all (Fs < 1). A followed between subject comparison however showed again a main effect for regulatory focus, $F(1,122) = 4.874$, $\eta^2 = .037$, $p = .029$, which was moderated by a marginal regulatory shift interaction, $F(1,122) = 3.562$, $\eta^2 = .027$, $p = .062$, in the matter of promotion shift claiming higher prices ($M =4.21$, $SD = 1.02$) compared to prevention shift ($M = 3.42$, $SD = 1.26$), whilst the state groups did not differ in the maximum price judgment ($M =3.75$ vs. $M =3.68$).

Finally, and beyond previous research, we conducted a repeated measure ANOVA of the price range between minimum and maximum price with 2 levels for own and other products, which revealed strong between subject effects for regulatory focus, $F(1,122) = 27.698$, $\eta^2 = .172$, $p < .001$, and the shift interaction, $F(1,122) = 10.056$, $\eta^2 = .062$, $p = .002$. All within subject interactions with endowment lacked from significance (all Fs < 1). Since the overall range observation revealed no endowment interactions, we controlled averaged range estimates for both own and other products in a post-hoc t-test to clarify the impact of the regulatory focus and shift interaction. Participants in the promotion-focus conditions produced relatively broader price ranges ($D = 4.25$) compared to participants in the prevention-focus conditions ($D = 2.77$). This differential was more pronounced after a shift, $D = 2.43$ vs. 1.25, $t(62) = 6.174$, $p < .001$, $d =$

1.57, than in a static context, $D = 1.82$ vs. 1.52, $t(60) = 1.430$, $p = .158$, $d = -.43$.

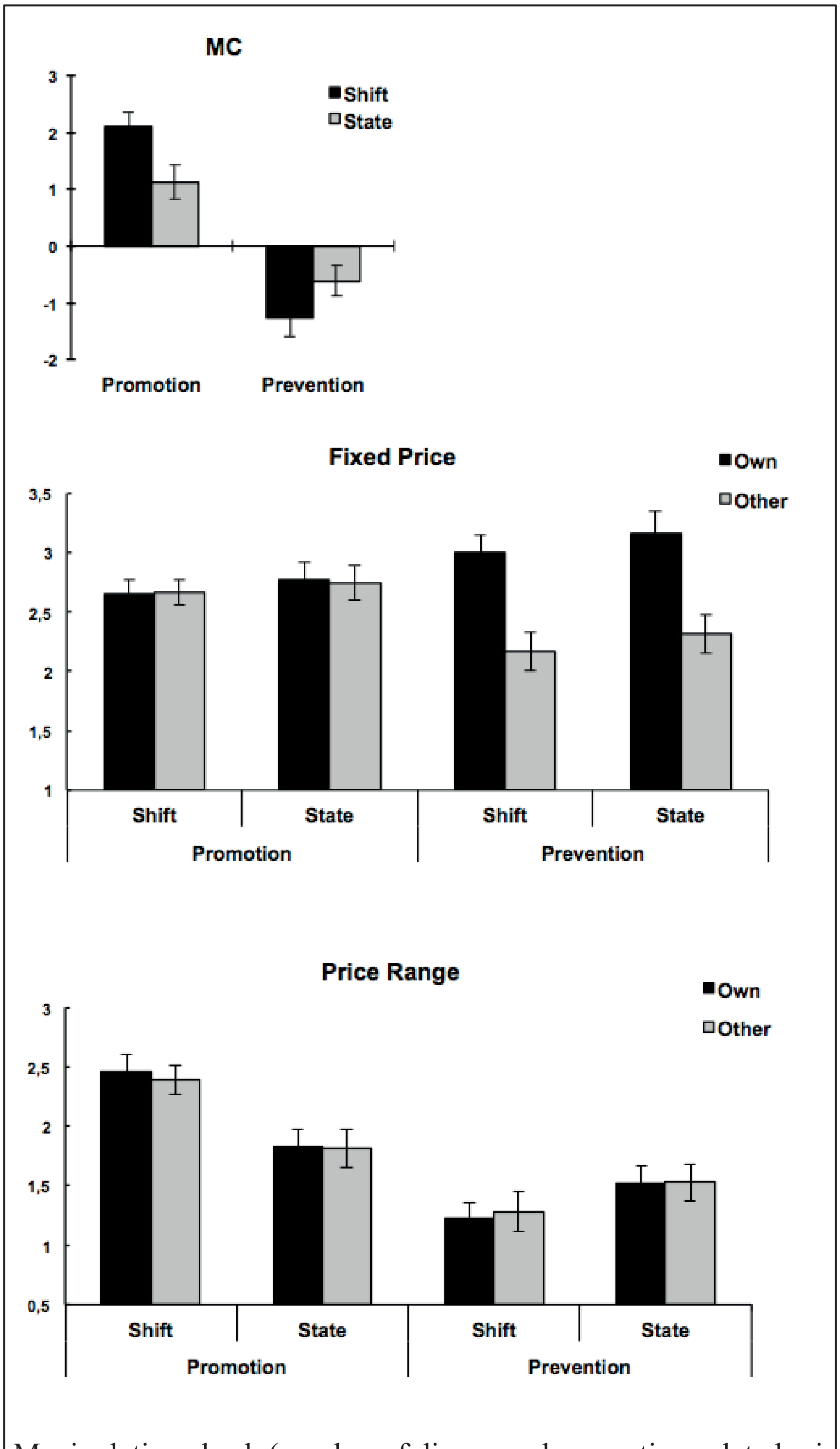

Figure 6. Manipulation check (number of discovered promotion-related minus prevention-related words), mean fixed price judgments and price ranges (max. - min.) as a function of regulatory focus (promotion, prevention) context (shift, state), and endowment (own, other).

Table 3: Mean price judgments (and standard deviations) by experimental conditions.

Endowment	Regulatory Focus	Context	Fixed Price		Price Range	
Own	Prevention	*Shift*	2.99	*(.88)*	1.21	*(.82)*
		State	3.16	*(.99)*	1.52	*(.8)*
	Promotion	*Shift*	2.65	*(.70)*	2.46	*(.79)*
		State	2.77	*(.82)*	1.82	*(.82)*
Other	Prevention	*Shift*	2.16	*(.89)*	1.27	*(.94)*
		State	2.31	*(.9)*	1.52	*(.86)*
	Promotion	*Shift*	2.66	*(.59)*	2.39	*(.70)*
		State	2.74	*(.80)*	1.81	*(.88)*

2.3.3. Discussion

Based on our previous evidence that behavior is more sensitive to relative changes than to absolute levels, we manipulated shifts in regulatory focus orthogonally to absolute levels of promotion versus prevention focus. Moreover, we made an attempt to assess the endowment effect – people's tendency to overestimate the value of their own goods – at a high level of reliability by applying a multi-possession sample instead of only one item, and by including additionally to the classic fixed price estimation, a negotiation tasks which asked for a price range in minimum and maximum terms.

The experiment provided a conceptual replication of the endowment effect in the case of fixed price estimates. However, aggregated across all owned products, the endowment effect was markedly higher under prevention focus than under promotion focus. However, a triple-interaction of the shift manipulation did not influence the sensitivity to the endowment effect. Nevertheless, the success of the sensitivity treatment was again obtained by the independent manipulation check that measured the relative accessibility of promotion-related and prevention-related concepts across all groups. Moreover, the successful sensitization by the shift led to a more stimulating pattern for the negotiation task. Interestingly, and even if it lacked statistical significance, it was only the minimum price that varied between own and other products, in the matter that it was higher for prevention focus. This is reasonable from a loss aversion perspective (Kahneman, Knetsch, & Thaler, 1990). Since the minimum price would be the seller's actual price-limit in a real negotiation setting, the occurrence of the endowment effect would not be very surprising. Thus, people in prevention focus rather want to avoid a bad deal for their belongings and therefore set a marginally higher minimum limit for their goods.

The maximum price instead, has a subjective quality of what people might pay, and a more elaborate implication for a real sale under prevention focus. In the light of our adaptive strategy model, functions of the accommodation type involve in a more conservative, cautious judgment (cf. Fiedler & Hütter, 2013) and so does the prevention focus. Since the loss aversion bias only refers to one side of the loss-gain dimension, the decision-style for maximum prices might be corrected by a conservative bias, in the matter of fair judgments towards own and other products.

Surprisingly, the average price range for the possessed products was nearly the same as the price range for the unpossessed products for all groups. We expected the price range to be narrower for own products compared to the unpossessed since the willingness to deal with the owner's belongings should be reduced by the endowment effect. Our findings, however, indicate another account. The endowment effect seems to be generally reduced when people are asked to negotiate. Moreover, we obtained a strong influence of the regulatory focus on the negotiation task in terms of broader price ranges for promotion focus compared to prevention focus, which was enhanced by the sensitization of the shift-treatment. Thus, the expected negotiation advantage of promotion over prevention focus was accentuated after a shift, when a promotion focus (prevention focus) manipulation was preceded by a contrastive prevention focus (promotion focus) manipulation, relative to a regulatory-focus state condition. People in promotion shift have set the lowest minimum and highest maximum prices for their goods.

This supports our prediction that people in promotion focus find enhanced exploration for opportunities as reflected by broad negotiation ranges. That matches our previous evidence from Experiment 1 consistently and is also in line with our adaptive strategy model. Our findings on creativity indicate that a subset of generative measures of creative online performance was apparently more sensitive to promotion shift than the subset of non-generative indices of creativity. If we treat the negotiation task as a more generative measure compared to a single fixed price estimate, the effect of regulatory focus resp. promotion shift, in particular, makes perfect sense since an explorative processing style is indeed a characteristic feature of assimilative strategies (Fiedler, 2001). Thus, the negotiation task can be interpreted as another measure of generativity compared to just one fixed price estimate, and is therefore more sensible to a change in regulatory strategies.

Further support for these findings can be found in marketing and consumer literature, in which advertisement ratings, for instance, were influenced by the creative abilities of the advertisement judges (Caroff & Besançon, 2008). Also in line with the present evidence are several findings from Forgas' Affect Infusion Model (AIM; Forgas, 1995) that indicates affect and motivation as the predominant moderators for judgments on product attractiveness and familiarity (e.g. Forgas, Levinger, & Moylan, 1994).

Still, and beyond the validation of the classic endowment effect, the major novel finding again concerns the catalyst role, played by the regulatory shift manipulation. It was again the shift that enhanced functions of the assimilation type, reflected by a broad negotiation level, which overruled accommodative processing, provoked by the endowment effect. However, it remains unclear whether a relative change is also capable of reducing biases in its favorable direction, namely those who are evoked by assimilation processing. The findings raise the legitimate question about either an enhancement of top-down generated biases or an adjustment function due to the regulatory shift. We will adress this question in the following experiment by applying the regulatory shift treatment to judgments on human vs. machine performances, also known as the hot hand and the gambler's fallacy.

2.4. Regulatory Shift and Hot Hand vs. Gambler's Fallacy

Most people associated with the game of basketball believe that a player who has just scored several times in a row is now more likely to score—because he or she is "hot." This phenomenon is called the "hot hand" fallacy and was first observed by Gilovich, Vallone, and Tversky (1985). Their study showed that people have an incorrect expectation that a run of the same outcome will continue. However, when the authors computed the sequential dependencies between successive scoring attempts of players, they found that there was no such dependency. Gilovich and colleagues explained that judgment by representativeness, which can lead people to reject the randomness of sequences that contain the expected number of runs because the appearance of long runs in short samples makes the sequence appear unrepresentative of randomness (Tversky & Gilovich, 1989).

The rationale behind the "representativeness" was offered by Kahneman and Tversky (1972) and strangely, also used as an explanation for the exact opposite phenomenon, namely the gambler's fallacy: The belief that, for random events, runs of a particular outcome (e.g., heads on the toss of a coin) will be balanced by a tendency for the opposite outcome (e.g., tails). They argue that people expect the essential characteristics of a chance process to be represented not only globally in an entire sequence of random outcomes but also locally in each of its parts. Thus, long runs of the same outcome lack from representativeness and are thereby not perceived as representative of the expected output of a random device. People will consequently expect runs of the same outcome to be less likely than they are (e.g. five times red in a row in roulette). Numerous experiments in probability learning empirically confirmed the reality of this bias in tasks where subjects were asked to predict the next outcome in a series of random binary alternatives (e.g. Budescu, 1987; Jarvick, 1951).

Ayton and Fisher (2004) raised the legitimate question regarding the validity of the representativeness explanation for both phenomena: If observation of the runs associated with conditional independence in basketball is reason for observers to reject the notion that the sequence of success and failure is random, why do people not come to a similar conclusion in situations where the gambler's fallacy has been observed? – In roulette for instance. According to the representativeness, in both cases, subjects reject the random sequences they see as being unrepresentative of their faulty concept of statistical randomness. By believing that chance mechanisms should not exhibit long runs, the gambler's fallacy is invoked, whereas observing long runs of success refutes the notion that outcomes are random, and so the hot hand fallacy is invoked. However, without clarifying a mechanism to identify which of the two distinct and opposing prior expectations arises, there is an incomplete explanation of both the hot hand and gambler's fallacies with a single heuristic.

Ayton and Fisher's (2004) suggestion is that a biased concept of "pure" statistical randomness is not primarily responsible but separate concepts of positive and negative recency that are cued when people decide which sort of previous experience the data is most likely to resemble. Their findings indicate that different biases are acquired through experience via sequences of events— negative recency in the natural ecology of uncertain events involving natural phenomena is influenced by sampling without replacement (Ayton, Hunt, & Wright, 1989; Lopes, 1982) while the experience of positive recency in repetitions of human skilled performance with varying outcomes (Adams, 1995; Gilden & Wilson, 1995).

These rationales about expectations of positive resp. negative recencies are in line with a milestone work by Rotter (1966) about generalized expectancies for internal versus external control of reinforcement. Derived from social learning theory (Rotter, 1954), reinforcement acts to strengthen the expectancy that a particular behavior or event will be followed by that reinforcement in the future. For instance, a learning situation in which an experimenter arbitrarily determines the right response for whether or not food is given, regardless of the participant's behavior, will produce a different kind of learning than one where the participant believes his behavior determines whether or not the reinforcement will occur. In other words, learning under *skill* conditions is different from learning under *chance* conditions.

For instance, a study by James and Rotter (1958) emphasized the extinction of verbal expectancies. Under conditions of partial and total reinforcement, an extrasensory perception type of task was used with experimenter control. The exact same sequence of 50% partial reinforcement was given to two groups (two other groups had 100% reinforcement) for ten training trials. Two groups were told that guessing in the task had been shown by scientists to be entirely a matter of luck, and two groups were told that there was evidence that some people are considerably skilled at the task. While the groups did not differ at the end of the training trials, the chance and skill groups did differ significantly in the number of trials to extinction.

From a motivated cognition perspective, we find strong parallels to the adaptive strategy model of assimilative and accommodative processing (Fiedler, 2001; Bless, Fiedler, & Forgas, 2006). Since the internal control of reinforcement is nothing but the belief in a self-determined impose of internalized structures onto the external world (assimilation), whereas external control of reinforcement is the natural modification of internal structures in accordance to external constrains (accommodation). Thus, if the claim of Ayton & Fisher regarding biased expectations of sequences is derived from human success in the case of the hot hand fallacy, and from automated chance in the case of the gambler's fallacy, then the locus of control (Rotter, 1966) influenced by self-regulation should have an impact on the believe in the fallacies. Bless and Fiedler (2006) claim that the distinction between internally and externally driven adaption can be sensibly applied to all aspects of regulation. However, regulatory focus research has not examined how expectancies from prior outcomes can be influenced by goal pursuit. Brendl and

Higgins (1996) discussed this possibility, but no evidence was provided so far. Bridging biased expectancies practically with the adaptive strategy framework, gives us a good reason to do so.

Moreover, we want to point out a poor cross-validity for most studies concerning the hot-hand and gambler's fallacy by applying only one choice dimension to either a skill or a chance scenario. The option of a possible cold hand – to believe in an ongoing unsuccessful strike – or maintaining in bad luck during a gambling session is often neglected. Thus, we propose not just the measure of positive outcome expectations, but also the within control for predictions on random and negative sequences. Also, we believe that the reliability of the fallacies is not sufficiently illustrated by the measure of only one expected outcome – e.g. does the series stop or not? According to the range-frequency model (Parducci, 1965; 1968), we assume that judgments on an expectation range would strengthen the robustness of the prediction and permit more insights behind the fallacies natures. Thus, we suggest that a serial prediction, as recorded by an estimate for the next ten trials would enrich the validity of both fallacies, additionally to the classic prediction of the next single occasion.

Considering the adaptive strategy model (Fiedler, 2001, Fiedler & Hütter, 2013), experience of negative recency should encourage functions of the accommodation type, namely a bottom-up state of external control and thus be sensitive to the believe in the gambler's fallacy. Contrarily, assimilation function would rather be encouraged by an experience of positive recency due to a top-down process of internal control and thus be sensitive to the believe in a hot-hand fallacy. Furthermore, and in the light of our previous evidence, we want to add more value to the real effect behind goal achievement by inducing additionally to the regulatory focus state manipulation, the regulatory shift, as an enhanced sensitization for the treatment (Fischoff, Slovic & Lichtenstein, 1979), and strengthen the fallacies validity by adding a serial prediction task to the single estimate. We assume that a change in regulatory focus should be the more diagnostic treatment than a mere state manipulation. Furthermore, and since we know that promotion focus leads to higher levels of assimilation, as reflected by strong generative processing (Exp. 1) and enhanced negotiation ranges (Exp.2), we expect an increased imagination for opportunities in promotion focus compared to prevention focus, as exposed by an overestimated serial prediction for successful outcomes. Thus, a shift from promotion to prevention should lead to a stronger believe in gambler's fallacy in a chance scenario, while a shift from prevention to promotion should lead to a stronger believe in hot-hand fallacy in a skill scenario.

Hypotheses. We expect convergent support for the facilitative influence of prevention focus on gambler's fallacy in chance scenario and promotion on hot-hand fallacy in skill context. Provided that the independent variable (regulatory focus) is manipulated effectively and the dependent variables (hot-hand and gambler's fallacy) are measured reliably. The causally effective variable should be a change in regulatory focus, rather than a static level. The impact of promotion focus on predictions should be more pronounced for serial predictions than for single estimates.

2.4.1. Method

Participants and design. N=98 students recruited from the *Studientportal* platform (Bock, Nicklisch, Baetge 2012), 74 females and 24 males, mean age = 24.92 SD = 7.12, were randomly assigned to the same 2 (regulatory focus) x 2 (shift) conditions as in the previous experiments and complemented with x 2 (game) x 3 (recency) dependent factors. The study was implemented on the SoSci-Survey online-platform (Leiner, 2014; Version 2.5.00-i).

Materials and procedures. Participants were invited to compete in a study on predictive capabilities. The same manipulation procedure and manipulation check was used as described in the general procedure section (chapter 2.1.). Upon completion of the manipulation phase, participants were instructed to make predictions on professional basketball player shots and on roulette outcomes as well.

For the basketball scenario we implemented YouTube-videos from the annual Footlocker three-point contest, in which basketball players perform five shots from five racks in a row (25 shots in total) from different spots on the three-point line. Only 15 shots (three racks) were presented to the participants. We picked three players with the same base rate on the first two racks (ten shots: four hits / six misses), but differ on their performance at the third rack (Hot player: 5 of 5, moderate player: 3 of 5, and cold player: 0 of 5). The number of hits and misses on all racks was permanently updated and prominently displayed in the video.

The exact same sequences of hits and misses were adapted to the roulette scenario. Another YouTube-video in which a roulette wheel spins several times with different outcomes was edited and complemented with a display for outcome-values. Again, the base rate for the first two rounds (five spins per round) was four black to six red, while a black number represents win and red loss. In the third section of each video, the outcomes were held the same as in the basketball scenario (hot spins: 5 of 5, moderate spins: 3 of 5, and cold spins: 0 of 5).

A total set of 6 videos (each lasted between 30 seconds and one minute) was presented to all participants of each condition in a counterbalanced order (Table 4). Note that the hot, moderate and cold performance is only defined by the last 5 trials, since all previous attempts in all scenarios had an equal success rate (4 hits, 6 misses).

Table 4: *Overview of 6 videos with balanced outcomes for both scenarios (hits from trials).*

Performance	***Basketball (Skill)***	***Roulette (Chance)***
Hot	*5:5*	*5:5*
Random	*3:5*	*3:5*
Cold	*0:5*	*0:5*

Participants were instructed to estimate the future outcomes after each video. First, they were asked to rate the probability of the next single shot. To measure a proper and more differentiated outcome compared to a binary answer, we used a nine-level likert-scale with the poles miss vs. hit, while each dimension refers to the confidence, that either a success or a fail will occur. On the following page, they were asked to guess the number of possible hits and possible misses independently for the upcoming 10 trials, each on an analog scale ranging from 0 to 10, resulting in an p(continuance) index of hits minus misses.

Thus, after watching each video they predicted the outcomes for the immediate next trial and the following next ten trials. All videos from each game with all recency observations were presented in a counterbalanced order. At the end of the session, they filled out a questionnaire with demographic information. The session lasted about 20 minutes. Participants were thanked, debriefed and rewarded with 8 Euros and a candy bar.

2.4.2. Results

Manipulation check. As in the previous experiments the manipulation check replicated the intended shift effects (Figure 7). An ANOVA of the difference between the number of identified promotion-related minus prevention-related words revealed again a strong main effect for regulatory focus, $F(1,94) = 15.579$, $\eta^2 = .137$, $p < .001$, and an interaction, $F(1,94) = 4.224$, $\eta^2 = .037$, $p < .05$. Participants in the promotion-focus condition produced relatively more promotion-related minus prevention-related words (D = 1.46). The opposite was observed for participants in the prevention-focus condition (D = -1.12). This differential treatment effect was more pronounced after a shift, D = 1.04 vs. -.97, $t(47) = 4.04$, $p < .001$, d = -1.18, than in a static context, D = .42 vs. -.20, $t(47) = 1.421$, $p = .165$, d = .41. The SAM measure for mood and arousal was not significantly affected (all Fs < 1).

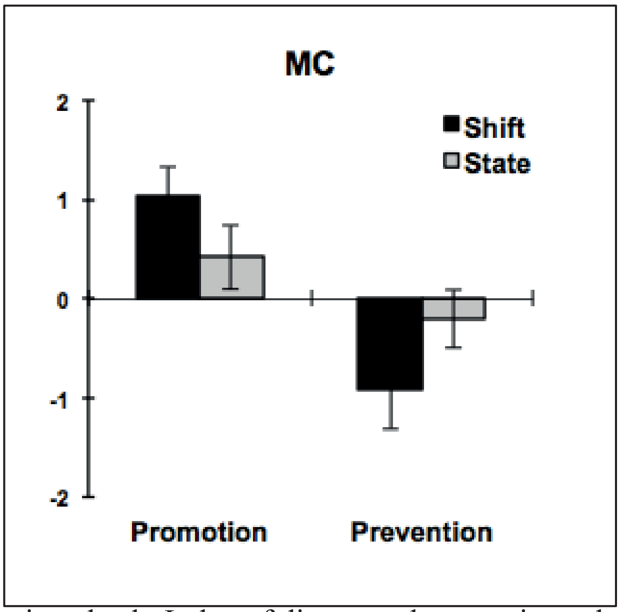

Figure 7. Manipulation check. Index of discovered promotion-related minus prevention-related words.

Single estimations (1st shot). A repeated measure ANOVA with 2 levels for context (skill, chance) and 3 levels for recency (positive, negative, neutral) was conducted to indicate the general effect of the hot hand fallacy across all groups on single predictions of the next shot. All means and standard deviations are listed in Table 5. A strong main effect for recency, $F(1,194)$ = 43.732, $\eta^2 = .311$ $p < .001$ and an interaction with game, $F(1,194) = 22.282$, $\eta^2 = .187$ $p < .001$ was observed (Figure 8).

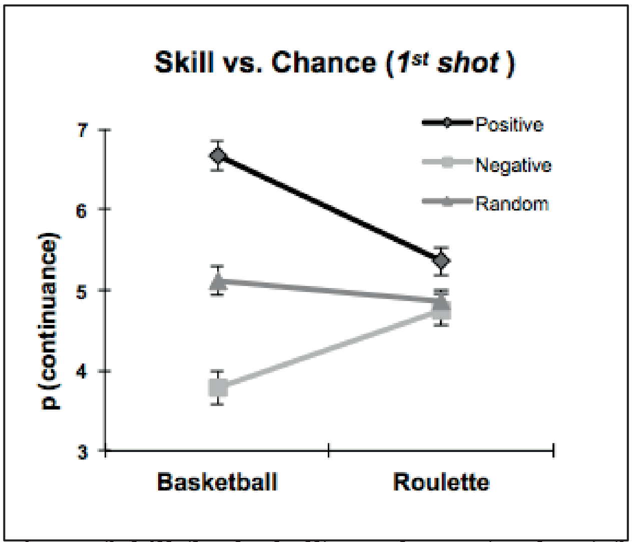

Figure 8. Interactions of skill (basketball) vs. chance (roulette) factors with recency (positive, negative, random) on 1st shot predictions across all experimental conditions.

All regulatory focus treatment effects on game and recency including interactions did not reach statistical significance (all Fs < 1). All groups replicated the predominant effect of the hot-hand fallacy in the basketball (skill) scenario. Predictions on 1st shot continuance were significantly higher for observed positive recency compared to negative recency, $t(97) = 9.652$, $p < .001$, $d = .70$. Both directions of predictions withstand a significant distance from random sequence in the skill scenario, $t(97) = 7.684$, $p < .001$, $d = .88$, and $t(97) = -5.295$, $p < .001$, $d = -.72$, which indicates the occurrence of a hot-hand and cold-hand fallacy. However, the chance scenario did not mirror this pattern. Only positive recency observations differed from random events, $t(97) = 2.430$ $p < .05$, $d = .32$, but note that the power of this statistical effect is caused by the large sample size and has rather an educational than a practical significance (Cohen,1977).

Table 5. *Mean continuance predictions (1st shot) across all experimental conditions aggregated from game and recency factors.*

Game	***Recency***	***Mean***	***SD***
Basketball	Positive	6.67	1.83
	Negative	3.77	2.06
	Random	5.11	1.71
Roulette	Positive	5.35	1.73
	Negative	4.75	1.92
	Random	4.85	1.37

Note. Means and standard deviations for 9-level Likert scale. Higher values represent higher hit probability.

Serial predictions (10 shots). The assessment of the serial predictions led to a more complex insight. A repeated measure ANOVA with 2 levels for game (basketball vs. roulette) and 3 levels for recency (positive, negative, random) was conducted to indicate the general hot-hand effect on serial predictions (see Table 6 for all means and standard deviations). Again, we find significant support for the skill provoked hot-hand fallacy as shown by a strong game main effect, $F(1,197) = 43.531$, $\eta^2 = .310$ $p < .001$, with regard to recency, $F(2,194) = 35.281$, $\eta^2 = .267$ $p < .001$, and a rather low game x recency interaction, $F(2,194) = 10.415$, $\eta^2 = .034$ $p < .05$. Although the random sequences differ from positive and negative sequences, the predictions for positive and negative recency unveil a different pattern from those in the 1st shot estimates (Figure X). Predictions on serial continuance were significantly higher for both positive $t(97) = 2.703$, $p < .01$, $d = .36$, and negative recency $t(97) = 4.864$, $p < .001$, $d = .56$, compared to random sequences in the roulette (chance) scenario, and even stronger in the basketball (skill) scenario: positive $t(97) = 5.418$, $p < .001$, $d = .72$, and negative recency $t(97) = 5.418$, $p < .001$, $d = .74$, compared to random sequences. Interestingly, the predictions for negative and positive recency did not differ at all (ts < 1), in none of both scenarios.

