Attention and Distraction in the Processing of Information

Effects of Relevance, Incongruence and Errors.

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Attention and distraction in the processing of information: Effects of relevance, incongruence and errors
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Thesis Radboud University Nijmegen – With ref. –
With summary in Dutch
ISBN: 978-90-9021850-2
Subject heading: attention, distraction, information processing
Cover: Café wall illusion, design by author
Print: Print Partners Ipskamp, Enschede

Attention and distraction in the processing of information: Effects of relevance, incongruence and errors.

Een wetenschappelijke proeve op het gebied van de Sociale Wetenschappen

Proefschrift

ter verkrijging van de graad van doctor
aan de Radboud Universiteit Nijmegen
op gezag van de rector magnificus prof.mr. S.C.J.J. Kortmann,
volgens besluit van het College van Decanen
in het openbaar te verdedigen op dinsdag 26 juni 2007
om 10.30 uur precies
door

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geboren op 20 september 1976
te Utrecht

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“Een proefschrift is er om te schrijven en niet om te lezen.”

- Miquel Bulnes

Chapter 1

General Introduction and Outline

"It is no doubt important to attend to the eternally beautiful,
and to believe the eternally true.
But it is more important not to be eaten."
- Jerry Fodor

Imagine exploring a strange new world. Though some may think of an expedition to Alpha Centauri, a first trip to the tropical rain forest or diving in the Caribbean will do just as well. While exploring such a location we've never been to, numerous things we encounter will be new to us. We may spot beautiful tropical flowers, or notice an impressive, man-eating bull shark that notices us as well.

In such unfamiliar environments, but in familiar ones as well, we process information in a way that helps us to navigate effectively through our surroundings. For example, although we usually start our explorations with a positive view of the world, threatening stimuli automatically grab our attention because these stimuli are extremely relevant to our survival. This attentional bias towards negative stimuli, or negativity in general, is termed automatic vigilance. Man-eating predators qualify as stimuli that instigate automatic vigilance, especially if they take an interest in us. In this manner, certain characteristics of a stimulus we encounter may automatically influence the way we process information.

Next to the influence of stimulus characteristics, the situation we find ourselves in can also motivate us to process information in certain ways. When a situation appears to be safe and there are many beautiful things to observe or there is food to be found, we become motivated to explore our environment. Such a motivational state makes us relatively eager in looking for rewarding opportunities. Conversely, the situation may provide us with clues that something is wrong, or dangerous. When fish suddenly swim away from something, or other people's faces have scared expressions, we are likely to become motivated to protect ourselves. In this motivational state we are more cautious, trying to prevent losses and avoid danger. Situational cues may thus prompt us to process information in different ways, with either a focus on rewards and opportunities or with a focus on losses and dangers.

Additionally, people differ in their way of regulating behavior and these different self-regulatory abilities interact with the active motivational states described above. Some individuals are inherently prone to think about the mistakes they make or the difficult situations they find themselves in, whereas others are more likely to act to change such a situation. These different strategies we use over and over to handle ourselves in difficult situations differ chronically between individuals and influence how they regulate (goal-directed) behavior. Broadly speaking, there are those who seem more geared toward action and change, and those who desire stability and deliberation. This difference in personality interacts with our motivational states to predict how well we are able to process information and regulate our behavior in stressful situations.

To predict how people respond to information from their environment, or which information they are attentive towards, is thus a complicated matter. As the examples above illustrate, we at least have to take into account the characteristics of the information or stimulus we encounter, the motivational mindset we find ourselves in during this encounter and our dispositional manner of self-regulation. In the present dissertation, each of these three factors is explored in a separate empirical chapter. This broad approach to the study of attention and distraction has the benefit of covering multiple research topics. However, it also unavoidably leads to a limited exploration of each domain.

In Chapter 2, stimulus movement (toward or away) is studied as an example of a perceiver relevant stimulus characteristic that may lead to greater attentiveness in information processing. Chapter 3 is concerned with the influence a temporary motivational state has on the processing of irrelevant environmental stimuli, which has a distracting effect on the task one is working on. Chapter 4 looks at how an individual's dispositional self-regulatory abilities interact with temporary motivation to predict task performance following errors. In the following sections, each of the three research domains will be introduced.