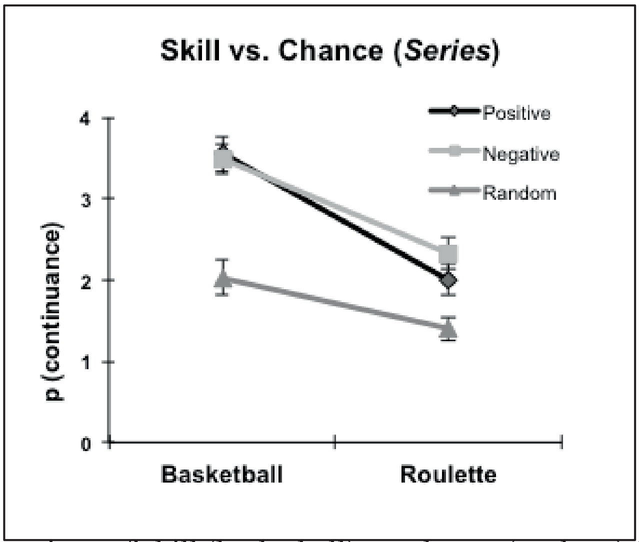

Figure 9. Interactions of skill (basketball) vs. chance (roulette) factors with observed recency (positive, negative, random) on serial predictions across all experimental conditions

Table 6. *Mean continuance predictions (10 shots) across all experimental conditions aggregated from game and recency factors.*

Game	*Recency*	*Mean*	*SD*
Basketball	Positive	3.55	2.11
	Negative	3.49	1.81
	Random	2.03	2.11
Roulette	Positive	2.01	1.94
	Negative	2.32	1.99
	Random	1.39	1.42

Note. Means and standard deviations for index of p(continuance). Higher values represent higher hit probability.

To get a more detailed picture of the serial predictions on positive and negative recency we conducted a repeated measure ANOVA without the random sequence data with 2 levels for game (basketball vs. roulette), 2 levels for recency (positive, negative) and the 2 x 2 (regulatory focus x shift) experimental treatment as between subject factors. All means and standard deviations for the resulting influences of the regulatory focus treatment are listed in Table 7.

Neither a main effect for recency, $F(1,94) = .827$, $\eta^2 = .009$ $p = .366$ nor the game x recency interaction were significant, $F(1,94) = 1.571$, $\eta^2 = .016$ $p = .231$. A strong main effect for game, $F(1,94) = 34.934$, $\eta^2 = .242$ $p < .001$, with a regulatory focus interaction, $F(1,94) = 9.066$, $\eta^2 = .063$ $p = .003$, and a triple-interaction with shift, $F(1,94) = 6.371$, $\eta^2 = .044$, $p < .05$, was observed. The rather moderate between subject effects of regulatory focus, $F(1,94) = 4.046$, $\eta^2 = .040$ $p < .05$, and the shift interaction, $F(1,94) = 4.149$, $\eta^2 = .041$, $p < .05$, were thus constricted by the game type. A subsequent assessment of recency for each game revealed no between subject effects in the roulette (chance) scenario (All Fs < 1), but strong between subject effects for regulatory focus, $F(1,94) = 15.807$, $\eta^2 = .128$, $p < .001$, and shift interaction $F(1,94) = 13.042$, $\eta^2 = .106$, $p < .001$, for the basketball (skill) scenario (Figure 10). All within subject interactions with recency lacked from significance (all Fs < 1).

However, we controlled averaged predictions for both positive and negative recency in a post-hoc t-test to clarify the impact of the regulatory focus and shift interactions in the basketball (skill) scenario. Participants in the promotion-focus conditions produced relatively more continuance expectations ($M = 4.09$, $SD = 1.76$) compared to participants in the prevention-focus conditions ($M = 2.93$, $SD = 1{,}81$). This differential was more pronounced after a shift, $M = 4.54$ vs. 2.35, $t(47) = 5.288$, $p < .001$, $d = 1.48$, than in a static context, $M = 3.63$ vs. 3.52, $t(47) = .490$, $p = .627$, $d = .05$.

Table 7. Mean continuance predictions by experimental conditions (regulatory focus x shift) and dependent factors (game x recency).

Game	***Recency***	***Regulatory Focus***	***Shift***	***Mean***	***SD***
Basketball	Positive	Promotion	*State*	3.44	2.43
			Shift	2.25	1.39
		Prevention	*State*	3.75	1.96
			Shift	4.72	1.84
	Negative	Promotion	*State*	3.60	2.18
			Shift	2.46	1.22
		Prevention	*State*	3.50	1.72
			Shift	4.36	1.55
	Random	Promotion	*State*	1.88	2.09
			Shift	2.46	2.23
		Prevention	*State*	2.33	2.20
			Shift	1.48	1.94
Roulette	Positive	Promotion	*State*	2.01	1.73
			Shift	2.29	2.18
		Prevention	*State*	1.79	1.96
			Shift	1.92	1.98
	Negative	Promotion	*State*	2.40	2.33
			Shift	2.42	1.77
		Prevention	*State*	2.38	1.95
			Shift	2.12	1.99
	Random	Promotion	*State*	1.64	1.63
			Shift	1.38	1.25
		Prevention	*State*	1.50	1.67
			Shift	1.08	1.12

Note. Serial predictions as an index of hits minus misses resulting in p(continuance).

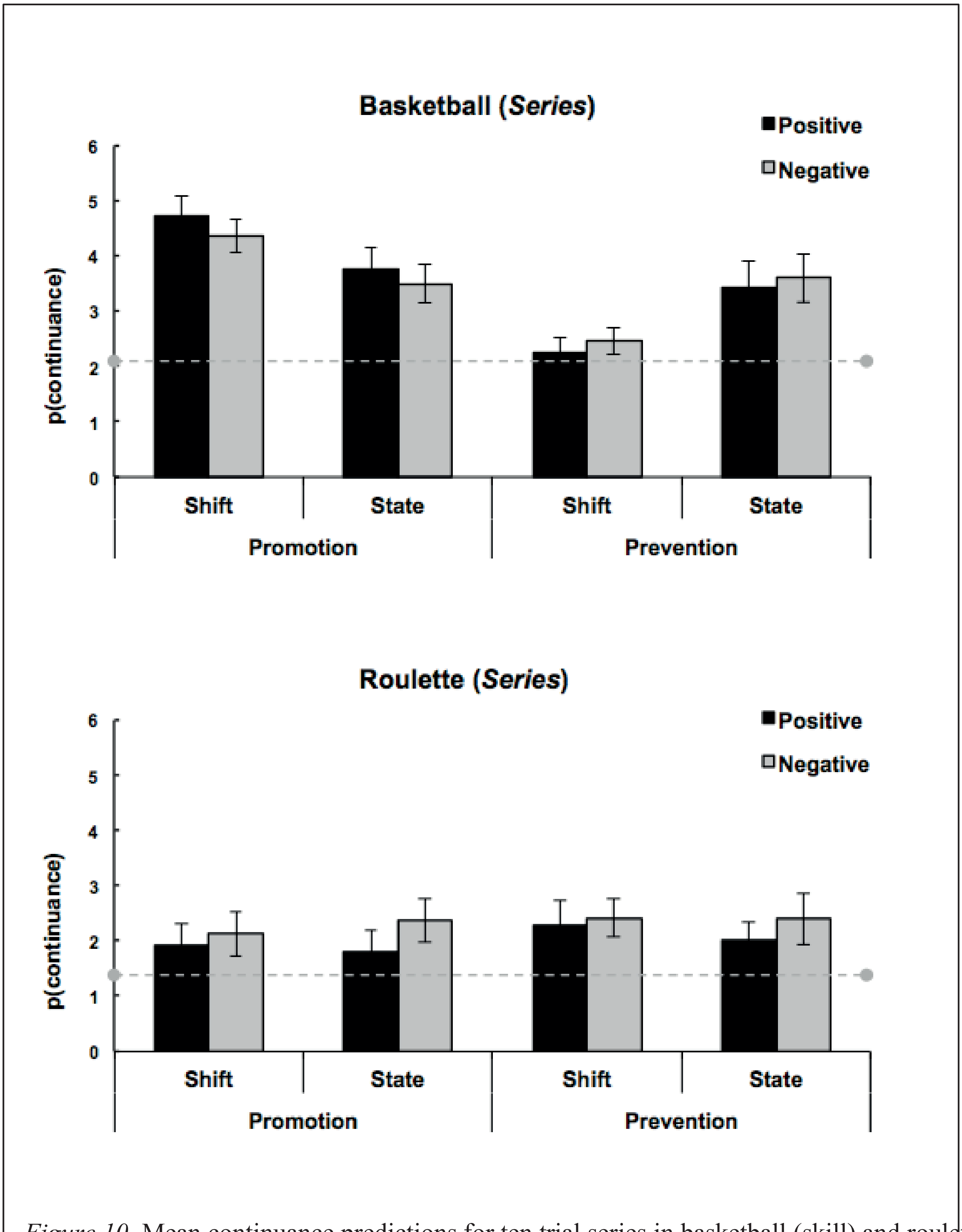

Figure 10. Mean continuance predictions for ten trial series in basketball (skill) and roulette (chance) scenario as a function of observed recency (positive vs. negative), regulatory focus (promotion vs. prevention), and context (shift vs. state). Average continuance prediction for random control is marked in the dashed line.

2.4.3. Discussion

Based on our previous evidence that behavior is more sensitive to relative changes than to absolute levels, we manipulated shifts in regulatory focus orthogonally to absolute levels of promotion versus prevention focus. Moreover, we made an attempt to assess the hot hand fallacy – people's tendency to predict the continuance of a sequence, and the gambler's fallacy – people's tendency to predict the discontinuance of a sequence, at a high level of reliability by applying positive, negative, and random sequence observations to skill and chance scenarios, and by including additionally to the classic immediate next trial prediction, a serial prediction tasks which asked for the continuance of the next ten trials for hits and misses.

The experiment provided a conceptual replication of the hot hand fallacy evoked by skill scenarios and the gambler's fallacy evoked by chance scenarios. For both measures (single and serial predictions) the predominant effect of the gambler's fallacy occurred by watching roulette, independently from the regulatory focus manipulations and recency functions. People from all groups expected rather the discontinuance of a sequence, no matter whether a sequence was positive (many hits in a row) or negative (many losses in a row). However, a slight increase of belief in continuance was shown by the serial prediction task, which was either enabled by larger task contingencies or by an implicit misinterpretation of chance as luck.

Wagenaar (1988) noted that in games of chance such as roulette, the outcomes of the wheel are typically held by gamblers to be random and governed by unpredictable chance. They may understand that the statistics of the wheel are against them, but they still bet because the outcome of a gamble is seen as the result of an interaction between the player's choice of number and the outcome of a random device. According to this argument, an analysis of the mathematics of the outcomes of the wheel offers no hope but this says nothing about peoples' choices. Players apparently believe that their choices of number to bet on can be "their lucky number". Thus, the outcomes of betting are commonly seen as governed by luck, which is not thought of in the same way as chance (see Wagenaar & Keren, 1988). Although the prediction task was not framed as a bet-and-win case, people perhaps had an implicit feeling of gaining an outcome, and thus expected a winning strike.

However, the within-comparison of predictions between roulette and basketball replicated Ayton and Fishers (2004) assumptions regarding the source of skill vs. chance sequences in all respects. People trapped in the hot hand resp. cold hand fallacy by watching professional basketball players, which provoked them to make much more predictions of continuing sequences, compared to roulette observations. In the case of single predictions (next trial), all groups acted like that, independently from the regulatory focus and shift manipulation. We infer that all manipulation effects have been overwhelmed by a classic memory operation, namely the recency effect (Ebbinghaus, 1885; Jarvik, 1951). When people are asked to freely recall a list of items, they tend to begin the recall with the end of the list. This is in line with the arguments of Ayton and Fisher that previous experience is primarily responsible for the context distinction of the gambler's and hot hand fallacy. Motivation, confidence, or fatigue, have been thereby attributed to human skill performance (Adams, 1995; Gilden and Wilson, 1996), while these concepts did not pertain to mechanics.

Moreover, our findings indicate that self-regulation can have an impact on the adjustment of those biases, in the case that the prediction of outcomes evokes a more generative estimation. The serial prediction task followed such an account by offering much more opportunities to generate a prediction and thus more insights about the moderation of the fallacies. Findings from the serial prediction task supported our assumption that the hot hand fallacy is moderated by the promotion focus, and the gambler's fallacy is moderated by the prevention focus, provided by the context of a skill scenario. Furthermore, we found substantial support for the effectiveness of the regulatory shift. The success of the sensitivity treatment was again obtained by the independent manipulation check that measured the relative accessibility of promotion-related and prevention-related concepts across all groups. It was again rather the change in regulatory focus than the state manipulation that had an influence on the occurrence of the biased (unbiased) expectations. More specifically, the promotion shift (change from prevention to promotion) led to higher levels of believing in the hot hand, while prevention shift (change from promotion to prevention) stimulated an adjustment towards randomness, reflected by the expected discontinuity of positive and negative sequences. That was not the case for regulatory state groups.

Surprisingly, the predictions for negative recency did not differ from those for positive recency at all. Just a slight tendency for higher positive recency predictions in promotion compared to slightly higher negative recency predictions in prevention occurred, but this interaction was statistically not significant. The matter of watching poor scoring performance compared to vast scoring disappeared across all groups. They all expected for both scenarios nearly the same (positive) outcome, which was still pronounced by the promotion shift. Thus, the belief in a “cold hand” did not just disappear, it changed into the hot hand fallacy, primarily for those under promotion shift. This is theoretically in line with the regulatory focus since promotion focus is mainly concerned with ideals and hopes (Higgins, 1997; Friedman, Förster, & Denzler, 2007) and thus might interpret failure as an opportunity to transform poor performance into success, as pronounced by the regulatory shift. This assumption, however, remains unclear and needs further investigation.

Despite, both regulatory foci were solely associated with human performance and not with the chance context. We expected regulatory modes of prevention being sensitive to the roulette scenario since chance should evoke a bottom-up state of external dependence. Although prevention focus is related to functions of the accommodation type, the regulatory focus manipulation must not necessarily activate all facets of adaptive strategy (Bless & Fielder, 2006). Since the externally driven, bottom-up processing style, similar to Rotter's locus of control (1960), is predominantly sensitive to degrees of freedom in a task, we assume that an experimental framing of self-determination (Ryan & Deci, 2000) might serve as a more reliable moderator for regulatory focus in the (mis-)perception of chance contexts.

Nevertheless, with regard to our adaptive strategy model (Fiedler, 2001), the opportunity to generate a more extensive prediction is, just as the generation of creative outcomes (exp.1), or broad negotiation ranges (exp.2), a function of the assimilation type, and was again evoked by the promotion focus. The tendency to a more careful and conservative judgment, on the other hand, is involved in functions of the accommodation type and was affected by the prevention focus. That means the adjustment to the truth of randomness, as a more conservative, cautious prediction of future outcomes is more related to prevention focus (Higgins, 2014; Liberman, Idson, Camacho, & Higgins, 1999).

Again, and beyond the validation of the classic hot hand and gambler's fallacy, we found substantial support for the supportive role played by the regulatory shift manipulation. It was again promotion shift that enhanced functions of the assimilation type, this time reflected by a strong liberal bias towards overestimations, while prevention shift corrected the false impression of the hot hand. However, it remains unclear whether a relative change in self-regulation is truly responsible for the underpinnings of maladaptive decisions. Our findings give us good hints to speculate about regulatory focus dependencies on liberal versus conservative judgments, but they are in fact constrained by the dependent effects of the task context and reveal little about how goal-directed behavior affects decisions on an objective and rudimentary level. Also, the independent variables are limited to the effectiveness of the framing task. Since the manipulation of regulatory focus is conceptually concerned with ideals and hopes resp. oughts and responsibilities on an abstract level, it cannot activate all layers of assimilation-accommodation within one treatment. Thus, we faced this issues by developing a new manipulation for regulatory focus and regulatory shift, which is based on a signal detection paradigm to target a) the most reliable treatment and measure for regulatory focus b) the true nature behind regulatory focus' decision approach.

2.5. Regulatory Shift and Signal Detection Theory

The Social Sciences Citation Index cites over 2,000 references to an influential book by Green and Swets (1966) that describes the signal detection theory (SDT) and its application to psychology. Since then SDT is widely accepted by psychologists, although fewer than half of the studies to which SDT is applicable actually make use of the theory (Lynn & Barett, 2014).

Stanislaw & Todorov (1999) created a very comprehensive access to the function of SDT, by firstly considering a yes or no decision task which involves signal trials that present one or more signals, and noise trials that present one or more noise stimuli. For example, yes/no tasks in auditory perception may present a tone during signal trials and nothing at all during noise trials, whereas yes/no tasks for memory may present old (previously studied) words during signal trials and new (distractor) words during noise trials. After each trial, the subjects indicate whether a signal was presented (i.e., whether a tone was presented, or whether the word was previously studied). According to SDT, people in a yes/no task base their response on the value that a decision variable achieves during each trial (e.g. volume). If the decision variable is sufficiently high during a given trial, people will respond yes (a signal was presented); otherwise, people will respond no (no signal was presented). That is defined by the criterion.

Most of the tasks studied by psychologists involve decision variables that are only internally represented by participants performing the task (Stanislav & Todorov, 1999). For instance, the decision variable may be the apparent loudness experienced during each trial in an auditory perception study, or the feeling of familiarity associated with each stimulus item in a memory study. In each of these cases, people compare the decision variable (which only they can observe) to the criterion they have adopted. A yes response is thus only made if the auditory stimulus seems loud enough, or the stimulus item seems sufficiently familiar. On signal trials, yes responses are correct and are termed as hits. On noise trials, yes responses are incorrect and are termed as false alarms. The performance on a yes or no task can therefore be described in hit rates (the probability of responding yes on signal trials) and false-alarm rates (the probability of responding yes on noise trials).

If the people use an appropriate decision variable, and if they are capable of distinguishing between signals and noise, the decision variable will be affected by the stimuli that are presented. For example, previously studied words in a memory test should, on average, seem more familiar than distractors (noise). However, some previously studied words will seem more familiar than others. Distractors will also vary in their familiarity. Furthermore, factors such as neural noise and fluctuations in attention may affect the decision variable, even if the stimulus is held constant. Thus, the decision variable will have a range of different values across signal trials and a range of different values across noise trials (Stanislav & Todorov, 1999).

A distribution of values realized by the decision variable across signal trials is the signal distribution, whereas the according distribution for noise trials is the noise distribution (Figure 11). The hit rate equals the proportion of the signal distribution that exceeds the criterion (black), whereas the false-alarm rate equals the proportion of the noise distribution that exceeds the criterion (red) as illustrated in Figure 11. If the criterion is set to an even lower, or more liberal, value (i.e., moved to far left in Figure 11), it will almost always be exceeded on signal trials. This will produce mostly yes responses and a high hit rate. However, the criterion will also be exceeded on most noise trials, resulting in a high proportion of yes responses on noise trials (i.e., a high false-alarm rate).

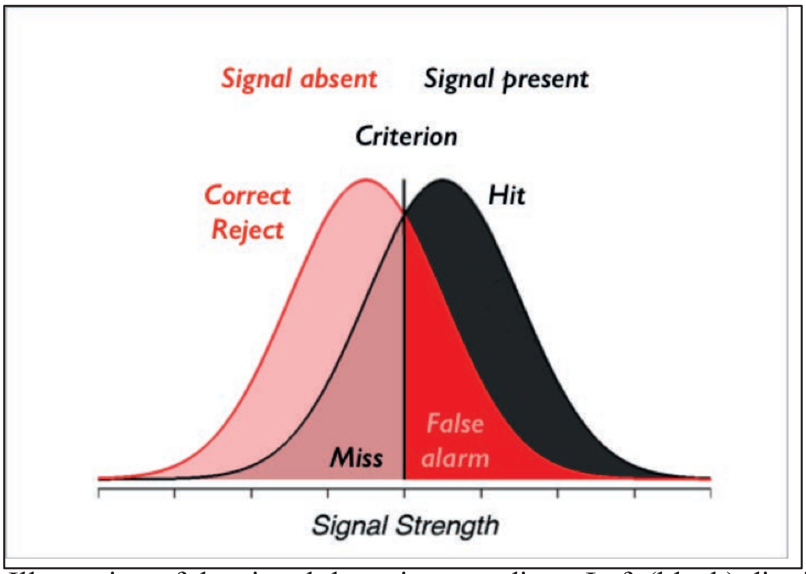

Figure 11. Illustration of the signal detection paradigm. Left (black) distribution represents signal, while right (red) distribution represents noise. The distance between the distributions represents sensitivity. Criterion determines the liberal (moves left) or conservative (moves right) decision tendency.

A liberal criterion biases the subject toward responding yes (left), regardless of the stimulus, whereas a high, or conservative value for the criterion (right), biases the subject toward responding no, because the criterion will rarely be exceeded on signal or noise trials. This will result in a low false-alarm rate, but also a low hit rate. The only way to increase the hit rate while reducing the false-alarm rate is to reduce the overlap between the signal and the noise distributions. The hit and false-alarm rates reflect two factors: response bias – the general tendency to respond yes or no, as determined by the location of the criterion – and the degree of overlap between the signal and the noise distributions. The latter factor is usually called sensitivity, reflecting the perceptual origins of SDT: When an auditory signal is presented, the decision variable will have a greater value (the stimulus will sound louder) in listeners with more sensitive hearing. The major contribution of SDT to psychology is the separation of response bias and sensitivity (Stanislav & Todorov, 1999).

This has an important implication for comparing the efficacy of two tests to diagnose a certain effect. Let's take two tests for the same mental disorder for instance. One test may have a higher hit rate than the other, but a higher false-alarm rate as well. This problem typically arises because the tests use different criteria for determining when the disorder is actually present. SDT can solve this problem by determining the sensitivity of each test in a metric that is independent of the criterion (Rey, Morris-Yates. & Stanislav, 1992). SDT can be therefore applied whenever two stimulus types or categories must be discriminated.

Psychologists first applied the theory in studies of perception (Green & Swets, 1966), where subjects discriminated between auditory signals (stimuli) and noise (no stimuli). The signal and noise labels remained, but SDT has since been applied in many other psychological areas such as social judgments or mood and motivation (e.g. Crowe & Higgins, 1997; Fiedler, Nickel, Muehlfriedel, & Unkelbach, 2001; Unkelbach, Forgas, & Denson, 2008). Lynn and Barrett (2014) for instance applied SDT to diagnose social threat. According to them, SDT is particularly useful in situations under uncertainty and risk. Uncertainty is present when alternative options are perceptually similar to one another (e.g., a scowling facial expression sometimes means that the person is angry and sometimes means that the person is merely concentrating). Risk is present when misclassification carries some relative cost (e.g.,when failing to correctly identify someone as angry incurs punishment that would otherwise have been avoided). However, both situations can be affected by self-regulation strategies, such that the avoidance of punishment has a different quality than approaching reward, in accordance to the same goal (e.g. being socially accepted).

This is where the regulatory focus theory (Higgins, 1997) docks on. If individuals in a promotion focus are strategically inclined to approach matches to desired end-states, they should be eager to attain advancement. In contrast, if individuals in a prevention focus are strategically inclined to avoid mismatches to desired end-states, they should be vigilant to assure safety and security. Crowe & Higgins (1997) hypothesized that this difference would be related to differences in the strategic decision tendencies in SDT. Their findings supported these predictions. People with promotion eagerness (vs. prevention vigilance) wanted to accomplish "hits" (i.e., approach a match with the desired end-state). In contrast, people with prevention vigilance (vs. promotion eagerness) wanted to avoid errors of commission (i.e., avoid mismatches with the desired end-state). Moreover, people in promotion focus showed a stronger liberal bias. Thus, the tendency to make more hits, but also more false alerts, while responses in prevention focus were more conservative, meaning fewer hits, but also more correct rejections. However, these results might have been not only determined by the strategic focus, but also by differences in the response latencies, since participants in prevention focus waited longer on average to response.

In line with that, Förster, Higgins, and Bianco (2003) asked in a pair of studies promotion- and prevention-focused participants to complete a series of four "connect-the-dot" pictures. They assessed the number of dots participants connected for each picture within the allotted time frame, which constituted a measure of goal completion speed. They also assessed the number of dots participants missed up to the highest dot they reached for each picture which constituted a (reverse) measure of the accuracy of goal completion. As they assumed, promotion-focused participants were faster, (i.e., got through a greater percentage of the pictures in the allotted time), whereas prevention-focused participants were more accurate (i.e., made fewer errors in the portions of the pictures that they had completed).

However, we believe that this confounds of speed and accuracy can be disentangled, even in a signal detection task. If the true interest lies in response tendency (or liberal bias), then the response latencies need to be held constant. Thus, when regulatory focus differs indeed in response tendency, such that promotion focus evokes a stronger liberal bias while prevention focus centers to a more conservative response criterion, it should be independent of how fast people response.

With this in mind, we have created a task that combines the signal detection paradigm with a regulatory focus treatment that differs fundamentally from the previous studies. Although the writing essay manipulations were successfully reflected by an independent manipulation check, neither an eager nor a vigilant behavior on goal approach, resp. goal avoidance has been observed directly. We can only assume that participants in promotion focus, writing about their hopes and desires, are subjectively in an approaching-like mode. We also have not observed participants in prevention focus acting vigilantly by avoiding a certain goal, just by writing about duties and obligations.

An alternative treatment for regulatory focus has been used in previous studies by applying a gain and loss framing (e.g. Idson, Liberman, & Higgins, 1999; Lee, Aaker, & Gardner, 2000). Since promotion focus is associated with approaching towards gains and non-gains, while prevention focus is rather associated with avoidance of loss and non-loss. Although the measure of gains and losses provides objective results of explicit behavior, a theoretically consistent manipulation check of implicit behavior remains lacking. Compared to a mere subjective questionnaire which has been the mainly used method in previous literature, the application of

SDT is a more reliable measure of an implicit motivation model. Moreover, and combined with an explicit gain and loss framing the highest level of validity should be granted. Thus, we were aspired to develop a tool that a) explicitly calls for eager and vigilant strategies towards a measurable goal (monetary gain or loss), and b) implicitly measures the response tendency (liberal or conservative) simultaneously, as an independent manipulation check, and c) inhibits boundary effects of speed and sensitivity by keeping these conditions constant. All within one task, which we named RFDrive.

Beyond the methodological advantage of RFDrive and with regard to our main assumptions, we are interested in the effectiveness of regulatory shift on adaptive strategy. Again, we assume that it is the change from prevention to promotion and vice versa that is responsible for a higher diagnostic of the latter state and thus for stronger effects (Fischoff, Slovic & Lichtenstein, 1979). In this case, decision criterion or liberal bias. Thus, people in promotion shift should have a stronger tendency to approach a gain-signal resulting in higher false alert rates (hitting noise), while people in prevention shift should rather have a stronger tendency to avoid a loss-signal resulting in more correct rejections (missing noise). This difference should be more pronounced after a change compared to a mere state manipulation of regulatory focus. Moreover, we assume that this new treatment should also lead to carry over effects on adaptive strategy as described by the assimilation-accommodation model (Fiedler, 2001). To close the circle of generative vs. non-generative processing, we decided to apply the very first task of this work – the brick task (cf. Friedman & Förster, 2001). It calls for the generation of multiple ideas for the usage of an ordinary brick. Since promotion focus is associated with processing of the assimilation type (top-down, generative) and prevention focus is associated with processing of the accommodation type (bottom-up, non-generative), people in promotion focus should generate more ideas, consistently with a stronger liberal bias in the signal detection task, compared to people in prevention focus.

Hypotheses. We expect convergent support for the facilitative influence of regulatory focus on response tendency and idea generation. Provided that the independent variable (regulatory focus) is manipulated effectively and the dependent variables (response tendency and idea generation) are measured reliably. The impact of promotion focus should be more pronounced for liberal bias and idea generation. The causally effective variable should be a change in regulatory focus, rather than a static level.

2.5.1. Method

Participants and design. *N*=79 students recruited from the Studentportal platform (Bock, Nicklisch, Baetge 2012), 51 females and 28 males, mean age = 23.06, *SD* = 4.56, were randomly assigned to the same 2 (regulatory focus) x 2 (shift) conditions as in previous experiments, but with a different treatment method as described below. The software was developed from scratch in python (2018; Version 3.6.5) and the full code is attached (Appendix A).

Materials and procedures. Participants were invited to compete in a study on attention capabilities. Those who were assigned to the promotion focus conditions had the chance to gain two additional euros to their participation reward of five euros. Individuals in the prevention groups were initially rewarded with additional two euros, which they had to defend in the following game:

The basic procedure of RFDrive was either to collect or avoid dropping symbols from the top of the screen (Figure 12). All symbols were randomly allocated on the top-screen with increasing speed levels, which adapted to the amount of the dropped symbols (the detailed programmed function is attached in Appendix A. The more symbols are collected or avoided, the faster they drop. A yellow point on the display's bottom represents the participant's avatar, which could only be moved at the bottom of the screen by using the left and right arrow-key of the keyboard. In promotion focus, they had to collect as many green triangles as possible (signal). Every hit of a green triangle added one cent to their final reward. One round was limited to 200 dropping signals and thus a possible additional reward of two euros. The progress was displayed on the top left of the screen (starting from 0, +1) so that the participants could simultaneously follow their gains. In prevention focus, they had to avoid the same amount of dropping red triangles (signal). Every hit from a red triangle caused the loss of a cent and therefore a possible loss of two euros. The progress was also displayed on the top left of the screen, so that the individuals were simultaneously confronted with the leakage of their reward (starting from 200, -1). One game-mode stopped automatically after 200 dropped signals with further instructions.

Additionally, to the signal, which represented the explicit measure of the regulatory strategy, we tested the implicit decision style by combining the signal with noise. We added a similar amount of grey squares as distractors. Since we invited participants to an attention span experiment, we instructed participants in all conditions that the distractors would not have any impact on their final reward. This was true for the signal. Neither a hit nor a miss of the grey squares led to a gain or loss. However, with this additional collection of data, we were able to validate a liberal resp. conservative decision bias.

In line with the previous experiments, participants in the shift conditions started either with the promotion or prevention focus gameplay and switched the mode after they have passed the first round by either collecting or avoiding 200 symbols. The following focus was directly depending on the latter, since individuals in prevention shift gained a certain amount of money in the first round and had to avoid the loss of it in the second. While those in promotion shift previously lost a certain amount of two euros, followed by the chance to gain again. For those in the state conditions, a neutral round with 200 independent symbols (grey triangles), which had no impact on their reward, was previously conducted to eliminate time-effects. After the neutral round, which was introduced as an attention-testing phase, they started either the promotion or prevention game mode depending on their random group assignment.

Every game mode lasted around 60 seconds. After finishing the RFDrive treatment, they completed the self-assessment manakin test for mood and arousal (SAM; Bradley & Lang, 1994) to control for affective side effects of the manipulation. Afterwards, they were asked to generate as many uses for a brick as possible. At the end of the session, which lasted about 7 minutes, participants were thanked, debriefed and rewarded with 5 Euros plus the earned amount of the RFDrive treatment, which appeared at the end of the session on center of the screen.

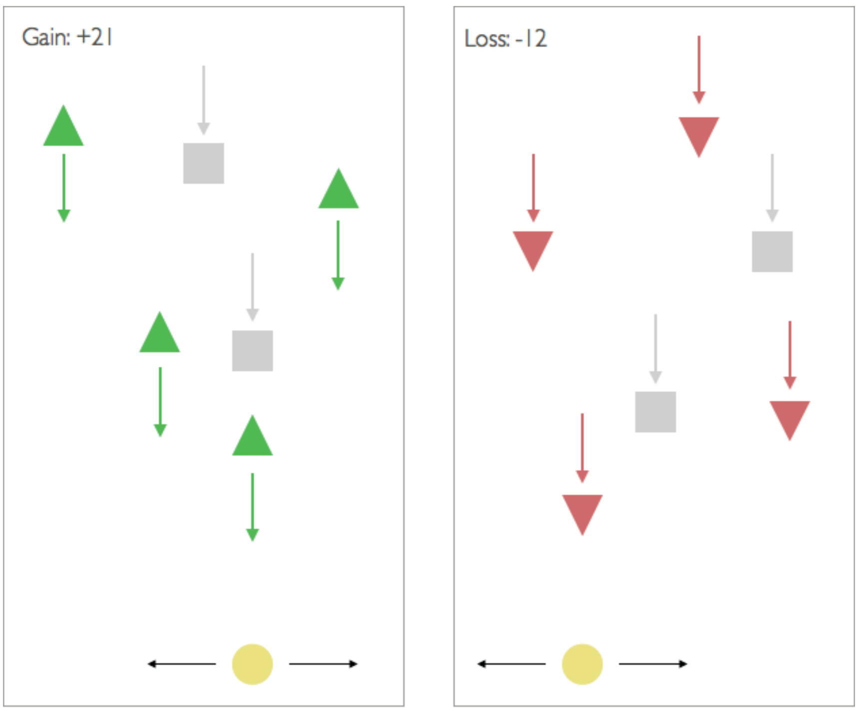

Figure 12. Screenshot of promotion (left) and prevention (right) game modes of RFDrive. Promotion requires an eager strategy to collect green triangles (gain signal), while prevention

requires a vigilant strategy to avoid red triangles (loss signal). Grey squares function as distractors (noise) independent of monetary outcomes.

2.5.2. Results

Manipulation check & ideas generated. The SAM measure for mood and arousal was not significantly affected (all Fs < 3). An ANOVA of the signal detection performance on signal revealed an obviously strong main effect for regulatory focus, $F(1,75) = 1587.713$, $\eta^2 = .954$, $p < .001$, since the participants followed the instructions to collect (hit) in promotion and avoid (miss) in prevention conditions. Neither the shift nor its interaction touched this main effect (Fs < 6). This effect is canceled when the successful prevention misses are treated as hits. Thus, a calculation of the sensitivity (d' = z[Hits] – z[False Alerts]) as the dependent variable in an ANOVA shows no performance advantage for one regulatory focus, $F(1,75) = .899$, $\eta^2 = .008$, $p = .346$, and without any shift or interaction effect (Fs < 1). Means and standard deviations for signal detection performance on hits and false alerts are listed in Table 8.

Table 8. *SDT: Signal and noise descriptives by experimental conditions.*

Regulatory Focus	**Context**	**Hits (Signal)**		**False Alerts (Noise)**	
		Mean	*SD*	*Mean*	*SD*
Prevention	Shift	29.25	7.02	26.60	6.79
	State	26.67	6.47	36.14	9.33
Promotion	Shift	118.56	16.36	77.83	4.45
	State	121.15	8.97	68.35	6.58

A conduction of the false alert rates showed an expected strong main effect for regulatory focus, $F(1,75) = 680.197$, $\eta^2 = .860$, $p < .001$, and a regulatory shift interaction, $F(1,97) = 35.366$, $\eta^2 = .045$ $p < .001$, reflecting an enhanced effect after a shift of regulatory focus (Figure 13). A further calculation of the liberal bias (c = - [z(Hits) + z(False Alerts)] / 2) yielded a repetition of this pattern by a strong regulatory focus main effect, $F(1,75) = 46.640$, $\eta^2 = .347$, $p < .001$, along with a supportive interaction of the shift, $F(1,75) = 12.196$, $\eta^2 = .091$, $p < .001$, in the direction of a higher liberal bias for promotion focus ($M = -0.91$, $SD = 0.16$) compared to prevention focus ($M = -0.68$, $SD = 0.33$) for the state conditions, $t(39) = -2.63$, $p < .01$, $d = .84$, and a more pronounced effect for the promotion shift ($M = -0.91$, $SD = 0.16$) compared to prevention shift ($M = -1.09$, $SD = 0.18$), $t(36) = -6.604$, $p < .001$, $d = -2.21$.

The ANOVA for the brick task also exhibited this canonical pattern of a strong regulatory-focus main effect, $F(1,75) = 42.441$, $\eta^2 = .323$, $p < .001$, along with a significant interaction, $F(1,75) = 9.764$, $\eta^2 = .074$, $p < .01$, reflecting an enhanced generativity-effect after a shift of regulatory focus. A post-comparison of the particular conditions obtained more generated ideas for promotion focus ($M = 7.85$, $SD = 3.58$) compared to prevention focus ($M = 5.48$, $SD = 2.48$), $t(39) = 2.47$, $p < .01$, $d = .80$, and an enhanced effect for the promotion shift ($M = 11.5$, $SD = 4.21$) compared to prevention shift ($M = 4.75$, $SD = 1.71$), $t(36) = -6.604$, $p < .001$, $d = -2.21$.

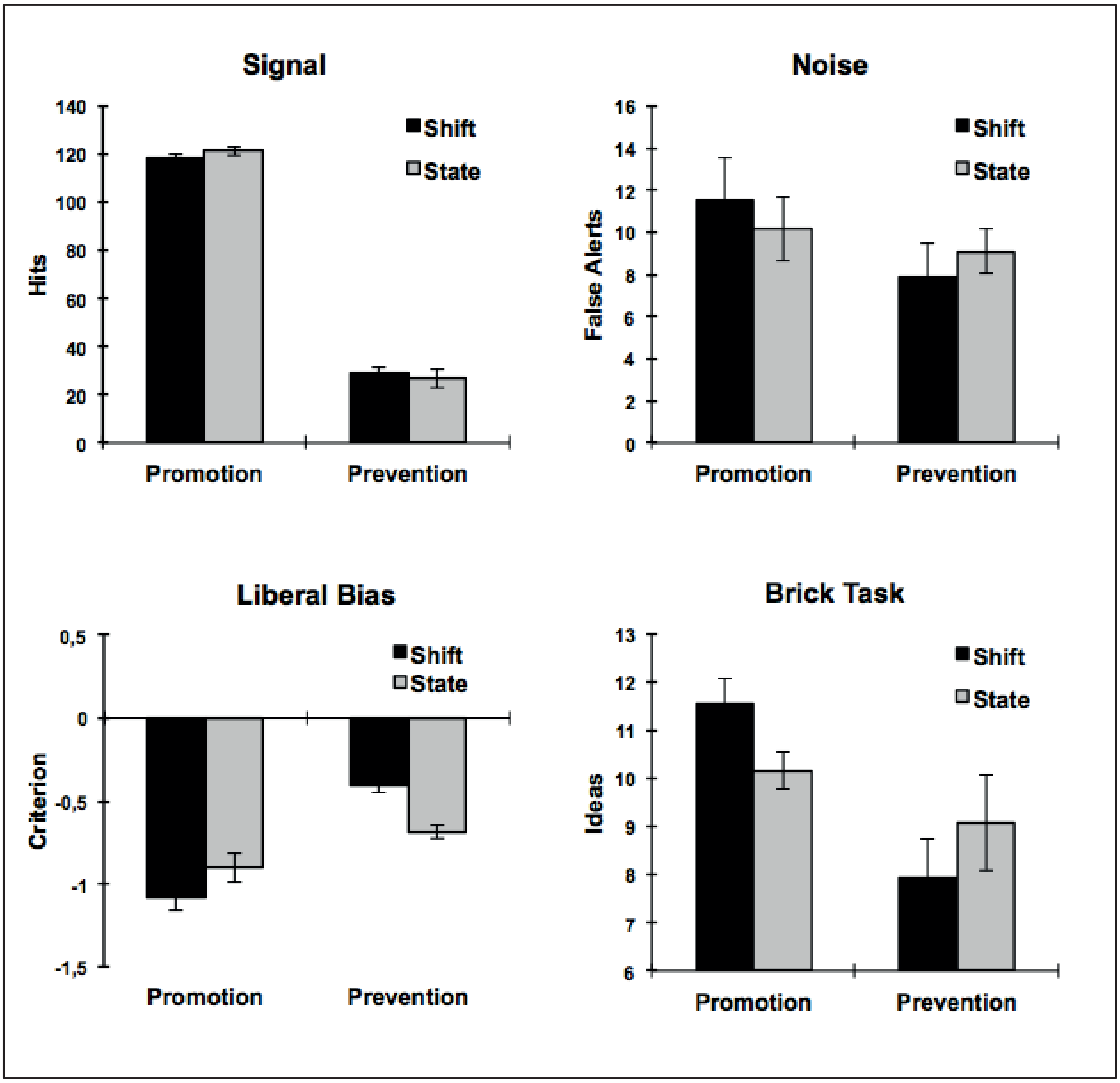

Figure 13. Signal detection performance (hits & false alerts) with manipulation check (liberal bias) and brick task (generated ideas) as a function of regulatory focus (promotion vs. prevention), and context (shift vs. state).

2.5.3. Discussion

In line with the evidence of three previous experiments, that behavior is more sensitive to relative changes than to absolute levels, we manipulated shifts in regulatory focus orthogonally to absolute levels of promotion versus prevention focus. To do so, we developed a program called

RFDrive that provided a high level of objectivity by measuring motivational strength on an explicit level, reflected by a monetary outcome (signal) and also on an implicit level, reflected by decision behavior towards distractors (noise). The subjective decision tendency (liberal bias) was measured at a high level of reliability by assessing next to the signal of promotion vs. prevention related items, the false alerts on independent noise items in order to calculate a signal detection analysis. Additionally, we have complemented the new manipulation procedure with the same generation task that we applied in experiment 1 (brick task).

The experiment provided a conceptual replication and validation of the regulatory focus resp. shift manipulation procedures. People in promotion focus were eager to gain a reward, which was reflected by a higher hit-rate compared to prevention focus. Those in prevention focus were highly vigilant to defend their reward, which was logically reflected by a higher miss-rate compared to prevention focus. Although the performance (final reward) on the explicit level (sensitivity) was not affected by the shift, the implicit measure of the decision tendency reflected the predicted pattern. Promotion focus led to more false alerts on the independent measure than prevention focus and thus resulting in a stronger the liberal bias. This was again enhanced by the regulatory shift, a change from prevention to promotion resulted in an enhanced liberal bias compared to the state condition of promotion focus. Thus, people that changed from promotion to prevention performed more correct rejections compared to the prevention state.

Finally, the carry over effect of the manipulation was demonstrated by a higher level of idea generation in promotion shift compared to the mere state manipulation. It was again the change from prevention to promotion that was mostly supportive to produce many ideas and thus consistently the strongest adaptive strategy activation of the assimilation type.

As noted in the beginning, Carver and Scheier (1981) believe that negative feelings arise from the expectancy about whether or not the discrepancy to a status quo can be reduced. Thus, the state of comfort or discomfort is highly dependent on the comparative standard and its attainability. The modification of the status quo was not considered in this experiment. However, we want to address the variability of the status quo as an additional factor in the regulatory shift context and propose procedures how to investigate it.

The regulatory focus theory (Higgins, 1997) can also be translated in the terms of the motivation to attain +1 from 0 (promotion focus) versus the motivation to maintain 0 against -1 (prevention focus). However, the status quo of 0 is not defined in the classic manipulation procedure offered by Higgins and colleagues (1997). It rather asks for a diffuse and subjective idea of a status quo (desires and ideals for promotion, concerns, and responsibilities for prevention). Conversely, the RFDrive treatment initiated a very clear status quo by defining an objective zero-state of monetary gain (vs. loss), and a concrete goal (reward). However, the adjustment of the status quo in RFDrive is flexible. A plus or minus state (e.g. starting with depts in a promotion framing with eager strategies) or a goal that is not attainable (e.g. collect x symbols in x minutes) could be set as well.

Let us have a few speculations about what a shifted status quo might bring. Research by Scholer, Zou, Fujita, Stroessner, and Higgins (2010) demonstrated that when presented with a condition of loss, those with a strong prevention focus switch their strategy from conservative to risky if that is what is needed in order to restore the status quo. Thus, people seem to switch their choices when they are making decisions beginning with -1. Zou, Scholer, and Higgins (2014) on the other hand controlled whether being in a condition of +1 will cause promotion-focused people to make a similar reversal in riskiness: They reasoned that analogous to what happens in a prevention focus, a risky or conservative tactic is in the service of the underlying motivation; in the case of promotion, moving beyond the status quo 0 to a better +1. As predicted, those with a strong promotion focus were significantly more likely to choose a risky choice than a conservative choice in a small gain condition than those in a large gain condition. Subsequent studies showed that the effect of being less likely to choose the risky choice in the large gain (vs. small gain) condition was only true when the gain was subjectively experienced as being large enough to be experienced as progress. When sufficient progress is perceived as a definite +1 gain, those with a strong promotion focus are motivated to keep their definite +1 gain and not risk it unnecessarily. This mechanism was confirmed by subsequent studies by Zou and colleagues (2014) who found that the tactic switching from risky to conservative among promotion-focused individuals was mediated by the individual perception of progress. When perceived progress was high, the motivation to continue adopting a risky tactic dropped significantly. Thus, what happens in promotion and prevention when the current status quo state is 0 can be different from what happens when the current state is -1 or +1. Therefore it might be possible that people with a prevention focus would be less sensitized to accuracy when the current state is a painful -1, and individuals with a promotion focus would be more accurate when the current state is a pleasant +1. This assumption would be assessable with the application of RFDrive by setting the status quo below or above 0, alsong with the assessment of the decision criterion. However, another assumption regarding the interaction of the regulatory shift with the status quo needs further investigation as well.

Still, and beyond the validation of another regulatory focus treatment, the major novel finding concerns the catalyst role, played by the regulatory shift manipulation. It was again the shift from prevention to promotion that enhanced functions of the assimilation type, reflected by a pronounced liberal bias and enhanced idea generation, whilst the shift from promotion to prevention sensitized functions of the accommodation type, reflected by conservative decision behavior and less generated ideas. A more global role of the RFDrive method and further possible applications will be considered in the general discussion.

3. General Discussion

We reasoned that systematic validation is contingent on the appropriate operationalization of the independent variable and the dependent variable. Drawing on the relativity approach, which implies that manipulations of high and low absolute levels on an independent variable are unavoidably confounded with manipulations of upward and downward changes, respectively, and based on evidence that behavior is more sensitive to relative changes than to absolute levels (Fischoff, Slovic & Lichtenstein, 1979), we manipulated changes (shifts) in regulatory focus (Higgins, 1997) orthogonally to absolute levels of promotion versus prevention focus. Moreover, we made an attempt to assess a variety of adaptive strategies (Fiedler, 2001) at a high level of convergent validity by a series of different dependent variables, including generative vs. non-generative tasks, over- vs. underestimations and conservative vs. liberal judgments. The adaptive strategy model differs between cognitive processing of the assimilation type (top-down, generative, productive) and the accommodation type (bottom-up, sensitive, reproductive). We assumed that a promotion shift (change from prevention to promotion) should result in stronger assimilative effects compared to a mere state manipulation of promotion focus. A prevention shift (change from promotion to prevention) should result in stronger accommodative effects compared to a mere state manipulation of prevention focus.

In the first experiment, we applied multiple measures of generative on-demand creativity and self-reports of creative experience as a non-generative test. Creative performance was markedly higher under promotion focus than under prevention focus and thus a consistent replication of previous effects (Baas, DeDreu, Nijstad, 2008). Moreover, the creativity advantage of promotion over prevention focus was accentuated after a shift when a promotion focus manipulation was preceded by a contrastive prevention focus manipulation and vice versa, relative to a regulatory-focus state condition. Moreover, the results showed stronger regulatory-focus effects on generative tests than on non-generative tests. Since this finding was only based on one non-generative measurement and had to be validated with a more comprehensive sample of non-generative tasks, we designed a second experiment that provided a more appropriate role of non-generative processing.

The second experiment was concerned with the reinforced function of the regulatory shift on biased fixed-price estimations (non-generative) and negotiation ranges (generative).
To cover that, we made an attempt to assess the classic endowment effect – people's tendency to overestimate the value of their own goods (Thaler, 1980) – on both, fixed and negotiable prices. The endowment effect was unattached by the shift and markedly higher under prevention focus than under promotion focus, but only for non-generative fixed-price estimations. Conversely, the more generative negotiation price range was highly impacted by the regulatory shift in terms of broader price ranges for promotion focus compared to prevention focus, enhanced by the sensitization of the shift-treatment. Again, we found stronger regulatory-focus effects on generative tests than on non-generative tests. Moreover, the endowment effect was deactivated by the generative call for negotiations – people tended to trade their endowments equally to other goods. However, this supportive role of the regulatory shift in reducing biases was only observed for a bias of the accommodation type (endowment effect). Thus, and with respect to our adaptive strategy model, we were eager to validate this valuable effect on irrational processing evoked by assimilation strategies as well.

The third experiment was therefore an attempt to capture errors in top-town reasoning by assessing the hot-hand fallacy – people's tendency to predict the continuance of a sequence, and the gambler's fallacy – people's tendency to predict the discontinuance of a sequence (Gilovich, Vallone, & Tversky, 1985), at a high level of reliability by applying positive, negative, and random sequence observations to skill and chance scenarios, and by including additionally to the classic immediate next trial prediction (non-generative), a serial prediction tasks which asked for the continuance of the next ten trials for hits and misses (generative). Again, we found strong regulatory-focus effects on generative tests. Although the regulatory focus manipulation had no effect on our chance scenario (replicated skill vs. chance assumption by Ayton & Fisher, 2004), findings from the serial prediction task showed a moderation of the hot hand fallacy by the promotion focus, and the moderation of the gambler's fallacy by the prevention focus, provided by the context of a skill scenario. These effects were enhanced by the regulatory shift. It was again rather the change in regulatory focus than the state manipulation that had an influence on the occurrence of these expectation effects. Specifically, the promotion shift (change from prevention to promotion) led to stronger belief in the hot hand, while prevention shift (change from promotion to prevention) stimulated an adjustment towards randomness, reflected by expected discontinuity (gambler's fallacy) of positive and negative sequences. Again, we found support for the reduction of irrational reasoning by the regulatory shift, also in the processing of the assimilation type.

However, these adjustments of irrationalities were in fact constrained by the dependent effects of the task context and reveal little about how the regulatory shift affects false or correct judgments fundamentally. We were therefore encouraged to assess the impact of the regulatory shift on liberal (assimilative) vs. conservative (accommodative) decision styles on a principal level by applying a signal detection paradigm (SDT; Green & Swets, 1966). Moreover, and although all three previous experimental manipulations succeeded in an independent manipulation check by measuring the relative accessibility of promotion-related and prevention-related concepts, the validation of the regulatory focus manipulation was limited to the "best practice" treatment suggested by Higgins (1997). Therefore, we designed a completely new treatment to target these issues. Thus, the fourth experiment was concerned with a methodological development of a valid regulatory focus manipulation tool with a highly reliable treatment control within the same framing task. To do so, we designed a game in which participants had either approach (promotion) or avoid (prevention) signals to gain (vs. loss) monetary profit. Additionally, we combined the monetary signals with an outcome independent noise (implied by SDT). As a result, the regulatory focus manipulation was objectively assessed on an explicit level by the final monetary gain (vs. loss) and furthermore on an implicit level by the decision tendency reflected by conservative decisions in prevention focus and a liberal bias in promotion focus. This pattern was again enhanced by the regulatory shift. A change from prevention to promotion led to even more false alerts and thus a stronger liberal bias, while a shift from promotion to prevention led to more correct rejections and thus to more conservative decisions. Moreover, we made an attempt to bridge the new manipulation effects to the generativity assumption and applied a creativity test from the first experiment. Again, we have found a stronger generativity affiliation with the regulatory shift compared to the mere state manipulation of the regulatory focus.

To sum up, results of four different experiments support our main assumptions, that a relative change (shift) is the more relevant causal factor for an effect compared to an absolute manipulation level (state). We demonstrated that by regulatory focus (promotion vs. prevention) activation of adaptive strategies (assimilation vs. accommodation). More specifically, generativity and productivity (assimilation) depended on promotion focus, while sensitivity and re-productivity (accommodation) depended on prevention focus. Moreover, our results indicate that regulatory shift counteracts maladaptive strategy as reflected by the endowment effect and the hot hand fallacy.

However, these corrective effects occurred only in generative tasks that called for more productivity, such as the negotiation task and the prediction of a continuance series. Thus, the congruency of the task framing with the regulatory focus activated adaptive function seemed to be asymmetric. It was rather the promotion-assimilation fit than the prevention-accommodation fit that influenced maladaptive strategy beneficially. Former research on mood congruency supports our findings by claiming that congruency is asymmetrically stronger in a positive than in a negative mood (Blaney, 1986; Clore, Schwarz, & Conway, 1994). Moreover, a study by Fiedler, Nickel, Asbeck, and Pagel (2004) on mood congruency and the generation effect tested this asymmetry, particularly on adaptive strategy. They applied the generation effect paradigm (Slamecka & Graf, 1978), which refers to the general memory advantage of self-generated over experimenter-provided information. Participants were presented with stimulus pairs of which the second part was either complete (e.g., FATHER-MOTHER) or had to be generated from incomplete fragments (e.g., FATHER-M__HE_). These stimulus pairs had to be recalled in a subsequent memory task after a mood treatment. Their findings emphasize an enhanced mood-congruency effect for stimuli that were self-generated in an assimilative, knowledge-driven process, but little congruency for experimenter-provided stimuli that were encoded in an accommodative, stimulus-driven process. Moreover, their findings indicate that the basic congruency effect with self-generated information was asymmetrically stronger for positive than negative mood which is consistent with the notion that positive rather than negative mood facilitates assimilation. This is in line with our findings that showed a congruence asymmetry of promotion-assimilation compared to prevention-accommodation. However, our results indicate that beyond this asymmetry, a treatment fit with the adaptive nature of the assimilation task could reduce maladaptive reasoning. This promising effect deserves certainly more attention in further investigations.

3.1. Limitations and prospects

Although we did consider different operationalizations of independent and dependent variables, the present work does by no means cover an exhaustive investigation of all related effects on adaptive strategy. The next section discusses some conceptual limitations and offers a basis for future related research.

The first experiment was primarily concerned with regulatory shift effects on creativity. Drawing on our adaptive strategy model, we focused on the meta-category of creative performance, namely generativity. Although we have applied four different creativity tests to provide reliable effects, we did not covered the full spectrum of creative performance in particular. According to multifaceted models of creativity (e.g. Amabile, 1996; Guilford, 1950; Sternberg, 1999; Torrance, 1966) being creative can be considered in several generative sub- or follow-up outcomes, such as fluency, originality, global/abstract thinking, elaboration, and innovation. The applied tests in our first experiment might serve these subscales partly, but we did not assess these sub-categories explicitly. The brick task, for instance, asked for multiple usages for a brick, but only the number of ideas generated (productivity) was considered. Task-speed (fluency), the novelty of the generated ideas (originality) and the amount of detail in response (elaboration) was neglected. However, a large number of studies provided strong support for the association of regulatory focus with these specific creativity dimensions (Baas, DeDreu, Nijstad, 2008; Lanaj, Chang, Johnson, 2012). For instance, Friedman and Förster (2001) demonstrated a strong relation of promotion focus and originality by applying the brick task in order to measure novel ideas. Förster & Higgins (2005) also measured the influence of regulatory focus on global vs. local processing which was tested by applying the Navon task (Navon, 1977). In the most common version, participants are asked to respond as quickly as possible when they see a letter, such as an "H" or an "L." Among the stimulus figures they are shown, there is a large shape that forms that letter (e.g., "H"), and this large shape is itself composed of multiple copies of small shapes that either also form that same letter ("H") or form a different letter ("S"). People are typically fastest to respond that they see the letter ("H") when it is both the larger global shape and the smaller local letters that make up the shape. Peoples' strength of promotion ideal- and prevention ought self-guides have been measured first. Participants were then instructed to respond if the stimulus contained the letter L or if the stimulus contained the letter H as quickly as possible. Four of the figures included global targets. Four other figures included local targets. The study found that individuals with stronger promotion ideal self-guides were quicker to respond to the large global letters and slower to respond to the small local letters, whereas individuals with stronger prevention ought self-guides were quicker to respond to the small local letters and slower to respond to the large global letters.