Characteristics of the perceived stimulus

Not every stimulus we encounter is processed thoroughly by our cognitive system. Since our cognitive capacity is limited, our attention is mainly directed toward stimuli that are relevant or of interest to us. This selectivity in attention is functional, in part because it facilitates behavior aimed at accomplishing our goals and needs. Rather unsurprisingly, the most basic need most living organisms wish to fulfill is continued survival.

Stimuli that are especially relevant for this basic need are valenced stimuli: the positive and negative things that are present or appear in our perceptual environment. No wonder then, that evaluating stimuli as good (liked, desirable) or bad (disliked, undesirable) is seen as a primary response (Zajonc, 1980), and one of the most elementary forms of categorizing our environment. Supporting this affective primacy hypothesis, evaluations have been shown to occur without intention or even conscious thought (e.g. Fazio, Sanbonmatsu, Powel & Kardes, 1986; Kunst-Wilson & Zajonc, 1980). Evaluating stimuli is therefore thought to be a fully automatic process; it is efficient, without the need for conscious thought, unintentional and uncontrollable (cf. Bargh, 1994; Norman & Shalice, 1986; see also Bargh & Chartrand, 1999).

Information processing thus appears to begin with evaluating what is seen (consciously or not). Following this evaluative start, positive and negative stimuli subsequently have an asymmetrical impact on information processing and behavior. Studies on loss aversion (Kahneman & Tversky, 1984), impression formation (e.g. Fiske, 1980) and decision making (Kahneman & Tversky, 1979) all show that negative information is weighed more heavily than positive information. It was on the basis of these studies that Pratto and John (1991) concluded that it might be adaptively functional to automatically direct more attention to negative than positive stimuli.

This is a plausible assumption since negative events are usually more pressing than positive ones and may often require immediate responses to change or adjust the current situation. Also, all other things being equal, the consequences of positive events (e.g. attending the eternally beautiful) are outweighed by the consequences of negative events (e.g. being eaten). To enhance chances of survival then, attentional capacity needs to be directed toward undesirable stimuli, a mechanism termed *automatic vigilance* by Pratto and John.

In their influential article, Pratto and John provide evidence for automatic vigilance by demonstrating that color naming latencies in a Stroop task are longer for negative trait words than for positive ones. These longer latencies imply that more attention was held by the trait word, thereby slowing down the naming of the color the trait was written in. The attention grabbing and holding effect of negative stimuli was also apparent in superior recall of negative compared to positive traits in a surprise recall task following the color naming.

Automatic vigilance is not limited to trait words but also occurs when people perceive faces (Hansen & Hansen, 1988; see also Öhman, Lundqvist, & Esteves, 2001). When presented with a grid of schematic faces wherein one face differs from the rest, it is easier to detect a discrepant angry face than a discrepant happy face. These results are commonly explained by assuming that negative faces attract attention more rapidly than positive ones. Furthermore, interference by negative or threat related stimuli is especially likely in situations where negative stimuli have to compete with other stimuli for processing resources (i.e. attention). This is apparent in visual search tasks using angry and neutral faces (Eastwood, Smilek & Merikle, 2003; Fox, Lester, Russo, Bowles, Pichler & Dutton, 2000).

Whether these attentional effects on the speed of responding to negative stimuli are caused by attentional capture or difficulty in disengagement from negative stimuli has been a subject of debate. Studies using interference paradigms, like the Stroop task typically show holding of attention by negative stimuli, leading to slower responses. On the other hand, studies employing visual search tasks show facilitated responses for negative stimuli, implying that negative stimuli are easier to detect than positive ones. Recent research by Van der Wulp and colleagues (Van der Wulp, Semin, Galucci & Finkenauer, 2007) suggests that both processes may be involved, but at different phases of responding to positive and negative stimuli. Negative stimuli are easier to detect than positive ones, but take more attention to be processed. Thus, whether facilitation or inhibition of responses to negative stimuli is found is thought to depend on the phase of information processing that is measured by the experimental paradigm used (See also the discussion on processing efficiency in different experimental paradigms in chapter 3).