Studies on persuasion by Lee and Aaker (2004) resulted in higher processing fluency and persuasive advantage for messages framed in promotion focus compared to those in prevention focus. Still, all previous studies on the relationship between regulatory focus and creativity did not consider that the relevant factor for the creative performance is rather the change than the state manipulation of regulatory focus as demonstrated by our findings. We, therefore, suggest empathically the application of the regulatory shift to investigate specific categories of creative performance in future research.

Innovation on the other hand, plays a special role here. Hesselbein, Goldsmith, & Somerville (2002) define innovation as the change that creates a new dimension of performance, which implies the successful exploitation of new ideas, methods or devices. The crucial distinction to creativity in general is the successful transfer of ideas into useful applications. This follow-up outcome of idea-exploitation has not been addressed in our experiments, since it refers to more field-related research. Nevertheless, our insights reinforce a good reason to consider the regulatory shift in innovation research, since recent studies on regulatory focus in work- and sport related environments provide promising results. A multi-level analyses of Wallace and colleagues (2016) for instance identified a positive relation of employee innovation with promotion focus. According to Memmert, Hüttermann, and Orliczek (2013) are promotion-framed athletes are more able to produce original, flexible, and adequate solutions to sport-specific problems. Again, we want to emphasize the beneficial role of the regulatory shift applied to investigations of innovation research, assuming that the shift might lead to more robust idea transfers into useful applications.

A trivial anecdote that addresses this subject as well is the rise and fall of the Apple inventor Steve Jobs (Belk & Tumbat, 2005). Jobs co-founded Apple in 1976 with his friend Steve Wozniak and they quickly gained fame for the first highly successful mass-produced personal computers. A decade later in 1985, Jobs was forced out of Apple after a long power struggle on the companies' market position and strategy. Jobs took a few of his Apple colleagues with him to found NeXT, a moderately successful computer platform development company that specialized in computers for higher-education. Meanwhile, Apples' sales have dropped and the company had been at the verge of bankruptcy. Later on, Apple merged with NeXT in 1997, and Jobs became CEO of his former company within a few months. He was largely responsible for helping revive Apple and developed a line of products that had larger cultural ramifications, beginning in 1997 with the "Think different" advertising campaign and leading to the nowadays worlds most prestigious and innovative computer brand.

This was by all means not solely justified by the forced prevention of Jobs from working for Apple and the followed promotion to the company's director. All biographies and articles about him and other prominent and successful characters share an important common factor regarding goal-directed behavior and success. According to our generic self-regulation model, this major component in goal-pursuit needs to be addressed as well, namely self-relevance.

Self-relevance includes among other principles, people's beliefs of self-efficacy (Bandura, 1986) from a strategic perspective, and possible selves (Markus & Nurius, 1986) from a goal perspective. These facets of self-relevance are considered as crucial factors for effort (Multon, Brown, & Lent, 1991). People's beliefs about their capabilities and a future state-imagination exert an important influence at virtually all stages of the self-regulation process and thus on adaptive processing.

Let us start with the concept with the highest overlap regarding regulatory focus: the possible selves. In the classic regulatory focus manipulation, promotion focus is concerned with the imagination of hopes and ideals, and prevention focus is concerned with the imagination of duties and responsibilities. The higher-level implication would be the imagination of a possible self. A promotion ideal might be defined as "constantly doing my workout", whilst a prevention responsibility might be defined as "avoiding unhealthy food". The corresponding possible selves would, therefore, be an athletic self in the case of promotion, and a sickly self in the case of prevention. Thus, people's ideas about what they may be like in the future influences motivated behavior. Markus and her colleagues (Markus & Nurius, 1986; Markus & Wurf, 1987) defined the term possible selves to refer to these beliefs. According to them, most of our possible selves are positive, but people have obviously negative possible selves as well. Typically, these negative possible selves involve fears of what we may become if we fail to take some course of action. A recovering smoking addict, for example, may have a clear image of what he will be like if he returns to smoking. These negative possible selves also serve motivational, to the extent that people are motivated to avoid them (Oyserman & Markus, 1990). According to our findings, the vision of a change between negative and possible selves might be the more effective method to vividly imagine a clear possible self and thus might serve to higher motivation in reaching it. This assumption would, however, require an assessment of possible selves in a longitudinal study design. The regulatory shift should predict the attainment resp. avoidance of possible selves.

Another self-relevant factor is people's belief in their abilities to succeed. Bandura (1986) refers to such beliefs as self-efficacy. People with high self-efficacy beliefs think they have the ability to succeed at a task, to overcome obstacles, and to reach their goals. People with low self-efficacy beliefs doubt their ability to succeed and do not believe they have what it takes to reach their goals. Importantly, these beliefs are only partly based on people's actual abilities. In any given domain, people with high self-efficacy beliefs are not necessarily more capable than those with low self-efficacy beliefs. These judgments about the self-influence how hard and long people work at attaining a goal. Assumed that all else being equal, people work harder and persist longer when they believe they have the wherewithal to succeed than when they have doubts about their abilities (Bandura, 1986). This is particularly true when obstacles to success are encountered. Which is the case with almost all important goals in life. John White (1982) documented the important role of beliefs in long-term lifegoals in his book "Rejection". White notes that a common characteristic of many eminent scientists, artists, and writers is an unshakable belief in their abilities. Although these beliefs are prone to biases (e.g. overconfidence or better-than-average; Kahneman, & Tversky, 1977; Brwon, 1987) they allowed them to weather rejection and overcome disappointment.

That raises the theoretical question whether rejection, as the antagonist of success, might serve in the reinforcement of self-efficacy beliefs. Just as Walt Disney was fired in 1919 from one of his first animation jobs at the Kansas City Star newspaper because his editor felt he "lacked imagination and had no good ideas" (Connors, Smith, & Hickman, 1998) or Micheal Jordan who was rejected in a try out for the Emsley A. Laney High School varsity basketball team in 1978, because the trainers thought he was too small (Jordan & Vancil, 1998). An empirical implication, however, would be a consideration of self-efficacy as a moderator for the link between regulatory shifts and goal attainment. Beliefs of self-efficacy might be influenced by failures in a regulatory focus process. The RFDrive treatment, for instance, could simulate a scenario with high and low error-rates by adjusting game parameters (e.g. speed). However, the assumption of a strengthened self-efficacy, aroused by failure may lead to higher persistence towards reaching self-relevant goals, remains open.

Previous studies about how regulatory focus is related to failure coping strategies may give some good hints to follow in this regard. After a failure, people sometimes imagine how things might have turned out differently had they taken certain actions (additive counterfactuals) or not taken certain actions (subtractive counterfactuals). Roese, Hur, and Pennington (1999) tested the prediction that people's regulatory focus would moderate the frequency with which they generate additive versus subtractive counterfactuals in response to a failure. Because additive counterfactuals lead people to imagine how things might have turned out differently had they not missed an opportunity for advancement (for a "hit"), they represent an eager strategy of reversing a past error of omission by taking a particular action. Thus, additive counterfactuals should be preferred by people with a promotion focus. In contrast, because subtractive counterfactuals lead people to imagine how things might have turned out differently had they avoided a mistake (avoided an "error of commission'), they represent a vigilant strategy of reversing a past error of commission by not taking a particular action. Thus, subtractive counterfactuals should be preferred by people with a prevention focus.

In another study conducted by Roese and colleagues (1999), participants read hypothetical scenarios involving either promotion failures (i.e., failures to attain accomplishment-related goals) or prevention failures (i.e., failures to attain safety-related goals). Participants were then asked, for each scenario, to expand in writing upon a counterfactual stem reading, (e.g. "If only...”). As predicted, participants who had received promotion-framed scenarios were more likely than participants who had received prevention-framed scenarios to generate additive counterfactuals, whereas the reverse was true for subtractive counterfactuals.

However, one could reason that the strengthening effect of failures on self-efficacy beliefs may not be captured in a snapshot of a controlled experiment. Just as the attainment of a possible self needs a long-term observation, a general belief in the self’s efficacy might grow slowly. Both conceptions are by definition rather assigned to a trait-dimension than to a state-dimension, thus they claim to predict stable habits in unstable situations. Regulatory focus theory also insists to differentiate in a “chronic” focus that aims at the presence of a general promotion orientation and general prevention orientation (Higgins, 1997; Lockwood, Jordan, & Kunda, 2002). We have neglected the role of a chronic regulatory focus orientation, since we were interested in manipulation effects that had a direct impact on adaptive processing. One could argue that long-term goals, like the attainment of a possible self, are rather affected by a chronic regulatory focus than by an immediately effective treatment. Another argument about why we have not controlled for any trait-dimension of regulatory focus, were concerns regarding the validity of the commonly used methods to measure regulatory focus orientations. As we discussed in the general method section, the usage of questionnaires to capture motivational tendencies lacks objectivity (Summerville & Rose, 2008). However, a prospect suggestion for a more reliable measure of chronic regulatory focus tendencies might be the pure noise application of the RFDrive method. When participants have the possibility to react to solely neutral symbols (without any defined purpose), we could observe and measure a general tendency of approach or avoiding behavior. Thus, we assume that people with a general promotion orientation should be eager to collect more of the neutral symbols whilst those who are generally prevention oriented should be vigilant to avoid more of them. This hypothesis, however, needs to be tested with a further cross-validation of other chronic focus measurements.

If we consider beliefs as moderating factors in the self-regulation process, then we may discuss the role of self-serving beliefs as well. Findings of two experiments from Braga, Mata, Ferreira, & Sherman (2016) indicate that the motivation to observe the end of a streak or its continuation will lead to wishful predictions supported by strategic beliefs in the hot hand or in the gambler's fallacy. Moreover, when the favorable team was on a scoring streak, people believed more likely in the hot hand and thus expected its continuation. If, on the contrary, the rival team was on a scoring streak, they turned to the belief that it must come to an end (gambler's fallacy). They have argued that the motivation to observe such outcomes can affect human reasoning in a self-serving way, by having, for instance, a greater tendency to accept favorable information (Ditto & Lopez, 1992; Liberman & Chaiken, 1992), and by adopting qualitatively different reasoning strategies that conform better to one's own goals (Mata, Garcia-Marques, Ferreira, & Mendonça, 2015). In our investigation of the hot hand and gambler's fallacy, we did not cover any favorability of observed athletes. Thus, a possible moderation of the regulatory shift by self-serving beliefs might be of interest in future experiments.

Self-relevant beliefs that influence maladaptive reasoning are not limited to the hot hand resp. gambler's fallacy. Studies from Donner and Swaminathan (2012) controlled for several boundary conditions of the endowment effect. They have argued that people cope with social self-threat by increasing their valuations of goods that are closely linked to their identities. They asked respondents to imagine a previous relationship in which they felt unloved and rejected and further encouraged them to think about how they felt being in this relationship, to imagine conversations and interactions with this person, and to write about their thoughts and feelings regarding themselves in relation to this person. According to Shaver and Hazan 1988, interpersonal rejection is a powerful threat to a person's social self and results in a negative view of the self. Their findings showed that a social self-threat increased selling prices, thus moderating the endowment effect. After a social self-threat, individuals seem to have strong possession-self links, since possessions can enhance the self (Beggan 1992; Sivanathan and Pettit 2010) and help individuals to cope with the threat. Although the prevention focus manipulation may have induced some level of threat implicitly, we did not controlled whether the asked obligations and responsibilities may have caused any kind of threat at all. Regarding the findings of Donner and Swaminathan, a further investigation of regulatory shift and the endowment effect should consider social self-threat as a possible moderator.

To interim conclude, we want to emphasize the role of self-relevance in the regulatory circle and its effect on adaptive strategy for further investigations. Furthermore, we want to encourage future research to investigate the advantage of the regulatory shift on more specific categories of creativity. Finally, we also want address the important implication of an alterable status quo for future experiments.

We discussed what happens in promotion and prevention when the current status quo is 0 can be different from what happens when it is -1 or +1. According to (Zou, et al. 2014) this is true for making choices between relatively risky and conservative options, but this could be true as well for other assimilative (top-down, generative, and productive) or accommodative (bottom-up, sensitive, and reproductive) strategies under the different conditions of beginning at 0, -1, or +1. It is possible that people with a prevention focus would be more creative when the current state is a painful -1, since the need for a solution to overcome their struggles might solve their stickiness to the situation and shift their attention to generative processing. Baas, DeDreu, and Nijstad (2011) demonstrated that creativity in prevention focus can lead to similar levels of creativity as promotion focus when prevention goals are unfulfilled. People with a promotion focus on the other hand may be less creative, when the current state is a pleasant +1, since the need for productivity becomes obsolete in a state of saturation, and their attention may shift to a satisfying view over the *Schlaraffenland* that they have created.

Another interesting question would be whether a shift from prevention in the condition of -1 (from debt) to promotion in the condition of +1 (to fortune), would lead to accommodation, a sensitivity to keep the accomplished status quo, or further to assimilation, even more risky behavior, since everything beyond goal attainment might be seen as investable. This scenario would also serve for a more detailed observation of the endowment effect as well as the gambler's and hot hand fallacy. However, these assumptions regarding what might happen when we pay attention to the status quo need to be addressed in future research.

3.2. Application

The presented research did not have the primary goal of developing methods and practices in job-related or consumer contexts. The generated insights from regulatory shift on adaptive strategy are nevertheless a fruitful ground for the development of motivational strategies and training in educational, organizational, and professional settings.

For example, imagine a person who enters medical school with both a clearly articulated positive possible self (myself winning the Nobel prize in medicine) and a clearly articulated negative possible self (myself flunking out and ending up on the streets). The positive self-image provides a powerful incentive to succeed (promotion focus), while the negative self-image provides a powerful reason not to fail (prevention focus). As long as the positive image receives more attention than the negative, the two images working in concert may boost motivation more than either one alone. This view is supported by studies on the accompany of negative and positive possible selves by Oyserman & Markus (1990).

Possible selves in comparison to regulatory focus congruent role models have also been identified in a job-related context by Lockwood, Jordan & Kunda (2002). According to their findings promotion-focused individuals, who favor a strategy of pursuing desirable outcomes, are most inspired by positive role models, who highlight strategies for achieving success. Prevention-focused individuals on the other hand, who favor a strategy of avoiding undesirable outcomes, are most motivated by negative role models, who highlight strategies for avoiding failure. If we take a stable habit of a “chronic” regulatory focus for granted (Higgins, 1997), we would emphasize a leader-rotation account, which implies that promotion-oriented individuals should be steered by avoiding undesirable outcomes at first and then shifted towards pursuing desirable outcomes (promotion shift), whilst prevention-oriented individuals should be inspired to pursuit desirable outcomes at first and then shifted towards avoiding undesirable outcomes (prevention shift).

Moreover, and beyond the suggestion of a regulatory shift-sensitive leadership, we want to highlight the beneficial role of the shift on a more detailed, task-related level in accordance to the adaptive strategy model of assimilation and accommodation. There is hardly any job that requires only one adaptive strategy. A scientist for instance, has several generative phases in deriving hypotheses and designing experiments, but he or she is also required to record the generated insights carefully and very formal according to the publication standards of a scientific journal. A mason who is primarily engaged in laying bricks in accordance to a fixed building plan might be challenged by ground irregularities and needs to solve that creatively by carving bricks individually to balance the unevenness. However, some job positions require more assimilation, other more accommodation routines even within one category. A barkeeper in a pub might just tap beer all night long, while his colleague in the hotel lobby-bar across the street surprises his guests with fancy cocktail creations. It is therefore crucial to identify the accommodative or assimilative nature of job routines. Based on that, we would further suggest the strategic use of the regulatory shift to enhance job motivation and long-term performance.

A particular example for a prevention shift might be the routine of a surgeon. An operation on the heart must be performed highly precise and flawless. The surgeon could thus engage in more abstract, failure tolerant activities like painting or improvising on an instrument before shifting into the highly sensitive condition of the surgery. Conversely, a product designer, who works on the first draft of a new piece of furniture, has to think highly flexible in full generative mode. He could engage in highly detailed and error sensitive activities, like playing with a Jenga tower or building a house of cards before shifting into the highly creative design condition. Of course, those shifting activities are limited by costs and time pressure in reality. Although, the strategic use of the regulatory shift might appear uneconomical on the surface, but the motivational and performance advantage might be a pay-off in the long run. Companies are investing tremendous of ressources in on-the job trainings to enhance job-performance and employee-satisfaction (Colquitt, LePine, & Noe, 2000). Instead of investing in redundant motivation trainings or *doppelte lottchens* that are based on the very same (and often not effective) principles, we would rather suggest to identify the task-nature of an individual job-profile and shift the adaptive strategy on a micro-level.

Finally, we want to speculate about a “cognitive debiasing” application of the regulatory shift. One principle among strategies for reducing maladaptive reasoning is meta-cognition (Garner, 1987; Moran & Tai, 2001). Meta-cognition is a reflective approach to problem solving that involves stepping back from the immediate problem to examine and reflect on the thinking process. Although meta-cognition is by itself a shift from current reasoning, we want to go one step further and recommend particular framings of assimilation to minimize vulnerable situations in which maladaptive reasoning might occur. According to our results, we want to address the endowment effect (Kahneman, Knetsch, & Thaler, 1990) and the hot-hand fallacy (Gilovich, Vallone, & Tversky, 1985) in particular. Trading products and services by defining a price range in minimum and maximum prices instead of a fixed price, offers the possibility for an internal negotiation-process, which might prevent from an exaggerated pricing evoked by the endowment effect. According to Herzog and Hertwich (2009), "dialectic bootstrapping" reduces errors of estimates by averaging his or her first estimate with a second one that harks back to somewhat different knowledge. Beyond that, a state of promotion shift would expand the generated price range and should, therefore, lead to a more consistent judgment about a fair final price. Conversely, when it comes to judgments about performance continuity, a prevention shift framing should reduce overrating by narrowing the scope for positive repetitions. Given that this principle is robust, it could be applied to more accurate employee assessments in an organizational context, but also in the treatment of addictions (e.g. sports betting) from a clinical perspective.

4. Conclusion

Findings from four experiments validated the assumption that a relative change in self-regulation is the more relevant causal factor for the activation of adaptive strategies compared to an artificial attempt to manipulate an absolute state. We demonstrated that by applying the regulatory shift, which is the change from prevention focus (vigilant, avoidance, concerned with duties and responsibilities) to promotion focus (eager, approach, concerned with hopes and ideals), and vice versa. Adaptive strategies of the assimilation type (top-down, generative, productive, liberal) were enhanced by the latter focus on promotion, whilst adaptive strategies of the accommodation type (bottom-up, sensitive, re-productive, conservative) were strengthened by the latter focus on prevention. This pattern was reflected by a) the assessment of four creativity tests, b) the investigation of the endowment effect on the basis of fixed price judgments and negotiation levels, c) the assessment of the hot hand and gambler's fallacy by means of single and serial predictions, d) a new treatment development that includes a manipulation check with the aid of a signal detection analyses (RFDrive). Although we have demonstrated a variety of operationalizations for the sake of reliability and construct validity, we have only scratched the tip of the iceberg. However, the RFDrive method offers promising possibilities to investigate and validate a broader range of boundary conditions, such as the matter of the status quo, the role of self-efficacy under uncertainty, or the impact of motivational strength. This was expecially the case under conditions of the regulatory shift. It was our aim to promote the consideration of relativity in the attempt to manipulate experimental conditions in psychological investigations. Finally, we discussed a narrowing of cognitive biases through the regulatory shift and possible transfers to work-related contexts with the focus on motivation and productivity. We hope that our aim to advance the conceptualization of self-regulation will inspire future research in the field, and beyond.

References

Adams, R. M. (1995). Momentum in the performance of professional tournament pocket billiards players. *International Journal of Sport Psychology*, 26, 580-587.

Amabile, T. M. (1996). *Creativity in context: Update to the social psychology of creativity*. Hachette UK.

Arslan, P., & Fiedler, K. (2017). *Creativity depends on regulatory focus and, more strongly, on regulatory-focus shift*. Manuscript submitted for publication.

Ashby, W. R. (1961). *An introduction to cybernetics*. Chapman & Hall Ltd.

Atkinson, J.W. (1964). *An introduction to motivation.* Oxford, England: Van Nostrand.

Ayton, P., & Fischer, I. (2004). The hot hand fallacy and the gambler's fallacy: Two faces of subjective randomness?. *Memory & cognition*, *32*(8), 1369-1378.

Ayton, P., Hunt, A. J., & Wright, G. (1989). Psychological conceptions of randomness. *Journal of Behavioral Decision Making*, *2*(4), 221-238.

Baas, M., De Dreu, C. K., & Nijstad, B. A. (2008). A meta-analysis of 25 years of mood-creativity research: Hedonic tone, activation, or regulatory focus?. *Psychological bulletin*, *134*(6), 779.

Baas, M., De Dreu, C. K., & Nijstad, B. A. (2011). When prevention promotes creativity: The role of mood, regulatory focus, and regulatory closure. *Journal of personality and social psychology*, *100*(5), 794.

Bandura, A. (2001). Social cognitive theory: An agentic perspective. *Annual review of psychology*, *52*(1), 1-26.

Bandura, A. (1986). The explanatory and predictive scope of self-efficacy theory. *Journal of social and clinical psychology*, *4*(3), 359-373.

Bandura, A., & Jeffrey, R. W. (1973). Role of symbolic coding and rehearsal processes in observational learning. *Journal of personality and social psychology*, 26(1), 122.

Batey, M. (2012). The measurement of creativity: From definitional consensus to the introduction of a new heuristic framework. *Creativity Research Journal*, *24*(1), 55-65.

Beggan, J. K. (1992). On the social nature of nonsocial perception: The mere ownership effect. *Journal of personality and social psychology*, *62*(2), 229.

Beier, S., & Fiedler, K. (2014). Affect and cognitive processes in educational contexts. In *International handbook of emotions in education* (pp. 46-65). Routledge.

Belk, R., & Tumbat, G. (2005). The cult of Macintosh. *Consumption markets & culture*, *8*(3), 205-217.

Bischof, N. (1975). A systems approach toward the functional connections of attachment and fear. *Child Development*, 801-817.

Blaney, P. H. (1986). Affect and memory: a review. *Psychological bulletin*, *99*(2), 229.

Bless, H., & Burger, A. M. (2016). A closer look at social psychologists' silver bullet: Inevitable and evitable side effects of the experimental approach. *Perspectives on psychological science*, *11*(2), 296-308.

Bless, H., & Fiedler, K. (1995). Affective states and the influence of activated general knowledge. *Personality and Social Psychology Bulletin*, *21*(7), 766-778.

Bless, H., Fiedler, K., & Forgas, J. P. (2006). Mood and the regulation of information processing and behavior. *Affect in social thinking and behavior*, *6584*.

Bock, O., Nicklisch, A., & Baetge, I. (2012): hroot: Hamburg registration and organization online tool. *WiSo-HH Working Paper*.

Bodenhausen, G. V., Kramer, G. P., & Süsser, K. (1994). Happiness and stereotypic thinking in social judgment. *Journal of personality and social psychology*, *66*(4), 621.

Bolte, A., Goschke, T., & Kuhl, J. (2003). Emotion and intuition: Effects of positive and negative mood on implicit judgments of semantic coherence. *Psychological Science*, *14*(5), 416-421.

Bornstein, R. F. (1989). Exposure and affect: overview and meta-analysis of research, 1968–1987. *Psychological bulletin*, *106*(2), 265.

Bower, G. H. (1981). Mood and memory. *American psychologist*, *36*(2), 129.

Bowers, K. S., Regehr, G., Balthazard, C., & Parker, K. (1990). Intuition in the context of discovery. *Cognitive psychology*, *22*(1), 72-110.

Braga, J. P., Mata, A., Ferreira, M. B., & Sherman, S. J. (2017). Motivated reasoning in the prediction of sports outcomes and the belief in the "hot hand". *Cognition and Emotion*, *31*(8), 1571-1580.

Bradley, M. M., & Lang, P. J. (1994). Measuring emotion: the self-assessment manikin and the semantic differential. *Journal of behavior therapy and experimental psychiatry*, *25*(1), 49-59.

Brendl, C. M., & Higgins, E. T. (1996). Principles of judging valence: What makes events positive or negative?. In *Advances in experimental social psychology* (Vol. 28, pp. 95-160). Academic Press.

Brockner, J., & Higgins, E. T. (2001). Regulatory focus theory: Implications for the study of emotions at work. *Organizational behavior and human decision processes*, *86*(1), 35-66.

Brosnan, S. F., & Bshary, R. (2016). On potential links between inequity aversion and the structure of interactions for the evolution of cooperation. *Behaviour*, *153*(9-11), 1267-1292.

Brown, J. (1998). *The Self.* Routledge, Taylor and Francis Group.

Bruner, J. S., Postman, L., & Rodrigues, J. (1951). Expectation and the perception of color. *The American journal of psychology*, *64*(2), 216-227.

Budescu, D. V. (1987). A Markov model for generation of random binary sequences. *Journal of Experimental Psychology: Human perception and performance*, *13*(1), 25.

Camacho, C. J., Higgins, E. T., & Luger, L. (2003). Moral value transfer from regulatory fit: what feels right is right and what feels wrong is wrong. *Journal of personality and social psychology*, *84*(3), 498.

Carver, C. S., Lawrence, J. W., & Scheier, M. F. (1996). A control-process perspective on the origins of affect. *Striving and feeling: Interactions among goals, affect, and self-regulation*, 11-52.

Carver, C. S., & Scheier, M. F. (1981). The self-attention-induced feedback loop and social facilitation. *Journal of Experimental Social Psychology*, *17*(6), 545-568.

Carver, C. S., & Scheier, M. F. (1990). Origins and functions of positive and negative affect: A control-process view. *Psychological review*, *97*(1), 19.

Carver, C. S., & White, T. L. (1994). Behavioral inhibition, behavioral activation, and affective responses to impending reward and punishment: the BIS/BAS scales. *Journal of personality and social psychology*, *67*(2), 319.

Caroff, X., & Besançon, M. (2008). Variability of creativity judgments. *Learning and Individual Differences*, *18*(4), 367-371.

Cesario, J., Grant, H., & Higgins, E. T. (2004). Regulatory fit and persuasion: Transfer from" feeling right.". *Journal of personality and social psychology*, *86*(3), 388.

Chermahini, S. A., & Hommel, B. (2010). The link between creativity and dopamine: spontaneous eye blink rates predict and dissociate divergent and convergent thinking. *Cognition*, *115*(3), 458-465.

Chirumbolo, A., Livi, S., Mannetti, L., Pierro, A., & Kruglanski, A. W. (2004). Effects of need for closure on creativity in small group interactions. *European Journal of Personality*, *18*(4), 265-278.

Clore, G. L., Schwarz, N., & Conway, M. (1994). Affective causes and consequences of social information processing. *Handbook of social cognition*, *1*, 323-417.

Clore, G. L., & Storbeck, J. (2006). Affect as information about liking, efficiacy, and importance. In J. P. Forgas (Ed.), *Affect in social thinking and behavior* (pp. 123-142). New York: Psychology Press.

Cohen, J. (1977). *Statistical power analysis for behavioral sciences* (revised ed.). New York: Academic Press.

Colquitt, J. A., LePine, J. A., & Noe, R. A. (2000). Toward an integrative theory of training motivation: a meta-analytic path analysis of 20 years of research. *Journal of applied psychology*, *85*(5), 678.

Connors, R., Smith, T., & Hickman, C. (1998). *The Oz principle: Getting results through individual and organizational accountability*. Penguin.

Cronbach, L. J. (1951). Coefficient alpha and the internal structure of tests. *Psychometrika. 16 (3)*, 297–334.

Crowe, E., & Higgins, E. T. (1997). Regulatory focus and strategic inclinations: Promotion and prevention in decision-making. *Organizational behavior and human decision processes*, *69*(2), 117-132.

De Dreu, C. K., Baas, M., & Nijstad, B. A. (2008). Hedonic tone and activation level in the mood-creativity link: toward a dual pathway to creativity model. *Journal of personality and social psychology*, *94*(5), 739.

Ditto, P. H., & Lopez, D. F. (1992). Motivated skepticism: Use of differential decision criteria for preferred and nonpreferred conclusions. *Journal of Personality and Social Psychology*, *63*(4), 568.

Dommer, S. L., & Swaminathan, V. (2012). Explaining the endowment effect through ownership: The role of identity, gender, and self-threat. *Journal of Consumer Research*, *39*(5), 1034-1050.

Duval, T. S., & Wicklund, R. A. (1972). *A theory of objective self-awareness*. New York: Academic.

Ebbinghaus, H. (1885). *Ueber das Gedächtnis, Untersuchungen zur experimentellen Psychologie von Herm. Ebbinghaus,...* Duncker und Humblot.

Emmons, R. A. (1986). Personal strivings: An approach to personality and subjective well-being. *Journal of Personality and Social psychology*, *51*(5), 1058.

Eysenck, M. W., & Keane, M. T. (2000). *Cognitive psychology: A student's handbook*. Taylor & Francis.

Fazio, R. H., Sanbonmatsu, D. M., Powell, M. C., & Kardes, F. R. (1986). On the automatic activation of attitudes. *Journal of personality and social psychology*, *50*(2), 229.

Festinger, L. (1962). *A theory of cognitive dissonance* (Vol. 2). Stanford university press.

Fiedler, K. (1988). The dependence of the conjunction fallacy on subtle linguistic factors. *Psychological research*, *50*(2), 123-129.

Fiedler, K. (2001). Affective States Trigger Processes. *Theories of mood and cognition: A user's guidebook*, 85-98.

Fiedler, K., & Arslan, P. (2017). From a hedonic perspective on good life to an analysis of underlying adaptive principles. Chapter to appear in J. Forgas & R. Baumeister. *The social psychology of the good life*.

Fiedler, K., & Arslan, P. (2017). From a hedonic perspective on good life to an analysis of underlying adaptive principles. Chapter to appear in J. Forgas & R. Baumeister. *The social psychology of the good life*.

Fiedler, K., Asbeck, J., & Nickel, S. (1991). Mood and constructive memory effects on social judgement. *Cognition & Emotion*, *5*(5-6), 363-378.

Fiedler, K., & Bless, H. (2001). Social cognition: The construction of social reality.

Fiedler, K., & Hütter, M. (2013). Memory and emotion. *The sage handbook of applied memory*, 145.

Fiedler, K., & Juslin, P. (Eds.). (2006). *Information sampling and adaptive cognition*. Cambridge University Press.

Fiedler, K., Nickel, S., Asbeck, J., & Pagel, U. (2003). Mood and the generation effect. *Cognition & Emotion*, *17*(4), 585-608.

Fiedler, K., Nickel, S., Muehlfriedel, T., & Unkelbach, C. (2001). Is mood congruency an effect of genuine memory or response bias?. *Journal of Experimental Social Psychology*, *37*(3), 201-214.

Fischhoff, B., Slovic, P., & Lichtenstein, S. (1979). Subjective sensitivity analysis. *Organizational behavior and human performance*, *23*(3), 339-359.

Forgas, J. P. (1995). Mood and judgment: the affect infusion model (AIM). *Psychological bulletin*, *117*(1), 39.

Forgas, J. P., Levinger, G., & Moylan, S. (1994). Feeling good and feeling close: Mood effects on the perception of intimate relationships. *Personal Relationships, 2,* 165-184.

Förster, J., Higgins, E. T., & Bianco, A. T. (2003). Speed/accuracy decisions in task performance: Built-in trade-off or separate strategic concerns?. *Organizational Behavior and Human Decision Processes*, *90*(1), 148-164.

Freitas, A. L., & Higgins, E. T. (2002). Enjoying goal-directed action: The role of regulatory fit. *Psychological science*, *13*(1), 1-6.

Freud, S. (1952). *A general introduction to psychoanalysis*. New York: Washington Square Press. (Original work published 1920).

Frey, B. S., & Gallus, J. (2017). Towards an economics of awards. *Journal of Economic Surveys*, *31*(1), 190-200.

Friedman, R. S., & Förster, J. (2001). The effects of promotion and prevention cues on creativity. *Journal of personality and social psychology*, *81*(6), 1001.

Friedman, R. S., Förster, J., & Denzler, M. (2007). Interactive effects of mood and task framing on creative generation. *Creativity Research Journal*, *19*(2-3), 141-162.

Garner, R. (1987). *Metacognition and reading comprehension*. Ablex Publishing.

Gilden, D. L., & Wilson, S. G. (1995). On the nature of streaks in signal-detection. *Cognitive Psychology*, 28, 17-64.

Gilovich, T., Vallone, R., & Tversky, A. (1985). The hot hand in basketball: On the misperception of random sequences. *Cognitive psychology*, *17*(3), 295-314.

Guilford, J. P. (1967). Creativity: Yesterday, today and tomorrow. *The Journal of Creative Behavior*, *1*(1), 3-14.

Green, D. M., & Swets, J. A. (1966). *Signal detection theory and psychophysics*. New York: Wiley.

Hansen, J., Dechene, A., & Wänke, M. (2008). Discrepant fluency increases subjective truth. *Journal of Experimental Social Psychology*, *44*(3), 687-691.

Haws, K. L., Dholakia, U. M., & Bearden, W. O. (2010). An assessment of chronic regulatory focus measures. *Journal of Marketing Research*, *47*(5), 967-982.

Hecht, S. (1924). The visual discrimination of intensity and the Weber-Fechner law. *The Journal of general physiology*, *7*(2), 235-267.

Henker, N., Sonnentag, S., & Unger, D. (2015). Transformational leadership and employee creativity: the mediating role of promotion focus and creative process engagement. *Journal of Business and Psychology*, *30*(2), 235-247.

Herman, A., & Reiter-Palmon, R. (2011). The effect of regulatory focus on idea generation and idea evaluation. *Psychology of Aesthetics, Creativity, and the Arts*, *5*(1), 13.

Hertel, G., & Fiedler, K. (1994). Affective and cognitive influences in social dilemma game. *European Journal of Social Psychology*, *24*(1), 131-145.

Herzog, S. M., & Hertwig, R. (2009). The wisdom of many in one mind: Improving individual judgments with dialectical bootstrapping. Psychological Science, 20(2), 231-237.

Hesselbein, F., Goldsmith, M., & Somerville, I. (2002). *Leading for innovation and organizing for results*. Jossey-Bass.

Higgins, E. T. (1987). Self-discrepancy: a theory relating self and affect. *Psychological review*, *94*(3), 319.

Higgins, E. T. (1991). Development of self-regulatory and self-evaluative processes: Costs, benefits, and tradeoffs.

Higgins, E. T. (1997). Beyond pleasure and pain. *American psychologist*, *52*(12), 1280.

Higgins, E.T. (2017; in press). What Distinguishes Promotion and Prevention? Attaining "+1" from "0" as Non-Gain Versus Maintaining "0" as Non-Loss. *Polish Psychological Bulletin.*

Higgins, E. T., Friedman, R. S., Harlow, R. E., Idson, L. C., Ayduk, O. N., & Taylor, A. (2001). Achievement orientations from subjective histories of success: Promotion pride versus prevention pride. *European Journal of Social Psychology*, *31*(1), 3-23.

Higgins, E. T., Roney, C. J., Crowe, E., & Hymes, C. (1994). Ideal versus ought predilections for approach and avoidance distinct self-regulatory systems. *Journal of personality and social psychology*, *66*(2), 276.

Hsee, C. K., Salovey, P., & Abelson, R. P. (1994). The quasi-acceleration relation: Satisfaction as a function of the change of velocity of outcome over time. *Journal of Experimental Social Psychology*, *30*(1), 96-111.

Idson, L. C., Liberman, N., & Higgins, E. T. (2000). Distinguishing gains from nonlosses and losses from nongains: A regulatory focus perspective on hedonic intensity. *Journal of Experimental Social Psychology, 36(3),* 252-274.

Isen, A. M. (1987). Positive affect, cognitive processes, and social behavior. In *Advances in experimental social psychology*(Vol. 20, pp. 203-253). Academic Press.

Isen, A. M., Daubman, K. A., & Nowicki, G. P. (1987). Positive affect facilitates creative problem solving. *Journal of personality and social psychology*, *52*(6), 1122.

Isen, A. M., Johnson, M. M., Mertz, E., & Robinson, G. F. (1985). The influence of positive affect on the unusualness of word associations. *Journal of personality and social psychology*, *48*(6), 1413.

James, W. H., & Rotter, J. B. (1958). Partial and 100% reinforcement under chance and skill conditions. *Journal of Experimental Psychology*, *55*(5), 397.

Jauk, E., Benedek, M., & Neubauer, A. C. (2014). The road to creative achievement: A latent variable model of ability and personality predictors. *European journal of personality*, *28*(1), 95-105.

Jarvik, M. E. (1951). Probability learning and a negative recency effect in the serial anticipation of alternative symbols. *Journal of experimental psychology*, *41*(4), 291.

Jordan, M., & Vancil, M. (1998). *For the love of the game: My story*. Crown Publishers.

Kahneman, D., Knetsch, J. L., & Thaler, R. H. (1990). Experimental tests of the endowment effect and the Coase theorem. *Journal of political Economy*, *98*(6), 1325-1348.

Kahneman, D., & Tversky, A. (1984). Choices, values, and frames. *American psychologist*, *39*(4), 341.

Kahneman, D., & Tversky, A. (1977). *Intuitive prediction: Biases and corrective procedures*. Decisions and Designs Inc. McLean, VA.

Kahneman, D., & Tversky, A. (1972). Subjective probability: A judgment of representativeness. *Cognitive psychology*, *3*(3), 430-454.

Keller, P. A. (2006). Regulatory focus and efficacy of health messages. *Journal of Consumer Research*, *33*(1), 109-114.

Keller, P. A., Lee, A. Y., & Sternthal, B. (2006). *Value from Regulatory Construal Fit*. working paper, Marketing Department, Kellogg School of Management, Northwestern University, Evanston.

Koffka, K. (1935). *Principles of Gestalt psychology* (Vol. 44). Routledge.

Kohonen, T. (1988). An introduction to neural computing. *Neural networks,* 1(1), 3-16.

Krueger, J. & Kutzner, F. (2017) Homo Anomalus: Richard Thaler's Kuhnian Adventure Review of 'Misbehaving: The making of behavioral economics.' by Richard H. Thaler *The American Journal of Psychology.*

Lanaj, K., Chang, C. H., & Johnson, R. E. (2012). Regulatory focus and work-related outcomes: a review and meta-analysis. *Psychological bulletin*, *138*(5), 998.

Landauer, T. K. (1987). *Relations between cognitive psychology and computer system design.* Interfacing thought: cognitive aspects of human-computer interaction, 1-25.

Lawrence, J. W., Carver, C. S., & Scheier, M. F. (2002). Velocity toward goal attainment in immediate experience as a determinant of affect. *Journal of Applied Social Psychology*, *32*(4), 788-802.

Lee, A. Y., & Aaker, J. L. (2004). Bringing the frame into focus: the influence of regulatory fit on processing fluency and persuasion. *Journal of personality and social psychology*, *86*(2), 205.

Lee, A. Y., Aaker, J. L., & Gardner, W. L. (2000). The pleasures and pains of distinct self-construals: The role of interdependence in regulatory focus. *Journal of personality and social psychology*, *78*(6), 1122.

Leiner, D. J. (2014). SoSci Survey (Version 2.5.00-i) [Computer software]. Available at https://www.soscisurvey.de

Lerner, J. S., Small, D. A., & Loewenstein, G. (2004). Heart strings and purse strings: Carryover effects of emotions on economic decisions. *Psychological science*, *15*(5), 337-341.

Liberman, A., & Chaiken, S. (1992). Defensive processing of personally relevant health messages. *Personality and Social Psychology Bulletin*, *18*(6), 669-679.

Liberman, N., Idson, L. C., Camacho, C. J., & Higgins, E. T. (1999). Promotion and prevention choices between stability and change. *Journal of personality and social psychology*, *77*(6), 1135.

Liberman, N., Polack, O., Hameiri, B., & Blumenfeld, M. (2012). Priming of spatial distance enhances children's creative performance. *Journal of experimental child psychology*, *111*(4), 663-670.

Lockwood, P., Jordan, C. H., & Kunda, Z. (2002). Motivation by positive or negative role models: regulatory focus determines who will best inspire us. *Journal of personality and social psychology*, *83*(4), 854.

Lopes, L. L. (1982). Doing the impossible: A note on induction and the experience of randomness. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *8*(6), 626.

Lynn, S. K., & Barrett, L. F. (2014). "Utilizing" signal detection theory. *Psychological science*, *25*(9), 1663-1673.

Maddox, W. T., Baldwin, G. C., & Markman, A. B. (2006). A test of the regulatory fit hypothesis in perceptual classification learning. *Memory & Cognition, 34*(7), 1377-1397.

Mannhaupt, H.-R. (1983). Produktionsnormen für verbale Reaktionen zu 40 geläufigen Kategorien [German category norms for verbal items in 40 categories]. *Sprache & Kognition, 2*(4), 264-278.

Markus, H., & Nurius, P. (1986). Possible selves. *American psychologist*, *41*(9), 954.

Markus, H., & Wurf, E. (1987). The dynamic self-concept: A social psychological perspective. *Annual review of psychology*, *38*(1), 299-337.

Marsh, H. W. (1987). Students' evaluations of university teaching: Research findings, methodological issues, and directions for future research. *International journal of educational research*, *11*(3), 253-388.

Mata, A., Garcia-Marques, L., Ferreira, M. B., & Mendonça, C. (2015). Goal-driven reasoning overcomes cell D neglect in contingency judgements. *Journal of Cognitive Psychology*, *27*(2), 238-249.

Mednick, S. (1962). The associative basis of the creative process. *Psychological review*, *69*(3), 220.

Memmert, D., Hüttermann, S., & Orliczek, J. (2013). Decide like Lionel Messi! The impact of regulatory focus on divergent thinking in sports. *Journal of Applied Social Psychology*, *43*(10), 2163-2167.

Miller, G. A., Galanter, E., & Pribram, K. H. (1986). *Plans and the structure of behavior*. Adams Bannister Cox.

Moore, D. A., Swift, S. A., Sharek, Z. S., & Gino, F. (2010). Correspondence bias in performance evaluation: Why grade inflation works. *Personality and Social Psychology Bulletin*, *36*(6), 843-852.

Moran, D. J., & Tai, W. (2001). Reducing biases in clinical judgment with single subject treatment design. *The Behavior Analyst Today*, *2*(3), 196.

Multon, K. D., Brown, S. D., & Lent, R. W. (1991). Relation of self-efficacy beliefs to academic outcomes: A meta-analytic investigation. *Journal of counseling psychology*, *38*(1), 30.

Navon, D. (1977). Forest before trees: The precedence of global features in visual perception. *Cognitive psychology*, *9*(3), 353-383.

Oyserman, D., & Markus, H. R. (1990). Possible selves and delinquency. *Journal of personality and social psychology*, *59*(1), 112.

Rietzschel, E. F. (2011). Collective regulatory focus predicts specific aspects of team innovation. *Group Processes & Intergroup Relations*, *14*(3), 337-345.

Rotter, J. B. (1966). Generalized expectancies for internal versus external control of reinforcement. *Psychological monographs: General and applied*, *80*(1), 1.

Rotter, J. B. (1954). *Social learning and clinical psychology*. Englewood Cliffs, NJ, US: Prentice-Hall, Inc.

Parducci, A. (1965). Category judgment: a range-frequency model. *Psychological review*, *72*(6), 407.

Parducci, A. (1968). The relativism of absolute judgments. *Scientific American*, *219*(6), 84-93.

Powers, W. T. (1973). Feedback: Beyond Behaviorism: Stimulus-response laws are wholly predictable within a control-system model of behavioral organization. *Science*, *179*(4071), 351-356.

Piaget, J. (1954). Language and thought from a genetic perspective. *Acta Psychologica*, *10*, 51-60.

Reber, R., & Schwarz, N. (1999). Effects of perceptual fluency on judgments of truth. *Consciousness and cognition*, *8*(3), 338-342.

Rey, J. M., Morris-Yates, A., & Stanislaw, H. (1992). Measuring the accuracy of diagnostic tests using receiver operating characteristic (ROC) analysis. *International Journal of Methods in Psychiatric Re-*

search, 2, 39-50.

Rook, L., & van Knippenberg, D. (2011). Creativity and imitation: Effects of regulatory focus and creative exemplar quality. *Creativity Research Journal*, *23*(4), 346-356.

Roese, N. J., Hur, T., & Pennington, G. L. (1999). Counterfactual thinking and regulatory focus: Implications for action versus inaction and sufficiency versus necessity. *Journal of Personality and Social Psychology*, *77*(6), 1109.

Ryan, R. M., & Deci, E. L. (2000). Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *American psychologist*, *55*(1), 68.

Sacramento, C. A., Fay, D., & West, M. A. (2013). Workplace duties or opportunities? Challenge stressors, regulatory focus, and creativity. *Organizational Behavior and Human Decision Processes*, *121*(2), 141-157.

Scholer, A. A., Zou, X., Fujita, K., Stroessner, S. J., Higgins, E. T. (2010). When risk-seeking becomes a motivational necessity. *Journal of Personality and Social Psychology, 99*, 215-231.

Schwarz, N. (1990). *Feelings as information: Informational and motivational functions of affective states*. Guilford Press.

Schwarz, N., & Clore, G. L. (1996). Feelings and phenomenal experiences. *Social psychology: Handbook of basic principles*, *2*, 385-407.

Semin, G. R., Higgins, T., de Montes, L. G., Estourget, Y., & Valencia, J. F. (2005). Linguistic signatures of regulatory focus: how abstraction fits promotion more than prevention. *Journal of personality and social psychology*, *89*(1), 36.

Shah, J., & Higgins, E. T. (1997). Expectancy× value effects: Regulatory focus as determinant of magnitude and direction. *Journal of personality and social psychology*, *73*(3), 447.

Shaver, P. R., & Hazan, C. (1988). A biased overview of the study of love. *Journal of Social and Personal relationships*, *5*(4), 473-501.

Sivanathan, N., & Pettit, N. C. (2010). Protecting the self through consumption: Status goods as affirmational commodities. *Journal of Experimental Social Psychology*, *46*(3), 564-570.

Slamecka, N. J., & Graf, P. (1978). The generation effect: Delineation of a phenomenon. *Journal of experimental Psychology: Human learning and Memory*, *4*(6), 592.

Skinner, B. F. (1938). *The behavior of organisms: An experimental analysis*. New York, NY: Appleton-Century-Crofts.

Stanislaw, H., & Todorov, N. (1999). Calculation of signal detection theory measures. *Behavior research methods, instruments, & computers*, *31*(1), 137-149.

Sternberg, R.J. & Lubart, T. I. (1999): *The concept of crea4vity: Prospects and paradigms.* In R.J.

Strauman, T. J. (1989). Self-discrepancies in clinical depression and social phobia: Cognitive structures that underlie emotional disorders?. *Journal of Abnormal Psychology*, *98*(1), 14.

Strauman, T. J., Vieth, A. Z., Merrill, K. A., Kolden, G. G., Woods, T. E., Klein, M. H., ... & Kwapil, L. (2006). Self-system therapy as an intervention for self-regulatory dysfunction in depression: A randomized comparison with cognitive therapy. *Journal of Consulting and Clinical psychology*, *74*(2), 367.

Summerville, A., & Roese, N. J. (2008). Dare to compare: Fact-based versus simulation-based comparison in daily life. *Journal of Experimental Social Psychology*, *44*(3), 664-671.

Thaler, R. (1980), "Toward a Positive Theory of Consumer Choice," *Journal of Economic Behavior and Organization*, *1* (1), 39–60.

Torrance, E. P., Ball, O. E., & Safter, H. T. (1966). *Torrance tests of creative thinking*. Scholastic Testing Service.

Trope, Y., & Liberman, N. (2010). Construal-level theory of psychological distance. *Psychological review*, *117*(2), 440.

Tversky, A., & Gilovich, T. (1989). The cold facts about the "hot hand" in basketball. *Chance*, *2*(1), 16-21.

Unkelbach, C., Forgas, J. P., & Denson, T. F. (2008). The turban effect: The influence of Muslim headgear and induced affect on aggressive responses in the shooter bias paradigm. *Journal of Experimental Social Psychology*, *44*(5), 1409-1413.

Vallacher, R. R., & Wegner, D. M. (1987). What do people think they're doing? Action identification and human behavior. *Psychological review*, *94*(1), 3.

Vroom, V.H. (1964). Work and motivation. Oxford, England: Wiley.

Wagenaar, W.-A. (1988). *Paradoxes of gambling behavior*. Hove, U.K.: Erlbaum.

Wagenaar, W.-A., & Keren, G. (1988). Chance and luck are not the same. *Journal of Behavioral Decision Making*, 1, 65-75.

Wänke, M., & Hansen, J. (2015). Relative processing fluency. *Current Directions in Psychological Science*, *24*(3), 195-199.

Wallace, J. C., Butts, M. M., Johnson, P. D., Stevens, F. G., & Smith, M. B. (2016). A multilevel model of employee innovation: Understanding the effects of regulatory focus, thriving, and employee involvement climate. *Journal of Management*, *42*(4), 982-1004.

Watson, J. B. (1913). Psychology as the behaviorist views it. *Psychological Review,* 20, 158–177.

Watson, D., Clark, L. A., & Tellegen, A. (1988). Development and validation of brief measures of positive and negative affect: the PANAS scales. *Journal of personality and social psychology*, *54*(6), 1063.

Wertheimer, M., & Wertheimer, M. (1959). *Productive thinking*. New York: Harper.

White, J. (1982). *Rejection*. Addison Wesley Publishing Company.

Whittlesea, B. W., & Williams, L. D. (1998). Why do strangers feel familiar, but friends don't? A discrepancy-attribution account of feelings of familiarity. *Acta psychologica*, *98*(2-3), 141-165

Whittlesea, B. W., & Williams, L. D. (2000). The source of feelings of familiarity: the discrepancy-attribution hypothesis. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *26*(3), 547.

Wigfield, A., & Eccles, J. S. (2000). Expectancy–value theory of achievement motivation. *Contemporary educational psychology*, *25*(1), 68-81.

Witte, K. (1994). The manipulative nature of health communication research: ethical issues and guidelines. *American Behavioral Scientist*, *38*(2), 285-293.

Worth, L. T., & Mackie, D. M. (1987). Cognitive mediation of positive affect in persuasion. *Social cognition*, *5*(1), 76-94.

Yeo, J., & Park, J. (2006). Effects of Parent-Extension Similarity and Self Regulatory Focus on Evaluations of Brand Extensions. *Journal of Consumer Psychology*, *16*(3), 272-282.

Zabelina, D. L., Felps, D., & Blanton, H. (2013). The motivational influence of self-guides on creative pursuits. *Psychology of Aesthetics, Creativity, and the Arts*, *7*(2), 112.

Zirkel, S., & Cantor, N. (1990). Personal construal of life tasks: Those who struggle for independence. *Journal of personality and social psychology*, *58*(1), 172.

Zou, X., Scholer, A. A., Higgins, E. T. (2014). In pursuit of progress: Promotion motivation and risk preference in the domain of gains. Journal of Personality and Social Psychology, 106, 183-201.

List of figures

List of tables

Appendix A

RFDrive (Python 3.6.5. & Pygame 1.9.1.)

Main game code:

```
#!/usr/bin/env python3

"""
RFDrive – A Regulatory Focus Strength Measure

Authors: Peter-Samuel Arslan & Stefan Radev
Last modified: April 2018

"""

# ------------------------------------------------------------------------------

#Import Packages

import pygame
import time
import random
import os.path
from data_handler import DataHandler
from intro_handler import collect_bio_data
from manakin_handler import show_manakins
from instruction_handler import show_instructions
from brick_handler import show_brick_task
from results_handler import show_results

os.environ['SDL_VIDEO_CENTERED'] = '1'

#Package initializing/ activating
pygame.init()

# ------------------------------------------------------------------------------

### Game Definitions ###

#Data Handler#
dataHandler = DataHandler()

#Game surface size
display_width = 400
display_height = 700

#Create Surfaces/Windows ((width and height))
gameDisplay = pygame.display.set_mode((display_width,display_height))

#Name of the Game ('Window-title')
pygame.display.set_caption('RFDrive')

#Define Colors (R,G,B)
black = (0,0,0)
white = (255,255,255)
red = (200,0,0)
green = (50,205,50)
purple =(127,0,255)
grey = (160,160,160)

bright_red = (255,0,0)
bright_green = (50,255,50)
bright_purple = (153,51,255)
bright_grey = (180,180,180)

#Gameclock time-capture
clock = pygame.time.Clock()
```

```
#ParImg size
par_width = 50
par_height = 50

#prImg size
pr_width = 50
pr_height = 50

#prImg size
pv_width = 50
pv_height = 50
#Load Images
parImg = pygame.image.load(os.path.join("img","Point.png"))
prImg = pygame.image.load(os.path.join("img","prImg.png"))
pvImg = pygame.image.load(os.path.join("img","pvImg.png"))
iconImg = pygame.image.load(os.path.join("img","icon.png"))
prState = pygame.image.load(os.path.join("img",'PR_state.png'))
pvState = pygame.image.load(os.path.join("img",'PV_state.png'))
prShift = pygame.image.load(os.path.join("img",'PR_shift.png'))
pvShift = pygame.image.load(os.path.join("img",'PV_shift.png'))
dvInstr = pygame.image.load(os.path.join("img",'DV_Instruction.png'))

#Game-Icon
pygame.display.set_icon(iconImg)

### Display Counter for Prevention Signals
def loss_count(count):
    font = pygame.font.SysFont(None, 30)
    text = font.render("Verlust: -"+str(count), True, red)
    gameDisplay.blit(text,(5,5))

def nloss_count(count):
    font = pygame.font.SysFont(None, 25)
    text = font.render("Non-Loss: "+str(count), True, black)
    gameDisplay.blit(text,(5,15))

### Display Counter for Promotion Signals
def gain_count(count):
    font = pygame.font.SysFont(None, 30)
    text = font.render("Gewinn: +"+str(count), True, black)
    gameDisplay.blit(text,(5,5))

def ngain_count(count):
    font = pygame.font.SysFont(None, 25)
    text = font.render("Non-Gain: "+str(count), True, black)
    gameDisplay.blit(text,(5,20))

### Display Counter for Noise
def falsealert_count(count):
    font = pygame.font.SysFont(None, 25)
    text = font.render("FA: "+str(count), True, black)
    gameDisplay.blit(text,(5,35))

def correject_count(count):
    font = pygame.font.SysFont(None, 25)
    text = font.render("CR: "+str(count), True, black)
    gameDisplay.blit(text,(5,50))

### Create Participant Object
def par(x,y):
    gameDisplay.blit(parImg,(x,y))

### Create Prevention Objects
def pv1(pvx, pvy):
    gameDisplay.blit(pvImg,[pvx,pvy])

def pv2(pvx, pvy):
    gameDisplay.blit(pvImg,[pvx,pvy])

def pv3(pvx, pvy):
    gameDisplay.blit(pvImg,[pvx,pvy])

def pv4(pvx, pvy):
    gameDisplay.blit(pvImg,[pvx,pvy])
```

```
### Create Promotion Objects
def pr1(prx, pry):
    gameDisplay.blit(prImg,[prx,pry])

def pr2(prx, pry):
    gameDisplay.blit(prImg,[prx,pry])

def pr3(prx, pry):
    gameDisplay.blit(prImg,[prx,pry])

def pr4(prx, pry):
    gameDisplay.blit(prImg,[prx,pry])



### Create Neutral Objects
def noise(noisex, noisey, noisew, noiseh, color):
    pygame.draw.rect(gameDisplay, grey, [noisex,noisey,noisew,noiseh])

def noise2(noisex, noisey, noisew, noiseh, color):
    pygame.draw.rect(gameDisplay, grey, [noisex,noisey,noisew,noiseh])

def noise3(noisex, noisey, noisew, noiseh, color):
    pygame.draw.rect(gameDisplay, grey, [noisex,noisey,noisew,noiseh])

def noise4(noisex, noisey, noisew, noiseh, color):
    pygame.draw.rect(gameDisplay, grey, [noisex,noisey,noisew,noiseh])

# ------------------------------------------------------------------------------

### Game-Quit ###

def quit_game():

    # Show the manakins
    show_manakins(dataHandler)
    # Show the brick task
    show_brick_task(dataHandler)
       # Save data
    dataHandler.save_to_file()
    # Quit all
    pygame.quit()
    score = dataHandler.get_score()
    show_results(score)
    quit()

# ------------------------------------------------------------------------------

### Game-Over ###

def game_over():

    over = True

    while over:
        for event in pygame.event.get():
            if event.type == pygame.QUIT:
                pygame.quit()
                quit()

        gameDisplay.fill(white)
        gameDisplay.blit(dvInstr,(30,30))
        LargeText = pygame.font.SysFont('GillSans.ttf',60)
        TextSurf, TextRect = text_objects("", LargeText)
        TextRect.center = ((display_width/2),(display_height/4))
        gameDisplay.blit(TextSurf, TextRect)

        button("Weiter",125,575,150,50,grey,bright_grey,quit_game)

        pygame.display.update()
        clock.tick(15)

# ------------------------------------------------------------------------------
```

```
### Game-Introduction ###

def game_intro():

    intro = True

    while intro:
        for event in pygame.event.get():

            if event.type == pygame.QUIT:
                pygame.quit()
                quit()

        gameDisplay.fill(white)
        gameDisplay.blit(iconImg,(175,120))
        SmallText = pygame.font.SysFont('Helectiva.ttf',40)
        TextSurf, TextRect = text_objects("Bereit?", SmallText)
        TextRect.center = (200,325)
        gameDisplay.blit(TextSurf, TextRect)

        if state == 'PREVENTION':
            button("START",125,450,150,50,red,bright_red,pv_random)

        if state == 'PROMOTION':
            button("START",125,450,150,50,green,bright_green,pr_random)

        '''
        button("Promotion Shift",125,250,150,50,green,bright_green, pr_shift_A)
        button("Prevention Shift",125,300,150,50,red,bright_red, pv_shift_A)
        button("Promotion State",125,350,150,50,green,bright_green, pr_neutral)
        button("Prevention State",125,400,150,50,red,bright_red, pv_neutral)
        button("Quit!",125,600,150,50,grey,bright_grey,quit_game)
        '''

        pygame.display.update()
        clock.tick(15)


# ------------------------------------------------------------------------------

### Random-Gamemodes ###

def random_start():
    game_modes = [pr_neutral, pv_neutral, pr_shift_A, pv_shift_A]
    random.choice(game_modes)()

def pv_random():
    pv_modes = [pv_neutral, pr_shift_A]
    random.choice(pv_modes)()

def pr_random():
    pr_modes = [pr_neutral, pv_shift_A]
    random.choice(pr_modes)()

# ------------------------------------------------------------------------------

### Game Pause ###

pause = False

#Load Text
def text_objects(text, font):
    textSurface = font.render(text, True, black)
def button(msg,x,y,w,h,ic,ac,action=None):
    mouse = pygame.mouse.get_pos()
    click = pygame.mouse.get_pressed()

    if x+w > mouse[0] > x and y+h > mouse[1] > y:
        pygame.draw.rect(gameDisplay, ac,(x,y,w,h))
        if click[0] == 1 and action != None:
            action()

    else:
        pygame.draw.rect(gameDisplay, ic,(x,y,w,h))
```

```
    #Button Text
    smallText = pygame.font.SysFont("Arial.ttf",20)
    textSurf,textRect = text_objects(msg, smallText)
    textRect.center = ( (x+(w/2)), (y+(h/2)) )
    gameDisplay.blit(textSurf, textRect)


#Game-Return
def unpause():
    global pause
    pause = False

def paused():

    gameDisplay.fill(white)
    LargeText = pygame.font.SysFont('Arial.ttf',65)
    TextSurf, TextRect = text_objects("Paused", LargeText)
    TextRect.center = ((display_width/2),(display_height/3))
    gameDisplay.blit(TextSurf, TextRect)

    while pause:
            for event in pygame.event.get():
                if event.type == pygame.QUIT:
                    pygame.quit()
                    quit()

            button("Continue!",150,400,100,50,green,bright_green, unpause)
            button("Quit!",150,500,100,50,red,bright_red,quit_game)

            pygame.display.update()
            clock.tick(15)

# ---------------------------------------------------------------------------

### Break - Promotion State ###

neutralpr = False

#Load Text
def text_objects(text, font):
    textSurface = font.render(text, True, black)
    return textSurface, textSurface.get_rect()

#Create Buttons(position, size, in/active color, click-function)
def button(msg,x,y,w,h,ic,ac,action=None):
    mouse = pygame.mouse.get_pos()
    click = pygame.mouse.get_pressed()

    if x+w > mouse[0] > x and y+h > mouse[1] > y:
        pygame.draw.rect(gameDisplay, ac,(x,y,w,h))
        if click[0] == 1 and action != None:
            action()

    else:
        pygame.draw.rect(gameDisplay, ic,(x,y,w,h))

    #Button Text
    smallText = pygame.font.SysFont("Arial.ttf",20)
    textSurf,textRect = text_objects(msg, smallText)
    textRect.center = ( (x+(w/2)), (y+(h/2)) )
    gameDisplay.blit(textSurf, textRect)


def neutral2pr():

    gameDisplay.fill(white)
    gameDisplay.blit(prState,(30,30))
    LargeText = pygame.font.SysFont('Arial.ttf',40)
    TextSurf, TextRect = text_objects("", LargeText)
    TextRect.center = ((display_width/2),(display_height/3))
    gameDisplay.blit(TextSurf, TextRect)

    while neutral2pr:
            for event in pygame.event.get():
                if event.type == pygame.QUIT:
```

```
                    pygame.quit()
                    quit()

            button("WEITER",150,615,100,50,green,bright_green, pr_state)
            #button("Quit!",150,500,100,50,red,bright_red,quit_game)

            pygame.display.update()
            clock.tick(15)

# ------------------------------------------------------------------------------

### Break - Prevention State ###

neutralpv = False

#Load Text
def text_objects(text, font):
    textSurface = font.render(text, True, black)
    return textSurface, textSurface.get_rect()

#Create Buttons(position, size, in/active color, click-function)
def button(msg,x,y,w,h,ic,ac,action=None):
    mouse = pygame.mouse.get_pos()
    click = pygame.mouse.get_pressed()

    if x+w > mouse[0] > x and y+h > mouse[1] > y:
        pygame.draw.rect(gameDisplay, ac,(x,y,w,h))
        if click[0] == 1 and action != None:
            action()

    else:
        pygame.draw.rect(gameDisplay, ic,(x,y,w,h))

    #Button Text
    smallText = pygame.font.SysFont("Arial.ttf",20)
    textSurf,textRect = text_objects(msg, smallText)
    textRect.center = ( (x+(w/2)), (y+(h/2)) )
    gameDisplay.blit(textSurf, textRect)


def neutral2pv():

    gameDisplay.fill(white)
    gameDisplay.blit(pvState,(30,30))
    LargeText = pygame.font.SysFont('Arial.ttf',40)
    TextSurf, TextRect = text_objects("", LargeText)
    TextRect.center = ((display_width/2),(display_height/3))
    gameDisplay.blit(TextSurf, TextRect)

    while neutral2pv:
            for event in pygame.event.get():
                if event.type == pygame.QUIT:
                    pygame.quit()
                    quit()

            button("WEITER",150,615,100,50,red,bright_red,pv_state)
            #button("Quit!",150,500,100,50,green,bright_green,quit_game)

            pygame.display.update()
            clock.tick(15)

# ------------------------------------------------------------------------------

### Break - Promotion Shift ###

shift2pr = False

#Load Text
def text_objects(text, font):
    textSurface = font.render(text, True, black)
    return textSurface, textSurface.get_rect()

#Create Buttons(position, size, in/active color, click-function)
def button(msg,x,y,w,h,ic,ac,action=None):
    mouse = pygame.mouse.get_pos()
```

```
    click = pygame.mouse.get_pressed()

    if x+w > mouse[0] > x and y+h > mouse[1] > y:
        pygame.draw.rect(gameDisplay, ac,(x,y,w,h))
        if click[0] == 1 and action != None:
            action()

    else:
        pygame.draw.rect(gameDisplay, ic,(x,y,w,h))

    #Button Text
    smallText = pygame.font.SysFont("Arial.ttf",20)
    textSurf,textRect = text_objects(msg, smallText)
    textRect.center = ((x+(w/2)), (y+(h/2)))
    gameDisplay.blit(textSurf, textRect)


def shift2pred():

    gameDisplay.fill(white)
    gameDisplay.blit(prShift,(30,30))
    LargeText = pygame.font.SysFont('Arial.ttf',65)
    TextSurf, TextRect = text_objects("", LargeText)
    TextRect.center = ((display_width/2),(display_height/3))
    gameDisplay.blit(TextSurf, TextRect)

    while shift2pr:
            for event in pygame.event.get():
                if event.type == pygame.QUIT:
                    pygame.quit()
                    quit()

            button("WEITER",150,615,100,50,green,bright_green, pr_shift_B)
            #button("Quit!",150,500,100,50,red,bright_red,quit_game)

            pygame.display.update()
            clock.tick(15)

# -------------------------------------------------------------------------------

### Break - Prevention Shift ###

shift2pv = False

#Load Text
def text_objects(text, font):
    textSurface = font.render(text, True, black)
    return textSurface, textSurface.get_rect()

#Create Buttons(position, size, in/active color, click-function)
def button(msg,x,y,w,h,ic,ac,action=None):
    mouse = pygame.mouse.get_pos()
    click = pygame.mouse.get_pressed()

    if x+w > mouse[0] > x and y+h > mouse[1] > y:
        pygame.draw.rect(gameDisplay, ac,(x,y,w,h))
        if click[0] == 1 and action != None:
            action()

    else:
        pygame.draw.rect(gameDisplay, ic,(x,y,w,h))

    #Button Text
    smallText = pygame.font.SysFont("Arial.ttf",20)
    textSurf,textRect = text_objects(msg, smallText)
    textRect.center = ( (x+(w/2)), (y+(h/2)) )
    gameDisplay.blit(textSurf, textRect)

def shift2pved():

    gameDisplay.fill(white)
    gameDisplay.blit(pvShift,(30,30))
    LargeText = pygame.font.SysFont('Arial.ttf',65)
    TextSurf, TextRect = text_objects("", LargeText)
    TextRect.center = ((display_width/2),(display_height/3))
```

```
    gameDisplay.blit(TextSurf, TextRect)

    while shift2pv:
            for event in pygame.event.get():
                if event.type == pygame.QUIT:
                    pygame.quit()
                    quit()

            button("WEITER",150,615,100,50,red,bright_red,pv_shift_B)
            #button("Quit!",150,500,100,50,green,bright_green,quit_game)

            pygame.display.update()
            clock.tick(15)

# ------------------------------------------------------------------------------

### Neutral Gamemode ###

def pr_neutral():

    global neutralpr
    global pause

    #Central bottom position of parImg
    x = (display_width * 0.45)
    y = (display_height * 0.9)
    x_change = 0

    #Attributes of falling objects
    noise_width = 50
    noise_height = 50
    noise_speed = 5
    noise_startx = random.randrange(0, display_width-noise_width)
    noise_starty = -600

    noise2_width = 50
    noise2_height = 50
    noise2_speed = 5
    noise2_startx = random.randrange(0, display_width-noise_width)
    noise2_starty = -800

    noise3_width = 50
    noise3_height = 50
    noise3_speed = 5
    noise3_startx = random.randrange(0, display_width-noise3_width)
    noise3_starty = -1000

    noise4_width = 50
    noise4_height = 50
    noise4_speed = 5
    noise4_startx = random.randrange(0, display_width-noise_width)
    noise4_starty = -1200

    #Define Max Speed
    max_speed1 = 10
    max_speed2 = 12
    max_speed3 = 14
    max_speed4 = 16

    Total = 0

    gameExit = False
    while not gameExit:

        for event in pygame.event.get():
            if event.type == pygame.QUIT:#Define Quit
                pygame.quit()
                quit()
            if event.type == pygame.KEYDOWN: #Pushing Keys
                if event.key == pygame.K_LEFT:
                    x_change = -10
                if event.key == pygame.K_RIGHT:
                    x_change = 10
                if event.key == pygame.K_p:
                    pause = True
```

```
                paused()
        if event.type == pygame.KEYUP: #Release Keys
            if event.key == pygame.K_LEFT or event.key == pygame.K_RIGHT:
                x_change = 0

    #calc position
    x += x_change

    #Fill Background white
    gameDisplay.fill(white)

    #Load par
    par(x,y)

    #Load neutral objects
    noise(noise_startx, noise_starty, noise_width, noise_height, black)
    noise_starty += noise_speed

    noise2(noise2_startx, noise2_starty, noise_width, noise_height, black)
    noise2_starty += noise2_speed

    noise3(noise3_startx, noise3_starty, noise3_width, noise3_height, black)
    noise3_starty += noise3_speed

    noise4(noise4_startx, noise4_starty, noise4_width, noise4_height, black)
    noise4_starty += noise4_speed

    #Boundaries function
    if x > display_width - par_width or x < 0:
        x_change = 0


    #Noise1 Simulation
    if noise_starty > display_height: #Avoidance function
        noise_starty = 0 - noise_height
        noise_startx = random.randrange(0,display_width-noise_width)

    if y < noise_starty+noise_height: #Approach function

        if x + par_width > noise_startx and x < noise_startx + noise_width:
            noise_starty = 0 - noise_height
            noise_startx = random.randrange(0,display_width-noise_width)
            noise_speed = noise_speed + 0.25 if noise_speed < max_speed1 else noise_speed
            Total += 1

    #Noise2 Simulation
    if noise2_starty > display_height: #Avoidance function
        noise2_starty = 0 - noise_height
        noise2_startx = random.randrange(0,display_width-noise_width)

    if y < noise2_starty+noise_height: #Approach function

        if x + par_width > noise2_startx and x < noise2_startx + noise_width:
            noise2_starty = 0 - noise_height
            noise2_startx = random.randrange(0,display_width-noise_width)
            noise2_speed = noise2_speed + 0.5 if noise2_speed < max_speed2 else noise2_speed
            Total += 1

    #Noise3 Simulation
    if noise3_starty > display_height: #Avoidance function
        noise3_starty = 0 - noise_height
        noise3_startx = random.randrange(0,display_width-noise_width)
        noise3_speed = noise3_speed + 0.75 if noise3_speed < max_speed3 else noise3_speed
        Total += 1

    #Noise4 Simulation
    if noise4_starty > display_height: #Avoidance function
        noise4_starty = 0 - noise_height
        noise4_startx = random.randrange(0,display_width-noise_width)
        noise4_speed = noise4_speed + 1 if noise4_speed < max_speed4 else noise4_speed
        Total += 1


    #200 Items = 60 seconds
    if Total == 200:
```

```
            neutralpr = True
            neutral2pr()


        pygame.display.update()
        clock.tick(60) #Define the frames per second

# ------------------------------------------------------------------------------

### Neutral Gamemode ###

def pv_neutral():

    global neutralpv
    global pause

    #Central bottom position of parImg
    x = (display_width * 0.45)
    y = (display_height * 0.9)
    x_change = 0

    #Attributes of falling objects
    noise_width = 50
    noise_height = 50
    noise_speed = 5
    noise_startx = random.randrange(0, display_width-noise_width)
    noise_starty = -600

    noise2_width = 50
    noise2_height = 50
    noise2_speed = 5
    noise2_startx = random.randrange(0, display_width-noise_width)
    noise2_starty = -800

    noise3_width = 50
    noise3_height = 50
    noise3_speed = 5
    noise3_startx = random.randrange(0, display_width-noise3_width)
    noise3_starty = -1000

    noise4_width = 50
    noise4_height = 50
    noise4_speed = 5
    noise4_startx = random.randrange(0, display_width-noise_width)
    noise4_starty = -1200

    #Define Max Speed
    max_speed1 = 11
    max_speed2 = 13
    max_speed3 = 15
    max_speed4 = 17

    Total = 0

    gameExit = False
    while not gameExit:

        for event in pygame.event.get():
            if event.type == pygame.QUIT:#Define Quit
                pygame.quit()
                quit()
            if event.type == pygame.KEYDOWN: #Pushing Keys
                if event.key == pygame.K_LEFT:
                    x_change = -10
                if event.key == pygame.K_RIGHT:
                    x_change = 10
                if event.key == pygame.K_p:
                    pause = True
                    paused()
            if event.type == pygame.KEYUP: #Release Keys
                if event.key == pygame.K_LEFT or event.key == pygame.K_RIGHT:
                    x_change = 0

        #calc position
        x += x_change
```

```
        #Fill Background white
        gameDisplay.fill(white)

        #Load par
        par(x,y)

        #Load neutral objects
        noise(noise_startx, noise_starty, noise_width, noise_height, black)
        noise_starty += noise_speed

        noise2(noise2_startx, noise2_starty, noise_width, noise_height, black)
        noise2_starty += noise2_speed

        noise3(noise3_startx, noise3_starty, noise3_width, noise3_height, black)
        noise3_starty += noise3_speed

        noise4(noise4_startx, noise4_starty, noise4_width, noise4_height, black)
        noise4_starty += noise4_speed

        #Boundaries function
        if x > display_width - par_width or x < 0:
            x_change = 0


        #Noise1 Simulation
        if noise_starty > display_height: #Avoidance function
            noise_starty = 0 - noise_height
            noise_startx = random.randrange(0,display_width-noise_width)

        if y < noise_starty+noise_height: #Approach function

            if x + par_width > noise_startx and x < noise_startx + noise_width:
                noise_starty = 0 - noise_height
                noise_startx = random.randrange(0,display_width-noise_width)
                noise_speed = noise_speed + 0.25 if noise_speed < max_speed1 else noise_speed
                Total += 1

        #Noise2 Simulation
        if noise2_starty > display_height: #Avoidance function
            noise2_starty = 0 - noise_height
            noise2_startx = random.randrange(0,display_width-noise_width)

        if y < noise2_starty+noise_height: #Approach function

            if x + par_width > noise2_startx and x < noise2_startx + noise_width:
                noise2_starty = 0 - noise_height
                noise2_startx = random.randrange(0,display_width-noise_width)
                noise2_speed = noise2_speed + 0.5 if noise2_speed < max_speed2 else noise2_speed
                Total += 1

        #Noise3 Simulation
        if noise3_starty > display_height: #Avoidance function
            noise3_starty = 0 - noise_height
            noise3_startx = random.randrange(0,display_width-noise_width)
            noise3_speed = noise3_speed + 0.75 if noise3_speed < max_speed3 else noise3_speed
            Total += 1

        #Noise4 Simulation
        if noise4_starty > display_height: #Avoidance function
            noise4_starty = 0 - noise_height
            noise4_startx = random.randrange(0,display_width-noise_width)
            noise4_speed = noise4_speed + 1 if noise4_speed < max_speed4 else noise4_speed
            Total += 1


        #200 Items = 60 seconds
        if Total == 200:
            neutralpv = True
            neutral2pv()


        pygame.display.update()
        clock.tick(60) #Define the frames per second
# ---------------------------------------------------------------------------
```

```
### Promotion State ###

def pr_state():

    global pause

    #Central bottom position of parImg
    x = (display_width * 0.45)
    y = (display_height * 0.9)
    x_change = 0

    #Attributes of falling objects
    pr1_speed = 5
    pr1_startx = random.randrange(0, display_width-pr_width)
    pr1_starty = -600

    pr2_speed = 5
    pr2_startx = random.randrange(0, display_width-pr_width)
    pr2_starty = -800

    pr3_speed = 5
    pr3_startx = random.randrange(0, display_width-pr_width)
    pr3_starty = -1000

    pr4_speed = 5
    pr4_startx = random.randrange(0, display_width-pr_width)
    pr4_starty = -1200

    noise_width = 50
    noise_height = 50
    noise_speed = 5
    noise_startx = random.randrange(0, display_width-noise_width)
    noise_starty = -1100

    noise2_width = 50
    noise2_height = 50
    noise2_speed = 5
    noise2_startx = random.randrange(0, display_width-noise_width)
    noise2_starty = -1300

    #Counter variables
    Group = 1
    Loss = 0
    Gain = 0
    FA   = 0
    CR   = 0
    Total = 0

    #Define Max Speed
    max_speed1 = 8
    max_speed2 = 10
    max_speed3 = 12
    max_speed4 = 14

    gameExit = False
    while not gameExit:

        for event in pygame.event.get():
            if event.type == pygame.QUIT:#Define Quit
                pygame.quit()
                quit()
            if event.type == pygame.KEYDOWN: #Pushing Keys
                if event.key == pygame.K_LEFT:
                    x_change = -10
                if event.key == pygame.K_RIGHT:
                    x_change = 10
                if event.key == pygame.K_p:
                    pause = True
                    paused()
            if event.type == pygame.KEYUP: #Release Keys
                if event.key == pygame.K_LEFT or event.key == pygame.K_RIGHT:
                    x_change = 0

        #calc position
        x += x_change
```

```
#Fill Background white
gameDisplay.fill(white)

#Load par
par(x,y)

#Load Promotion objects
pr1(pr1_startx, pr1_starty)
pr1_starty += pr1_speed

pr2(pr2_startx, pr2_starty)
pr2_starty += pr2_speed

pr3(pr3_startx, pr3_starty)
pr3_starty += pr3_speed

pr4(pr4_startx, pr4_starty)
pr4_starty += pr4_speed

#Load neutral objects
noise(noise_startx, noise_starty, noise_width, noise_height, black)
noise_starty += noise_speed

noise2(noise2_startx, noise2_starty, noise_width, noise_height, black)
noise2_starty += noise2_speed

#Display counters
gain_count(Gain)
#ngain_count(Loss)
#falsealert_count(FA)
#correject_count(CR)

#Boundaries function
if x > display_width - par_width or x < 0:
    x_change = 0

#PR1 Catch & Avoidance
if pr1_starty > display_height: #Avoidance function (loop falling and count)
    pr1_starty = 0 - pr_height
    pr1_startx = random.randrange(0,display_width-pr_width)
    Loss += 1
    Total += 1

if y < pr1_starty+pr_height: #Approach function

    if x + par_width > pr1_startx and x < pr1_startx + pr_width:
        pr1_starty = 0 - pr_height
        pr1_startx = random.randrange(0,display_width-pr_width)
        pr1_speed = pr1_speed + 0.25 if pr1_speed < max_speed1 else pr1_speed
        Gain += 1
        Total += 1

#PR2 Catch & Avoidance
if pr2_starty > display_height: #Avoidance function (loop falling and count)
    pr2_starty = 0 - pr_height
    pr2_startx = random.randrange(0,display_width-pr_width)
    Loss += 1
    Total += 1

if y < pr2_starty+pr_height: #Approach function

    if x + par_width > pr2_startx and x < pr2_startx + pr_width:
        pr2_starty = 0 - pr_height
        pr2_startx = random.randrange(0,display_width-pr_width)
        pr2_speed = pr2_speed + 0.5 if pr2_speed < max_speed2 else pr2_speed
        Gain += 1
        Total += 1


#PR3 Catch & Avoidance
if pr3_starty > display_height: #Avoidance function (loop falling and count)
    pr3_starty = 0 - pr_height
    pr3_startx = random.randrange(0,display_width-pr_width)
    Loss += 1
```

```
            Total += 1

        if y < pr3_starty+pr_height: #Approach function

            if x + par_width > pr3_startx and x < pr3_startx + pr_width:
                pr3_starty = 0 - pr_height
                pr3_startx = random.randrange(0,display_width-pr_width)
                pr3_speed = pr3_speed + 0.75 if pr3_speed < max_speed3 else pr3_speed
                Gain += 1
                Total += 1

        #PR4 Catch & Avoidance
        if pr4_starty > display_height: #Avoidance function
            pr4_starty = 0 - pr_height
            pr4_startx = random.randrange(0,display_width-pr_width)
            Loss += 1
            Total += 1

        if y < pr4_starty+pr_height: #Approach function

            if x + par_width > pr4_startx and x < pr4_startx + pr_width:
                pr4_starty = 0 - pr_height
                pr4_startx = random.randrange(0,display_width-pr_width)
                pr4_speed = pr4_speed + 0.75 if pr4_speed < max_speed4 else pr4_speed
                Gain += 1
                Total += 1

        #Noise1 False Alerts & Correct Rejections
        if noise_starty > display_height: #Avoidance function
            noise_starty = 0 - noise_height
            noise_startx = random.randrange(0,display_width-noise_width)
            noise_speed = pr4_speed
            CR += 1

        if y < noise_starty+noise_height: #Approach function

            if x + par_width > noise_startx and x < noise_startx + noise_width:
                noise_starty = 0 - noise_height
                noise_startx = random.randrange(0,display_width-noise_width)
                noise_speed = pr4_speed
                FA += 1

        #Noise2 False Alerts & Correct Rejections
        if noise2_starty > display_height: #Avoidance function
            noise2_starty = 0 - noise_height
            noise2_startx = random.randrange(0,display_width-noise_width)
            noise2_speed = pr4_speed
            CR += 1

        if y < noise2_starty+noise_height: #Approach function

            if x + par_width > noise2_startx and x < noise2_startx + noise_width:
                noise2_starty = 0 - noise_height
                noise2_startx = random.randrange(0,display_width-noise_width)
                noise_speed = pr4_speed
                FA += 1

        #200 Items = 60 seconds
        if Total == 200:
            dataHandler.add_data("pr_state",[Gain, Loss, FA, CR])
            over = True
            game_over()


        pygame.display.update()
        clock.tick(60) #Define the frames per second

# ------------------------------------------------------------------------------

### Prevention State ###

def pv_state():

    global pause
```

```
    #Central bottom position of parImg
    x = (display_width * 0.45)
    y = (display_height * 0.9)
    x_change = 0

    #Attributes of falling prevention objects
    pv1_speed = 5
    pv1_startx = random.randrange(0, display_width-pv_width)
    pv1_starty = -600

    pv2_speed = 5
    pv2_startx = random.randrange(0, display_width-pv_width)
    pv2_starty = -800

    pv3_speed = 5
    pv3_startx = random.randrange(0, display_width-pv_width)
    pv3_starty = -1000

    pv4_speed = 5
    pv4_startx = random.randrange(0, display_width-pv_width)
    pv4_starty = -1200

    noise_width = 50
    noise_height = 50
    noise_speed = 5
    noise_startx = random.randrange(0, display_width-noise_width)
    noise_starty = -1100

    noise2_width = 50
    noise2_height = 50
    noise2_speed = 5
    noise2_startx = random.randrange(0, display_width-noise_width)
    noise2_starty = -1300

    #Counter variables
    Group = 2
    Loss = 0
    Gain = 0
    FA   = 0
    CR   = 0
    Total = 0
    Test = 1

    #Define Max Speed
    max_speed1 = 14
    max_speed2 = 16
    max_speed3 = 18
    max_speed4 = 20

    gameExit = False
    while not gameExit:

        for event in pygame.event.get():
            if event.type == pygame.QUIT:#Define Quit
                pygame.quit()
                quit()
            if event.type == pygame.KEYDOWN: #Pushing Keys
                if event.key == pygame.K_LEFT:
                    x_change = -10
                if event.key == pygame.K_RIGHT:
                    x_change = 10
                if event.key == pygame.K_p:
                    pause = True
                    paused()
            if event.type == pygame.KEYUP: #Release Keys
                if event.key == pygame.K_LEFT or event.key == pygame.K_RIGHT:
                    x_change = 0

        #calc position
        x += x_change

        #Fill Background white
        gameDisplay.fill(white)

        #Load Participant object
```

```
par(x,y)

#Load Prevention objects(noisex, noisey, noisew, noiseh)
pv1(pv1_startx, pv1_starty)
pv1_starty += pv1_speed

pv2(pv2_startx, pv2_starty)
pv2_starty += pv2_speed

pv3(pv3_startx, pv3_starty)
pv3_starty += pv3_speed

pv4(pv4_startx, pv4_starty)
pv4_starty += pv4_speed

#Load neutral objects
noise(noise_startx, noise_starty, noise_width, noise_height, black)
noise_starty += noise_speed

noise2(noise2_startx, noise2_starty, noise_width, noise_height, black)
noise2_starty += noise2_speed

#Display counters
loss_count(Loss)
#nloss_count(Gain)
#falsealert_count(FA)
#correject_count(CR)

if x > display_width - par_width or x < 0: #Boundaries function
    x_change = 0

#PV1 Catch & Avoidance
if pv1_starty > display_height: #Avoidance function (loop falling and count)
    pv1_starty = 0 - pv_height
    pv1_startx = random.randrange(0,display_width-pv_width)
    pv1_speed = pv1_speed + 0.25 if pv1_speed < max_speed1 else pv1_speed
    Gain += 1
    Total += 1


if y < pv1_starty+pv_height: #Approach function

    if x + par_width > pv1_startx and x < pv1_startx + pv_width:
        pv1_starty = 0 - pv_height
        pv1_startx = random.randrange(0,display_width-pv_width)
        Loss += 1
        Total += 1

#PV2 Catch & Avoidance
if pv2_starty > display_height: #Avoidance function (loop falling and count)
    pv2_starty = 0 - pv_height
    pv2_startx = random.randrange(0,display_width-pv_width)
    pv2_speed = pv2_speed + 0.5 if pv2_speed < max_speed2 else pv2_speed
    Gain += 1
    Total += 1

if y < pv2_starty+pv_height: #Approach function

    if x + par_width > pv2_startx and x < pv2_startx + pv_width:
        pv2_starty = 0 - pv_height
        pv2_startx = random.randrange(0,display_width-pv_width)
        Loss += 1
        Total += 1

#PV3 Catch & Avoidance
if pv3_starty > display_height: #Avoidance function (loop falling and count)
    pv3_starty = 0 - pv_height
    pv3_startx = random.randrange(0,display_width-pv_width)
    pv3_speed = pv3_speed + 0.75 if pv3_speed < max_speed3 else pv3_speed
    Gain += 1
    Total += 1


if y < pv3_starty+pv_height: #Approach function
```

```
            if x + par_width > pv3_startx and x < pv3_startx + pv_width:
                pv3_starty = 0 - pv_height
                pv3_startx = random.randrange(0,display_width-pv_width)
                Loss += 1
                Total += 1

        #PV4 Catch & Avoidance
        if pv4_starty > display_height: #Avoidance function (loop falling and count)
            pv4_starty = 0 - pv_height
            pv4_startx = random.randrange(0,display_width-pv_width)
            pv4_speed = pv4_speed + 0.75 if pv4_speed < max_speed4 else pv4_speed
            Gain += 1
            Total += 1

        if y < pv4_starty+pv_height: #Approach function

            if x + par_width > pv4_startx and x < pv4_startx + pv_width:
                pv4_starty = 0 - pv_height
                pv4_startx = random.randrange(0,display_width-pv_width)
                Loss += 1
                Total += 1

        #Noise1 False Alerts & Correct Rejections
        if noise_starty > display_height: #Avoidance function
            noise_starty = 0 - noise_height
            noise_startx = random.randrange(0,display_width-noise_width)
            noise_speed = pv4_speed
            CR += 1

        if y < noise_starty+noise_height: #Approach function

            if x + par_width > noise_startx and x < noise_startx + noise_width:
                noise_starty = 0 - noise_height
                noise_startx = random.randrange(0,display_width-noise_width)
                noise_speed = pv4_speed
                FA += 1

        #Noise2 False Alerts & Correct Rejections
        if noise2_starty > display_height: #Avoidance function
            noise2_starty = 0 - noise_height
            noise2_startx = random.randrange(0,display_width-noise_width)
            noise2_speed = pv4_speed
            CR += 1

        if y < noise2_starty+noise_height: #Approach function

            if x + par_width > noise2_startx and x < noise2_startx + noise_width:
                noise2_starty = 0 - noise_height
                noise2_startx = random.randrange(0,display_width-noise_width)
                noise_speed = pv4_speed
                FA += 1

        #200 Items = 60 seconds
        if Total == 200:
            dataHandler.add_data("pv_state",[Gain, Loss, FA, CR])
            over = True
            game_over()

        pygame.display.update()
        clock.tick(60) #Define the frames per second

# ------------------------------------------------------------------------------

### Prevention Start to Promotion Shift ###

def pr_shift_A():

    global shift2pr
    global pause

    #Central bottom position of parImg
    x = (display_width * 0.45)
    y = (display_height * 0.9)
    x_change = 0
```

```
#Attributes of falling prevention objects
pv1_speed = 5
pv1_startx = random.randrange(0, display_width-pv_width)
pv1_starty = -600

pv2_speed = 5
pv2_startx = random.randrange(0, display_width-pv_width)
pv2_starty = -800

pv3_speed = 5
pv3_startx = random.randrange(0, display_width-pv_width)
pv3_starty = -1000

pv4_speed = 5
pv4_startx = random.randrange(0, display_width-pv_width)
pv4_starty = -1200

noise_width = 50
noise_height = 50
noise_speed = 5
noise_startx = random.randrange(0, display_width-noise_width)
noise_starty = -1100

noise2_width = 50
noise2_height = 50
noise2_speed = 5
noise2_startx = random.randrange(0, display_width-noise_width)
noise2_starty = -1300

#Counter variables
Group = '3a'
Loss = 0
Gain = 0
FA   = 0
CR   = 0
Total = 0

#Define Max Speed
max_speed1 = 14
max_speed2 = 16
max_speed3 = 18
max_speed4 = 20

gameExit = False
while not gameExit:

    for event in pygame.event.get():
        if event.type == pygame.QUIT:#Define Quit
            pygame.quit()
            quit()
        if event.type == pygame.KEYDOWN: #Pushing Keys
            if event.key == pygame.K_LEFT:
                x_change = -10
            if event.key == pygame.K_RIGHT:
                x_change = 10
            if event.key == pygame.K_p:
                pause = True
                paused()
        if event.type == pygame.KEYUP: #Release Keys
            if event.key == pygame.K_LEFT or event.key == pygame.K_RIGHT:
                x_change = 0

    #calc position
    x += x_change

    #Fill Background white
    gameDisplay.fill(white)

    #Load Participant object
    par(x,y)

    #Load Prevention objects(noisex, noisey, noisew, noiseh)
    pv1(pv1_startx, pv1_starty)
    pv1_starty += pv1_speed
```

```
pv2(pv2_startx, pv2_starty)
pv2_starty += pv2_speed

pv3(pv3_startx, pv3_starty)
pv3_starty += pv3_speed

pv4(pv4_startx, pv4_starty)
pv4_starty += pv4_speed

#Load neutral objects
noise(noise_startx, noise_starty, noise_width, noise_height, black)
noise_starty += noise_speed

noise2(noise2_startx, noise2_starty, noise_width, noise_height, black)
noise2_starty += noise2_speed

#Display counters
loss_count(Loss)
#nloss_count(Gain)
#falsealert_count(FA)
#correject_count(CR)

if x > display_width - par_width or x < 0: #Boundaries function
    x_change = 0

#PV1 Catch & Avoidance
if pv1_starty > display_height: #Avoidance function (loop falling and count)
    pv1_starty = 0 - pv_height
    pv1_startx = random.randrange(0,display_width-pv_width)
    pv1_speed = pv1_speed + 0.25 if pv1_speed < max_speed1 else pv1_speed
    Gain += 1
    Total += 1


if y < pv1_starty+pv_height: #Approach function

    if x + par_width > pv1_startx and x < pv1_startx + pv_width:
        pv1_starty = 0 - pv_height
        pv1_startx = random.randrange(0,display_width-pv_width)
        Loss += 1
        Total += 1

#PV2 Catch & Avoidance
if pv2_starty > display_height: #Avoidance function (loop falling and count)
    pv2_starty = 0 - pv_height
    pv2_startx = random.randrange(0,display_width-pv_width)
    pv2_speed = pv2_speed + 0.5 if pv2_speed < max_speed2 else pv2_speed
    Gain += 1
    Total += 1

if y < pv2_starty+pv_height: #Approach function

    if x + par_width > pv2_startx and x < pv2_startx + pv_width:
        pv2_starty = 0 - pv_height
        pv2_startx = random.randrange(0,display_width-pv_width)
        Loss += 1
        Total += 1

#PV3 Catch & Avoidance
if pv3_starty > display_height: #Avoidance function (loop falling and count)
    pv3_starty = 0 - pv_height
    pv3_startx = random.randrange(0,display_width-pv_width)
    pv3_speed = pv3_speed + 0.75 if pv3_speed < max_speed3 else pv3_speed
    Gain += 1
    Total += 1


if y < pv3_starty+pv_height: #Approach function

    if x + par_width > pv3_startx and x < pv3_startx + pv_width:
        pv3_starty = 0 - pv_height
        pv3_startx = random.randrange(0,display_width-pv_width)
        Loss += 1
        Total += 1
```

```
        #PV4 Catch & Avoidance
        if pv4_starty > display_height: #Avoidance function (loop falling and count)
            pv4_starty = 0 - pv_height
            pv4_startx = random.randrange(0,display_width-pv_width)
            pv4_speed = pv4_speed + 0.75 if pv4_speed < max_speed4 else pv4_speed
            Gain += 1
            Total += 1

        if y < pv4_starty+pv_height: #Approach function

            if x + par_width > pv4_startx and x < pv4_startx + pv_width:
                pv4_starty = 0 - pv_height
                pv4_startx = random.randrange(0,display_width-pv_width)
                Loss += 1
                Total += 1

        #Noise1 False Alerts & Correct Rejections
        if noise_starty > display_height: #Avoidance function
            noise_starty = 0 - noise_height
            noise_startx = random.randrange(0,display_width-noise_width)
            noise_speed = pv4_speed
            CR += 1

        if y < noise_starty+noise_height: #Approach function

            if x + par_width > noise_startx and x < noise_startx + noise_width:
                noise_starty = 0 - noise_height
                noise_startx = random.randrange(0,display_width-noise_width)
                noise_speed = pv4_speed
                FA += 1

        #Noise2 False Alerts & Correct Rejections
        if noise2_starty > display_height: #Avoidance function
            noise2_starty = 0 - noise_height
            noise2_startx = random.randrange(0,display_width-noise_width)
            noise2_speed = pv4_speed
            CR += 1

        if y < noise2_starty+noise_height: #Approach function

            if x + par_width > noise2_startx and x < noise2_startx + noise_width:
                noise2_starty = 0 - noise_height
                noise2_startx = random.randrange(0,display_width-noise_width)
                noise_speed = pv4_speed
                FA += 1

        #200 Items = 60 seconds
        if Total == 200:
            dataHandler.add_data("pr_shift_a",[Gain, Loss, FA, CR])
            shift2pr = True
            shift2pred()

        pygame.display.update()
        clock.tick(60) #Define the frames per second

# ------------------------------------------------------------------------------

### Promotion Shift ###

def pr_shift_B():

    global pause

    #Central bottom position of parImg
    x = (display_width * 0.45)
    y = (display_height * 0.9)
    x_change = 0

    #Attributes of falling objects
    pr1_speed = 5
    pr1_startx = random.randrange(0, display_width-pr_width)
    pr1_starty = -600

    pr2_speed = 5
    pr2_startx = random.randrange(0, display_width-pr_width)
```

```
pr2_starty = -800

pr3_speed = 5
pr3_startx = random.randrange(0, display_width-pr_width)
pr3_starty = -1000

pr4_speed = 5
pr4_startx = random.randrange(0, display_width-pr_width)
pr4_starty = -1200

noise_width = 50
noise_height = 50
noise_speed = 5
noise_startx = random.randrange(0, display_width-noise_width)
noise_starty = -1100

noise2_width = 50
noise2_height = 50
noise2_speed = 5
noise2_startx = random.randrange(0, display_width-noise_width)
noise2_starty = -1300

#Counter variables
Group = '3b'
Loss = 0
Gain = 0
FA   = 0
CR   = 0
Total = 0

#Define Max Speed
max_speed1 = 8
max_speed2 = 10
max_speed3 = 12
max_speed4 = 14

gameExit = False
while not gameExit:

    for event in pygame.event.get():
        if event.type == pygame.QUIT:#Define Quit
            pygame.quit()
            quit()
        if event.type == pygame.KEYDOWN: #Pushing Keys
            if event.key == pygame.K_LEFT:
                x_change = -10
            if event.key == pygame.K_RIGHT:
                x_change = 10
            if event.key == pygame.K_p:
                pause = True
                paused()
        if event.type == pygame.KEYUP: #Release Keys
            if event.key == pygame.K_LEFT or event.key == pygame.K_RIGHT:
                x_change = 0

    #calc position
    x += x_change

    #Fill Background white
    gameDisplay.fill(white)

    #Load par
    par(x,y)

    #Load Promotion objects
    pr1(pr1_startx, pr1_starty)
    pr1_starty += pr1_speed

    pr2(pr2_startx, pr2_starty)
    pr2_starty += pr2_speed

    pr3(pr3_startx, pr3_starty)
    pr3_starty += pr3_speed

    pr4(pr4_startx, pr4_starty)
```

```
pr4_starty += pr4_speed

#Load neutral objects
noise(noise_startx, noise_starty, noise_width, noise_height, black)
noise_starty += noise_speed

noise2(noise2_startx, noise2_starty, noise_width, noise_height, black)
noise2_starty += noise2_speed

#Load counters
gain_count(Gain)
#ngain_count(Loss)
#falsealert_count(FA)
#correject_count(CR)

#Boundaries function
if x > display_width - par_width or x < 0:
    x_change = 0

#PR1 Catch & Avoidance
if pr1_starty > display_height: #Avoidance function (loop falling and count)
    pr1_starty = 0 - pr_height
    pr1_startx = random.randrange(0,display_width-pr_width)
    Loss += 1
    Total += 1

if y < pr1_starty+pr_height: #Approach function

    if x + par_width > pr1_startx and x < pr1_startx + pr_width:
        pr1_starty = 0 - pr_height
        pr1_startx = random.randrange(0,display_width-pr_width)
        pr1_speed = pr1_speed + 0.25 if pr1_speed < max_speed1 else pr1_speed
        Gain += 1
        Total += 1

#PR2 Catch & Avoidance
if pr2_starty > display_height: #Avoidance function (loop falling and count)
    pr2_starty = 0 - pr_height
    pr2_startx = random.randrange(0,display_width-pr_width)
    Loss += 1
    Total += 1

if y < pr2_starty+pr_height: #Approach function

    if x + par_width > pr2_startx and x < pr2_startx + pr_width:
        pr2_starty = 0 - pr_height
        pr2_startx = random.randrange(0,display_width-pr_width)
        pr2_speed = pr2_speed + 0.5 if pr2_speed < max_speed2 else pr2_speed
        Gain += 1
        Total += 1


#PR3 Catch & Avoidance
if pr3_starty > display_height: #Avoidance function (loop falling and count)
    pr3_starty = 0 - pr_height
    pr3_startx = random.randrange(0,display_width-pr_width)
    Loss += 1
    Total += 1

if y < pr3_starty+pr_height: #Approach function

    if x + par_width > pr3_startx and x < pr3_startx + pr_width:
        pr3_starty = 0 - pr_height
        pr3_startx = random.randrange(0,display_width-pr_width)
        pr3_speed = pr3_speed + 0.75 if pr3_speed < max_speed3 else pr3_speed
        Gain += 1
        Total += 1

#PR4 Catch & Avoidance
if pr4_starty > display_height: #Avoidance function
    pr4_starty = 0 - pr_height
    pr4_startx = random.randrange(0,display_width-pr_width)
    Loss += 1
    Total += 1
```

```
        if y < pr4_starty+pr_height: #Approach function

            if x + par_width > pr4_startx and x < pr4_startx + pr_width:
                pr4_starty = 0 - pr_height
                pr4_startx = random.randrange(0,display_width-pr_width)
                pr4_speed = pr4_speed + 0.75 if pr4_speed < max_speed4 else pr4_speed
                Gain += 1
                Total += 1

        #Noise1 False Alerts & Correct Rejections
        if noise_starty > display_height: #Avoidance function
            noise_starty = 0 - noise_height
            noise_startx = random.randrange(0,display_width-noise_width)
            noise_speed = pr4_speed
            CR += 1

        if y < noise_starty+noise_height: #Approach function

            if x + par_width > noise_startx and x < noise_startx + noise_width:
                noise_starty = 0 - noise_height
                noise_startx = random.randrange(0,display_width-noise_width)
                noise_speed = pr4_speed
                FA += 1

        #Noise2 False Alerts & Correct Rejections
        if noise2_starty > display_height: #Avoidance function
            noise2_starty = 0 - noise_height
            noise2_startx = random.randrange(0,display_width-noise_width)
            noise2_speed = pr4_speed
            CR += 1

        if y < noise2_starty+noise_height: #Approach function

            if x + par_width > noise2_startx and x < noise2_startx + noise_width:
                noise2_starty = 0 - noise_height
                noise2_startx = random.randrange(0,display_width-noise_width)
                noise_speed = pr4_speed
                FA += 1

        #200 Items = 60 seconds
        if Total == 200:
            dataHandler.add_data("pr_shift_b",[Gain, Loss, FA, CR])
            over = True
            game_over()


        pygame.display.update()
        clock.tick(60) #Define the frames per second

# ----------------------------------------------------------------------------

### Promotion Start to Prevention Shift ###

def pv_shift_A():

    global shift2pv
    global pause

    #Central bottom position of parImg
    x = (display_width * 0.45)
    y = (display_height * 0.9)
    x_change = 0

    #Attributes of falling objects
    pr1_speed = 5
    pr1_startx = random.randrange(0, display_width-pr_width)
    pr1_starty = -600

    pr2_speed = 5
    pr2_startx = random.randrange(0, display_width-pr_width)
    pr2_starty = -800

    pr3_speed = 5
    pr3_startx = random.randrange(0, display_width-pr_width)
    pr3_starty = -1000
```

```
pr4_speed = 5
pr4_startx = random.randrange(0, display_width-pr_width)
pr4_starty = -1200

noise_width = 50
noise_height = 50
noise_speed = 5
noise_startx = random.randrange(0, display_width-noise_width)
noise_starty = -1100

noise2_width = 50
noise2_height = 50
noise2_speed = 5
noise2_startx = random.randrange(0, display_width-noise_width)
noise2_starty = -1300

#Counter variables
Group = '4a'
Loss = 0
Gain = 0
FA   = 0
CR   = 0
Total = 0

#Define Max Speed
max_speed1 = 8
max_speed2 = 10
max_speed3 = 12
max_speed4 = 14

gameExit = False
while not gameExit:

    for event in pygame.event.get():
        if event.type == pygame.QUIT:#Define Quit
            pygame.quit()
            quit()
        if event.type == pygame.KEYDOWN: #Pushing Keys
            if event.key == pygame.K_LEFT:
                x_change = -10
            if event.key == pygame.K_RIGHT:
                x_change = 10
            if event.key == pygame.K_p:
                pause = True
                paused()
        if event.type == pygame.KEYUP: #Release Keys
            if event.key == pygame.K_LEFT or event.key == pygame.K_RIGHT:
                x_change = 0

    #calc position
    x += x_change

    #Fill Background white
    gameDisplay.fill(white)

    #Load par
    par(x,y)

    #Load Promotion objects
    pr1(pr1_startx, pr1_starty)
    pr1_starty += pr1_speed

    pr2(pr2_startx, pr2_starty)
    pr2_starty += pr2_speed

    pr3(pr3_startx, pr3_starty)
    pr3_starty += pr3_speed

    pr4(pr4_startx, pr4_starty)
    pr4_starty += pr4_speed

    #Load neutral objects
    noise(noise_startx, noise_starty, noise_width, noise_height, black)
    noise_starty += noise_speed
```

```
noise2(noise2_startx, noise2_starty, noise_width, noise_height, black)
noise2_starty += noise2_speed

#Display counters
gain_count(Gain)
#ngain_count(Loss)
#falsealert_count(FA)
#correject_count(CR)

#Boundaries function
if x > display_width - par_width or x < 0:
    x_change = 0

#PR1 Catch & Avoidance
if pr1_starty > display_height: #Avoidance function (loop falling and count)
    pr1_starty = 0 - pr_height
    pr1_startx = random.randrange(0,display_width-pr_width)
    Loss += 1
    Total += 1

if y < pr1_starty+pr_height: #Approach function

    if x + par_width > pr1_startx and x < pr1_startx + pr_width:
        pr1_starty = 0 - pr_height
        pr1_startx = random.randrange(0,display_width-pr_width)
        pr1_speed = pr1_speed + 0.25 if pr1_speed < max_speed1 else pr1_speed
        Gain += 1
        Total += 1

#PR2 Catch & Avoidance
if pr2_starty > display_height: #Avoidance function (loop falling and count)
    pr2_starty = 0 - pr_height
    pr2_startx = random.randrange(0,display_width-pr_width)
    Loss += 1
    Total += 1

if y < pr2_starty+pr_height: #Approach function

    if x + par_width > pr2_startx and x < pr2_startx + pr_width:
        pr2_starty = 0 - pr_height
        pr2_startx = random.randrange(0,display_width-pr_width)
        pr2_speed = pr2_speed + 0.5 if pr2_speed < max_speed2 else pr2_speed
        Gain += 1
        Total += 1


#PR3 Catch & Avoidance
if pr3_starty > display_height: #Avoidance function (loop falling and count)
    pr3_starty = 0 - pr_height
    pr3_startx = random.randrange(0,display_width-pr_width)
    Loss += 1
    Total += 1

if y < pr3_starty+pr_height: #Approach function

    if x + par_width > pr3_startx and x < pr3_startx + pr_width:
        pr3_starty = 0 - pr_height
        pr3_startx = random.randrange(0,display_width-pr_width)
        pr3_speed = pr3_speed + 0.75 if pr3_speed < max_speed3 else pr3_speed
        Gain += 1
        Total += 1

#PR4 Catch & Avoidance
if pr4_starty > display_height: #Avoidance function
    pr4_starty = 0 - pr_height
    pr4_startx = random.randrange(0,display_width-pr_width)
    Loss += 1
    Total += 1

if y < pr4_starty+pr_height: #Approach function

    if x + par_width > pr4_startx and x < pr4_startx + pr_width:
        pr4_starty = 0 - pr_height
        pr4_startx = random.randrange(0,display_width-pr_width)
```

```
                pr4_speed = pr4_speed + 0.75 if pr4_speed < max_speed4 else pr4_speed
                Gain += 1
                Total += 1

        #Noise1 False Alerts & Correct Rejections
        if noise_starty > display_height: #Avoidance function
            noise_starty = 0 - noise_height
            noise_startx = random.randrange(0,display_width-noise_width)
            noise_speed = pr4_speed
            CR += 1

        if y < noise_starty+noise_height: #Approach function

            if x + par_width > noise_startx and x < noise_startx + noise_width:
                noise_starty = 0 - noise_height
                noise_startx = random.randrange(0,display_width-noise_width)
                noise_speed = pr4_speed
                FA += 1

        #Noise2 False Alerts & Correct Rejections
        if noise2_starty > display_height: #Avoidance function
            noise2_starty = 0 - noise_height
            noise2_startx = random.randrange(0,display_width-noise_width)
            noise2_speed = pr4_speed
            CR += 1

        if y < noise2_starty+noise_height: #Approach function

            if x + par_width > noise2_startx and x < noise2_startx + noise_width:
                noise2_starty = 0 - noise_height
                noise2_startx = random.randrange(0,display_width-noise_width)
                noise_speed = pr4_speed
                FA += 1

        #200 Items = 60 seconds
        if Total == 200:
            dataHandler.add_data("pv_shift_a",[Gain, Loss, FA, CR])
            shift2pv = True
            shift2pved()


        pygame.display.update()
        clock.tick(60) #Define the frames per second

# ------------------------------------------------------------------------------
### Prevention Shift ###

def pv_shift_B():

    global pause

    #Central bottom position of parImg
    x = (display_width * 0.45)
    y = (display_height * 0.9)
    x_change = 0

    #Attributes of falling prevention objects
    pv1_speed = 5
    pv1_startx = random.randrange(0, display_width-pv_width)
    pv1_starty = -600

    pv2_speed = 5
    pv2_startx = random.randrange(0, display_width-pv_width)
    pv2_starty = -800

    pv3_speed = 5
    pv3_startx = random.randrange(0, display_width-pv_width)
    pv3_starty = -1000

    pv4_speed = 5
    pv4_startx = random.randrange(0, display_width-pv_width)
    pv4_starty = -1200

    noise_width = 50
    noise_height = 50
```

```
noise_speed = 5
noise_startx = random.randrange(0, display_width-noise_width)
noise_starty = -1100

noise2_width = 50
noise2_height = 50
noise2_speed = 5
noise2_startx = random.randrange(0, display_width-noise_width)
noise2_starty = -1300

#Counter variables
Group = '4b'
Loss = 0
Gain = 0
FA   = 0
CR   = 0
Total = 0


#Define Max Speed
max_speed1 = 14
max_speed2 = 16
max_speed3 = 18
max_speed4 = 20

gameExit = False
while not gameExit:

    for event in pygame.event.get():
        if event.type == pygame.QUIT:#Define Quit
            pygame.quit()
            quit()
        if event.type == pygame.KEYDOWN: #Pushing Keys
            if event.key == pygame.K_LEFT:
                x_change = -10
            if event.key == pygame.K_RIGHT:
                x_change = 10
            if event.key == pygame.K_p:
                pause = True
                paused()
        if event.type == pygame.KEYUP: #Release Keys
            if event.key == pygame.K_LEFT or event.key == pygame.K_RIGHT:
                x_change = 0

    #calc position
    x += x_change

    #Fill Background white
    gameDisplay.fill(white)

    #Load Participant object
    par(x,y)

    #Load Prevention objects(noisex, noisey, noisew, noiseh)
    pv1(pv1_startx, pv1_starty)
    pv1_starty += pv1_speed

    pv2(pv2_startx, pv2_starty)
    pv2_starty += pv2_speed

    pv3(pv3_startx, pv3_starty)
    pv3_starty += pv3_speed

    pv4(pv4_startx, pv4_starty)
    pv4_starty += pv4_speed

    #Load neutral objects
    noise(noise_startx, noise_starty, noise_width, noise_height, black)
    noise_starty += noise_speed

    noise2(noise2_startx, noise2_starty, noise_width, noise_height, black)
    noise2_starty += noise2_speed

    #Display counters
    loss_count(Loss)
```

```
#nloss_count(Gain)
#falsealert_count(FA)
#correject_count(CR)

if x > display_width - par_width or x < 0: #Boundaries function
    x_change = 0

#PV1 Catch & Avoidance
if pv1_starty > display_height: #Avoidance function (loop falling and count)
    pv1_starty = 0 - pv_height
    pv1_startx = random.randrange(0,display_width-pv_width)
    pv1_speed = pv1_speed + 0.25 if pv1_speed < max_speed1 else pv1_speed
    Gain += 1
    Total += 1


if y < pv1_starty+pv_height: #Approach function

    if x + par_width > pv1_startx and x < pv1_startx + pv_width:
        pv1_starty = 0 - pv_height
        pv1_startx = random.randrange(0,display_width-pv_width)
        Loss += 1
        Total += 1

#PV2 Catch & Avoidance
if pv2_starty > display_height: #Avoidance function (loop falling and count)
    pv2_starty = 0 - pv_height
    pv2_startx = random.randrange(0,display_width-pv_width)
    pv2_speed = pv2_speed + 0.5 if pv2_speed < max_speed2 else pv2_speed
    Gain += 1
    Total += 1

if y < pv2_starty+pv_height: #Approach function

    if x + par_width > pv2_startx and x < pv2_startx + pv_width:
        pv2_starty = 0 - pv_height
        pv2_startx = random.randrange(0,display_width-pv_width)
        Loss += 1
        Total += 1

#PV3 Catch & Avoidance
if pv3_starty > display_height: #Avoidance function (loop falling and count)
    pv3_starty = 0 - pv_height
    pv3_startx = random.randrange(0,display_width-pv_width)
    pv3_speed = pv3_speed + 0.75 if pv3_speed < max_speed3 else pv3_speed
    Gain += 1
    Total += 1


if y < pv3_starty+pv_height: #Approach function

    if x + par_width > pv3_startx and x < pv3_startx + pv_width:
        pv3_starty = 0 - pv_height
        pv3_startx = random.randrange(0,display_width-pv_width)
        Loss += 1
        Total += 1

#PV4 Catch & Avoidance
if pv4_starty > display_height: #Avoidance function (loop falling and count)
    pv4_starty = 0 - pv_height
    pv4_startx = random.randrange(0,display_width-pv_width)
    pv4_speed = pv4_speed + 0.75 if pv4_speed < max_speed4 else pv4_speed
    Gain += 1
    Total += 1

if y < pv4_starty+pv_height: #Approach function

    if x + par_width > pv4_startx and x < pv4_startx + pv_width:
        pv4_starty = 0 - pv_height
        pv4_startx = random.randrange(0,display_width-pv_width)
        Loss += 1
        Total += 1

#Noise1 False Alerts & Correct Rejections
if noise_starty > display_height: #Avoidance function
```

```
            noise_starty = 0 - noise_height
            noise_startx = random.randrange(0,display_width-noise_width)
            noise_speed = pv4_speed
            CR += 1

        if y < noise_starty+noise_height: #Approach function

            if x + par_width > noise_startx and x < noise_startx + noise_width:
                noise_starty = 0 - noise_height
                noise_startx = random.randrange(0,display_width-noise_width)
                noise_speed = pv4_speed
                FA += 1

        #Noise2 False Alerts & Correct Rejections
        if noise2_starty > display_height: #Avoidance function
            noise2_starty = 0 - noise_height
            noise2_startx = random.randrange(0,display_width-noise_width)
            noise2_speed = pv4_speed
            CR += 1

        if y < noise2_starty+noise_height: #Approach function

            if x + par_width > noise2_startx and x < noise2_startx + noise_width:
                noise2_starty = 0 - noise_height
                noise2_startx = random.randrange(0,display_width-noise_width)
                noise_speed = pv4_speed
                FA += 1

        #200 Items = 60 seconds
        if Total == 200:
            dataHandler.add_data("pv_shift_b",[Gain, Loss, FA, CR])
            over = True
            game_over()

        pygame.display.update()
        clock.tick(60) #Define the frames per second

# ---------------------------------------------------------------------------

### Run Application ###

def run_experiment():
    game_intro()

if __name__ == "__main__":

    # First we need show instructions
    state = show_instructions()
    # Then we collect bio data and write to handler
    collect_bio_data(dataHandler)
    # Then we run experiment
    run_experiment()
```

Data handler:

```
#!/usr/bin/env python3

from datetime import datetime
from collections import OrderedDict
import os

class DataHandler:
	def __init__(self):
		self.part_data = {
			"bio": OrderedDict(
				[("id", ""),
				("age", ""),
				("gender", ""),
				("language", ""),
				("job", ""),
				("major", "")
				])
				,
			"covariates": OrderedDict(
				[('mood', None),
				 ('arousal', None),
				 ('ideas', None),
				 ('n_ideas', None)
				 ]),
			"data": OrderedDict(
				[("pr_state_gain", None),
				("pv_state_gain", None),
				("pr_shift_b_gain", None),
				("pv_shift_b_gain", None),
				("pr_shift_a_gain", None),
				("pv_shift_a_gain", None),

				("pr_state_loss", None),
				("pv_state_loss", None),
				("pr_shift_b_loss", None),
				("pv_shift_b_loss", None),
				("pr_shift_a_loss", None),
				("pv_shift_a_loss", None),

				("pr_state_cr", None),
				("pv_state_cr", None),
				("pr_shift_b_cr", None),
				("pv_shift_b_cr", None),
				("pr_shift_a_cr", None),
				("pv_shift_a_cr", None),

				("pr_state_fa", None),
				("pv_state_fa", None),
				("pr_shift_b_fa", None),
				("pv_shift_b_fa", None),
				("pr_shift_a_fa", None),
				("pv_shift_a_fa", None),
				])}

	def get_score(self):
		"""Returns the points gained by the participant."""

		gains = ["pr_state_gain",
			 "pv_state_gain",
			 "pr_shift_b_gain",
			 "pv_shift_b_gain"]
		score = 0
		for g in gains:
			if self.part_data['data'][g] is not None:
				score += self.part_data['data'][g]
		return score / 100


	def add_data(self, block, data_list):
		#block = pr_state / pv_state / pr_shift / pv_shift
		for i, outcome in enumerate(["_gain","_loss", "_cr", "_fa"]):
			self.part_data["data"][block+outcome] = data_list[i]
```

```
def add_bio_field(self, key, val):
        """Adds a particular bio field. Called from Intro."""

        self.part_data['bio'][key] = val

def add_mankin_data(self, mood, arousal):
        """Adds the mood and arousal data from the last part."""

        self.part_data['covariates']['mood'] = mood
        self.part_data['covariates']['arousal'] = arousal

def add_ideas(self, ideas, n_ideas):
        """Adds all ideas as sentences and the total number of ideas."""

        self.part_data['covariates']['ideas'] = ideas
        self.part_data['covariates']['n_ideas'] = n_ideas


def save_to_file(self):
        path = os.path.dirname(os.path.abspath(__file__))
filename = self.part_data["bio"]["id"] + "_rf_drive_data" +
        datetime.now().strftime("%Y-%m-%d-%H-%M-%S") + ".txt"
        fullfile = os.path.join(path, "data", filename)

        with open(fullfile, "w") as f:
                f.write(";".join(self.part_data["bio"].keys()) + "\n")
                f.write(";".join(self.part_data["bio"].values()) + "\n")
                f.write(";".join(self.part_data["data"].keys()) + "\n")
                f.write(";".join(map(str, self.part_data["data"].values())) + "\n")

                #print(self.part_data['covariates'])
                f.write(";".join(self.part_data["covariates"].keys()) + "\n")
                f.write(";".join(self.part_data["covariates"].values()) + "\n")
```

Introduction handler (demographic data):

```
#!/usr/bin/env python3

import re
import tkinter as tk
from tkinter import ttk
from tkinter import font, TclError
from tkinter import messagebox as mbox


class Intro(tk.Frame):

    def __init__(self, root, dataHandler):
        super(Intro, self).__init__(root)

        # Store reference to root and initialize main members
        self._root = root
        self._dataHandler = dataHandler
        self._configureRoot()
        self._initWindow()

    def _configureRoot(self):
        """Sets style and geometry of root."""

        # Configure style
        self._root.style = ttk.Style()
        self._root.style.theme_use('clam')

    def _initWindow(self):
        """Initializes all components of the window."""
        # Show window
        self.pack(fill='both', expand=True)
        self.configure(background='black')

    def startExperiment(self):
        """Present instructions and starts the experiment."""

        # Ask for participant infos
        ParticipantInfoDialog(self._root, self._dataHandler)


class SmartEntry(tk.Entry):
    """A very simple entry extension to hold participant data in itself."""

    def __init__(self, parent, key):
        super(SmartEntry, self).__init__(parent)

        self.key = key


class ParticipantInfoDialog(tk.Toplevel):
    """Pop up dialog before the experiment to gather demographical data."""

    def __init__(self, root, dataHandler, fontSize=20):
        super(ParticipantInfoDialog, self).__init__()

        self.withdraw()
        self._root = root
        self._dataHandler = dataHandler
        self._keyWidgets = []
        self._font = font.Font(family="Liberation Sans", font=fontSize)
        self._configureLayout()
        self._center_on_screen()
        self.deiconify()
        self._wait()

    def _configureLayout(self):
        """Configure main layout and buttons."""

        # Configure attributes
        self.resizable(height=False, width=False)
        self.title("Participant Information")
```

```
        self.protocol("WM_DELETE_WINDOW", self._onClose)

        # Configure grid
        self.grid_columnconfigure(0, weight=1)
        self.grid_columnconfigure(1, weight=3)
        self.grid_rowconfigure(0, weight=1)

        # Define data fields
        infos = ['VP Nummer', 'Alter', 'Geschlecht', 'Muttersprache', 'Beruf', 'Studiengang']
        keys = ['id', 'age', 'gender', 'language', 'job', 'major']

        # Add to grid in a loop
        for i, info in enumerate(infos):
            # Add label in first column
            tk.Label(self, text=info, anchor='w', font=self._font)\
                    .grid(row=i, column=0, sticky='we', padx=(10, 0), pady=10)
            # Add entry
            entry = SmartEntry(self, keys[i])
            entry.configure(font=self._font)
            entry.grid(row=i, column=1, sticky='wens', padx=(0, 10), pady=10)
            self._keyWidgets.append(entry)

        # Add confirm button
        tk.Button(self, text='Bestätigen', command=self._onConfirm, font=self._font)\
                    .grid(row=len(infos), column=1, sticky='e')

    def _onConfirm(self):
        """Activated when confirm button clicked."""

        # Validate input, and if it's ok, continue with experiment
        if self._validateInput():
            self.destroy()
            self._root.destroy()

    def _validateInput(self):
        """Returns True if participant info ok, False otherwise."""

        # Loop through widgets
        for widget in self._keyWidgets:
            # Get key and value for convenience
            key = widget.key
            val = widget.get()

            keys = ['id', 'age', 'gender', 'language', 'job', 'major']
            # Check all fields
            if key == 'id':
                if re.match('^\d{3}$', val):
                    self._dataHandler.add_bio_field(key, val)
                else:
                    mbox.showerror('Fehler', 'VP Nr. muss eine dreistellige Nummer sein')
                    return False

            elif key == 'age':
                if val.isdigit():
                    self._dataHandler.add_bio_field(key, val)
                else:
                    mbox.showerror('Fehler', 'Eingabe für Alter muss eine Zahl sein!')
                    return False

            elif key == 'gender':
                if val != '':
                    self._dataHandler.add_bio_field(key, val)
                else:
                    mbox.showerror('Fehler', 'Bitte Geschlecht angeben!')
                    return False

            elif key == 'language':
                if val != '':
                    self._dataHandler.add_bio_field(key, val)
                else:
                    mbox.showerror('Fehler', 'Bitte Muttersprache angeben!')
                    return False

            elif key == 'job':
                if val != '':
```

```
                    self._dataHandler.add_bio_field(key, val)
                else:
                    mbox.showerror('Fehler', 'Bitte Beruf angeben!')
                    return False

            elif key == 'major':
                if val != '':
                    self._dataHandler.add_bio_field(key, val)
                else:
                    mbox.showerror('Fehler', 'Bitte Studiengang angeben!')
                    return False

 # If we are here, then we survived all tests
        return True

    def _wait(self):
        """Makes main window wait until the top level is destroyed."""

        # Hide close
        self.transient(self._root)
        # Make sure user can only interact with the popup
        self.grab_set()
        # Pop up
        self.lift(self._root)
        # Make root wait
        self._root.wait_window(self)

    def _center_on_screen(self):
        """Center dialog on screen."""

        self.update()
        w = self.winfo_screenwidth()
        h = self.winfo_screenheight()
        x = w/2 - self.winfo_width()/2
        y = h/2 - self.winfo_height()/2
        self.geometry("%dx%d+%d+%d" % (self.winfo_width(), self.winfo_height(), x, y))

    def _onClose(self):
        """Activated when user clicks close button."""

        if mbox.askyesno("Quit experiment", "Are you sure you want to abort the experiment?"):
            self.destroy()
            self._root.destroy()
            exit()


def collect_bio_data(dataHandler):
    """Interface to collect bio data and give back control to pygame."""

    root = tk.Tk()
    #root.attributes('-zoomed', True)
    root.attributes('-fullscreen', True)
    intro = Intro(root, dataHandler)
    intro.startExperiment()
    # Keep GUI alive during the session
    root.mainloop()
```

Instruction handler:

```
#!/usr/bin/env python3
import tkinter as tk
from tkinter import ttk
import os
import random
from PIL import ImageTk, Image

class Instructions(tk.Frame):

    def __init__(self, root):
        super(Instructions, self).__init__(root)

        # Store reference to root and initialize main members
        self._root = root
        self._configureRoot()
        self._initWindow()

        # Sort out images
        self.state = 'GENERAL' # Can be GENERAL, PREVENTION, or PROMOTION
        # At end of instructions - PREVENTION or PROMOTION
        self._img_path = './instructions/img'
        self._standard_img_names = [
            'a_cover.png',
            'b_welcome.png',
            'c_attention.png',
        ]
        self._prevention_img_names = [
            'Prevention_1.png',
            'Prevention_2.png'
        ]
        self._promotion_img_names = [
            'Promotion_1.png',
            'Promotion_2.png'
        ]

        # Lay out buttons and img label
        self._panel = tk.Label(self)
        self._panel.pack(anchor='center', pady=(40, 0))
        self._btns_frame = tk.Frame(self)
        ttk.Button(self._btns_frame,text='ZURÜCK',command=self._show_previous).pack(side='left')
        ttk.Button(self._btns_frame,text='WEITER',command=self._show_next).pack(side='right')
        self._btns_frame.pack(anchor='center', pady=10)

        # Prepare images
        self._images = []
        self._prevention_images = []
        self._promotion_images = []
        self._current_showing = -1
        self._prepare_images()
        self._show_next()

    def _configureRoot(self):
        """Sets style and geometry of root."""

        # Configure style
        self._root.style = ttk.Style()
        self._root.style.theme_use('clam')

    def _initWindow(self):
        """Initializes all components of the window."""

        # Show window
        self.pack(fill='both', expand=True)
        #self.configure(background='black')

    def _prepare_images(self):
        """Loads and resizes images to a standard size."""

        # Load general
        for img in self._standard_img_names:
            loc = os.path.join(self._img_path, img)
```

```
            image = Image.open(loc)
            self._images.append(ImageTk.PhotoImage(image))



        # load promotion
        for img in self._promotion_img_names:
            loc = os.path.join(self._img_path, img)
            image = Image.open(loc)
            self._promotion_images.append(ImageTk.PhotoImage(image))

        # load prevention
        for img in self._prevention_img_names:
            loc = os.path.join(self._img_path, img)
            image = Image.open(loc)
            self._prevention_images.append(ImageTk.PhotoImage(image))

    def _show_next(self):
        """Shows image indexed by next index."""

        # We are still at the general instructions
        if self.state == 'GENERAL':
            # Show current
            if self._current_showing < len(self._images) - 1:
                self._current_showing += 1
                self._panel.configure(image=self._images[self._current_showing])

            # Move to next STATE
            else:
                # Throw a coin to decide which game are we playing
                if random.random() < 0.5:
                    self._images += self._prevention_images
                    self.state = 'PREVENTION'
                else:
                    self._images += self._promotion_images
                    self.state = 'PROMOTION'
                self._current_showing += 1
                self._panel.configure(image=self._images[self._current_showing])


        # We are at a specific instriuction
        else:
            # Show current
            if self._current_showing < len(self._images) - 1:
                self._current_showing += 1
                self._panel.configure(image=self._images[self._current_showing])

            # End instructions, start experiment
            else:
                self.destroy()
                self._root.destroy()


    def _show_previous(self):
        """Shows image indexed by previous index."""

        if self._current_showing > 0:
            self._current_showing -= 1
            self._panel.configure(image=self._images[self._current_showing])


def show_instructions():
    """Present instructions."""

    root = tk.Tk()
    #root.attributes('-zoomed', True)
    root.attributes('-fullscreen', True)
    instr = Instructions(root)
    # Keep GUI alive during the session
    root.mainloop()
    return instr.state
```

Manakin handler:

```
#!/usr/bin/env python3

import tkinter as tk
from tkinter import ttk
from tkinter import font, TclError
from tkinter import messagebox as mbox


class RadioButtons(tk.Frame):

    def __init__(self, root, num=7):
        super(RadioButtons, self).__init__(root)

        self.grid_rowconfigure(0, weight=1)
        self._checked = tk.PhotoImage(file="./img/checked.png")
        self._unchecked = tk.PhotoImage(file="./img/unchecked.png")
        self._var = tk.IntVar()
        self._var.set('V')
        self._root = root
        self._buttons = []
        for bi in range(num):
            self.grid_columnconfigure(bi, weight=1)
            b = tk.Radiobutton(self, variable=self._var, value=bi,
            image=self._unchecked, selectimage=self._checked, indicatoron=False)
            b.grid(row=0, column=bi, sticky='wens', padx=5)
            self._buttons.append(b)

            if bi == num // 2:
                b.select()

    def data(self):
        """Returns the data of the manakin."""
        return str(7 - self._var.get())


class Manakin(tk.Frame):

    def __init__(self, root, dataHandler):
        super(Manakin, self).__init__(root)

        # Store reference to root and initialize main members
        self._root = root
        self._dataHandler = dataHandler
        self._configureRoot()
        self._initWindow()

    def _configureRoot(self):
        """Sets style and geometry of root."""

        # Configure style
        self._root.style = ttk.Style()
        self._root.style.theme_use('clam')

    def _initWindow(self):
        """Initializes all components of the window."""


        # Some grid settings
        # self.grid_rowconfigure(0, weight=1)
        # self.grid_rowconfigure(1, weight=1)
        #self.grid_columnconfigure(0, weight=1)

        self._question = tk.Label(self, text='Wie fühlst du dich im Moment?',
        font=('Helvetica', 24))

        self._SAMarousal = tk.PhotoImage(file="./img/SAMarousal.png")
        self._SAMood = tk.PhotoImage(file="./img/SAMood.png")

        # Initialize manakin
        self._manakin_arousal = tk.Label(self, image=self._SAMarousal)
        self._arousal_buttons = RadioButtons(self)
```

```
        self._manakin_mood = tk.Label(self, image=self._SAMood)
        self._mood_buttons = RadioButtons(self)


        self._question.grid(row=0, column=0, sticky='wens', pady=20)
        self._manakin_arousal.grid(row=1, column=0, sticky='wens')
        self._arousal_buttons.grid(row=2, column=0, sticky='wens', pady=(0, 40))
        self._manakin_mood.grid(row=3, column=0, sticky='wens')
        self._mood_buttons.grid(row=4, column=0, sticky='wens')

        # Add confirm button
        button = ttk.Button(self, text='Bestätigen', command=self._onConfirm)

        button.grid(row=6, column=0, sticky='n', pady=40)

        # Show window
        self.pack(anchor='center', expand=True)

    def _onConfirm(self):
        """Close manakins."""

        mood, arousal = self._mood_buttons.data(), self._arousal_buttons.data()
        if self._dataHandler is not None:
            self._dataHandler.add_mankin_data(mood, arousal)
        else:
            print('Mood: ', mood, 'Arousal: ', arousal)
        self.destroy()
        self._root.destroy()

def show_manakins(dataHandler=None):
    """Collect mood and arousal data."""

    root = tk.Tk()
    #root.attributes('-zoomed', True)
    root.attributes('-fullscreen', True)
    manakin = Manakin(root, dataHandler)
    # Keep GUI alive during the session
    root.mainloop()

if __name__ == "__main__":
    show_manakins(None)
```

Brick task handler:

```
#!/usr/bin/env python3

import tkinter as tk
from tkinter import ttk
from tkinter import font, TclError
from tkinter import messagebox as mbox


class IdeaEntries(tk.Frame):

    MAX_ENTRIES = 25
    def __init__(self, root):
        super(IdeaEntries, self).__init__(root)

        self._root = root
        self._entries = []
        self._vars = []

        # Add initial _entries
        for i in range(IdeaEntries.MAX_ENTRIES):
            textVar = tk.StringVar()
            e = tk.Entry(self, state='disabled',textvariable=textVar, width=50)
            e.bind("<KeyPress>", self._on_key_press)
            e.pack(anchor='center')
            self._entries.append(e)
            self._vars.append(textVar)
        self._entries[0].configure(state='normal')

    def data(self):
        """Returns the data of the idea entries."""

        texts_list = [v.get() for v in self._vars if v.get() != '']
        texts = '--'.join(map(str, texts_list))
        how_many = str(len(texts_list))
        return texts, how_many


    def _on_key_press(self, e):
        """Catch the key press event"""

        idx = self._entries.index(e.widget)
        self._activate_new_entry(idx+1)

    def _activate_new_entry(self, idx):
        """Append a new entry below the current one."""

        if idx < IdeaEntries.MAX_ENTRIES:
            self._entries[idx].configure(state='normal')


class BrickTask(tk.Frame):

    def __init__(self, root, dataHandler):
        super(BrickTask, self).__init__(root)

        # Store reference to root and initialize main members
        self._dataHandler = dataHandler
        self._root = root
        self._configureRoot()
        self._initWindow()

    def _configureRoot(self):
        """Sets style and geometry of root."""

        # Configure style
        self._root.style = ttk.Style()
        self._root.style.theme_use('clam')

    def _initWindow(self):
        """Initializes all components of the window."""
```

```
        # Some grid settings
        self._root.grid_rowconfigure(0, weight=1)
        self._root.grid_columnconfigure(0, weight=1)
        self.grid_rowconfigure(0, weight=1)
        self.grid_rowconfigure(1, weight=1)
        self.grid_rowconfigure(2, weight=1)
        self.grid_columnconfigure(0, weight=1)
        self.grid_columnconfigure(1, weight=1)

        # Create widgets
        self._brick_img = tk.PhotoImage(file="./img/brick.png")
        self._img_label = tk.Label(self, image=self._brick_img)
        self._question = tk.Label(self, text='Wofür könnte man diesen Stein verwenden?\n
        Bitte trage so viele Einfälle wie möglich\n
        rechts in die freien Felder ein\n(pro Zeile einen Einfall)',
        font=('Helvetica', 24))
        self._ideas_frame = IdeaEntries(self)
        button = ttk.Button(self, text='Weiter', command=self._onConfirm)

        # LAYOUT:

        # Column 0
        self._img_label.grid(row=0, column=0, padx=(20, 20))
        self._question.grid(row=1, column=0, padx=(20, 20))
        button.grid(row=2, column=0, padx=(20, 20))

        # COLUMN 1
        self._ideas_frame.grid(row=0, column=1, rowspan=3, padx=(20, 20))

        # Show window
        self.pack(expand=True, anchor='center')

    def _onConfirm(self):
        """Close manakins."""

        self.destroy()
        self._root.destroy()
        ideas, length_ideas = self._ideas_frame.data()
        if self._dataHandler is not None:
            self._dataHandler.add_ideas(ideas, length_ideas)
        else:
            print('Ideas: ', ideas)
            print('Number of ideas:', length_ideas)

def show_brick_task(dataHandler=None):
    """Collect mood and arousal data."""

    root = tk.Tk()
    #root.attributes('-zoomed', True)
    root.attributes('-fullscreen', True)
    manakin = BrickTask(root, dataHandler)
    # Keep GUI alive during the session
    root.mainloop()

if __name__ == '__main__':
    show_brick_task()
```

Result handler (final reward on screen):

```
#!/usr/bin/env python3

import tkinter as tk
from tkinter import ttk
from tkinter import font, TclError
from data_handler import DataHandler

class Results(tk.Frame):

    def __init__(self, root, euros):
        super(Results, self).__init__(root)

        # Store reference to root and initialize main members
        self._root = root
        self._configureRoot()
        self._initWindow()

        # Just write some text on labels
        tk.Label(self, text='Ende der Befragung', font=('Helvetica', 30)).pack(fill='both',
         expand=True, pady=30)
        tk.Label(self, text='Dein zusätzlich erspielter Beitrag beträgt:', font=('Helvetica',
         24)).pack(fill='both', expand=True)
        tk.Label(self, text='[{} Euro]'.format(euros), font=('Helvetica', 24,
         'bold')).pack(fill='both', expand=True, pady=(0, 30))

        text = 'Dein Gewinn wird der Einfachheit halber zu 10 cent Einheiten aufgerundet.\n
         Bitte melde Dich bei der Versuchsleitung \n
         um dir den Gesamtbeitrag für die Teilnahme auszahlen zu lassen!\n'
        tk.Label(self, text=text, font=('Helvetica', 24)).pack(fill='both', expand=True,
         pady=(0, 30))
        tk.Label(self, text='Herzlichen Dank für deine Teilnahme!', font=('Helvetica',
         24)).pack(fill='both', expand=True, pady=30)
        button = ttk.Button(self, text='Beenden', command=self._onConfirm)
        button.pack()

    def _configureRoot(self):
        """Sets style and geometry of root."""

        # Configure style
        self._root.style = ttk.Style()
        self._root.style.theme_use('clam')

    def _onConfirm(self):
        """Close experiment."""
        self.destroy()
        self._root.destroy()

    def _initWindow(self):
        """Initializes all components of the window."""
        # Show window
        self.pack(fill='both', expand=True)
        #self.configure(background='black')

def show_results(euros):
    """Simply show how much participants are supposed to get."""

    root = tk.Tk()
    #root.attributes('-zoomed', True)
    root.attributes('-fullscreen', True)
    intro = Results(root, euros)
    # Keep GUI alive during the session
    root.mainloop()
```

Declaration in accordance to § 8 (1) c) of the doctoral degree regulation of Heidelberg University, Faculty of Behavioural and Cultural Studies

UNIVERSITÄT HEIDELBERG
ZUKUNFT SEIT 1386

FAKULTÄT FÜR VERHALTENS- UND EMPIRISCHE KULTURWISSENSCHAFTEN

Promotionsausschuss der Fakultät für Verhaltens- und Empirische Kulturwissenschaften der Ruprecht-Karls-Universität Heidelberg
Doctoral Committee of the Faculty of Behavioural and Cultural Studies, of Heidelberg University

Erklärung gemäß § 8 (1) c) der Promotionsordnung der Universität Heidelberg für die Fakultät für Verhaltens- und Empirische Kulturwissenschaften
Declaration in accordance to § 8 (1) c) of the doctoral degree regulation of Heidelberg University, Faculty of Behavioural and Cultural Studies

Ich erkläre, dass ich die vorgelegte Dissertation selbstständig angefertigt, nur die angegebenen Hilfsmittel benutzt und die Zitate gekennzeichnet habe.
I declare that I have made the submitted dissertation independently, using only the specified tools and have correctly marked all quotations.

Erklärung gemäß § 8 (1) d) der Promotionsordnung der Universität Heidelberg für die Fakultät für Verhaltens- und Empirische Kulturwissenschaften
Declaration in accordance to § 8 (1) d) of the doctoral degree regulation of Heidelberg University, Faculty of Behavioural and Cultural Studies

Ich erkläre, dass ich die vorgelegte Dissertation in dieser oder einer anderen Form nicht anderweitig als Prüfungsarbeit verwendet oder einer anderen Fakultät als Dissertation vorgelegt habe.
I declare that I did not use the submitted dissertation in this or any other form as an examination paper until now and that I did not submit it in another faculty.

Vorname Nachname
First name Family name ______________________________

Datum, Unterschrift
Date, Signature ______________________________