Aside from alertness towards negativity, more vigilant processing has also been shown to exist for character traits that are relevant for perceivers (e.g. helpful, aggressive) in comparison with traits that are only relevant for the possessor of these traits (e.g. creative, unhappy; Wentura, Rothermund & Bak, 2000). These results demonstrate that attentiveness towards certain types of information from our environment is not solely determined by the valence of the information, but also by other characteristics that determine its relevance for the perceiver.

A different stimulus characteristic that may influence vigilant processing is movement of a perceived stimulus. As alluded to before, automatic vigilance can be explained from a functional point of view. We attend more to negative and perceiver-relevant character traits because these stimuli may be of importance for our continued survival. In other words, we are more or less conditioned to attend to negativity, because this is very relevant for our long-term goal of not being eaten. A similar rationale holds for the perception of stimuli moving toward or away from an individual. Stimuli that move toward a perceiver are more relevant for that perceiver than stimuli that move away. Just as negative events typically necessitate faster responses than neutral or positive events, approaching stimuli are more significant for a perceiver. The potential for threat is inherently larger for approaching stimuli than for receding stimuli. One would therefore expect more vigilant processing, in the form of heightened accuracy and/or faster responses when stimuli approach compared to a situation wherein stimuli are receding.

In Chapter 2, two experiments are reported that specifically addresses this hypothesized relationship between stimulus movement and vigilant processing. Firstly, however, this research into stimulus movement is distinguished from the approach/avoidance literature, which is concerned with movement of the perceiver. It is argued that the effects of perceiver movement are fundamentally different from the effects of stimulus movement. When a perceiver moves, processing benefits are determined by the congruency of the movement and the valence of the stimulus moved towards (see e.g. Strack & Deutsch, 2004). During our lives, approach is conditioned to positive things and avoidance to negative things. Thus, when we move toward something, we implicitly expect it to be positive. Likewise, when we avoid something, chances are it is negative. Movement of a stimulus is different in that we do not control whether what is moving towards us is positive or negative. We simply respond to what moves. As argued before from a functional perspective, stimuli that move toward us are more relevant and therefore instigate vigilant processing.

In the first experiment, participants complete an evaluation task, both when stimulus words move toward and away from them. Speed of responding is expected to be higher when stimuli move toward compared to when stimuli move away from the participants. In the second study, participants again complete an evaluation task with moving stimuli that are now difficult to perceive. The accuracy of the evaluations of these degraded stimuli is expected to be higher for stimuli moving towards participants than for stimuli moving away.

Motivational states of the perceiver

Attention is not exclusively directed toward stimuli that are of importance to our survival. To achieve our goals, for example, we need to be on the lookout for stimuli that are relevant for that goal. To illustrate: Aarts, Dijksterhuis, & De Vries (2001) showed that a person who is thirsty pays more attention to stimuli related to drinking. Also, using goals unrelated to survival needs, Moskowitz (2002) has demonstrated that stimuli associated with active goals are in a state of heightened activation and therefore receive more attention when people encounter them. Such attentional benefits of goal related stimuli ensure that we may become aware of potential situations or means for goal fulfillment when they present themselves. These examples demonstrate that the internal state of a perceiver, such as a goal, may influence the way stimuli from the environment are processed.

Next to goals, and possibly in a different manner, the motivational state of a perceiver may influence processing of environmental stimuli. One temporary motivational state likely to do this is the perceiver's active regulatory focus. Derived from the pleasure principle, which states that people approach pleasure and avoid pain, regulatory focus theory (Higgins, 1997) posits two distinct foci that regulate goal-directed behavior. The basic premise behind this theory is that in different situations, we have different needs. Two distinct and fundamentally different needs are those concerned with nurturance and security. These needs call for different ways of regulating our behavior.

In line with these needs, regulatory focus theory distinguishes between a promotion focus and a prevention focus. A promotion focus is a motivational state associated with nurturance, ideals and scoring hits. An individual with an active promotion focus typically uses eager response strategies and approach means to reach goals. In contrast, a prevention focus is concerned with safety, oughts and preventing misses. This focus is accompanied by a vigilant response strategy and avoidance means to reach goals (e.g. taking care to not lose a game).

Both foci are thought to be present in every individual. Although people may differ in their chronic preference for one of the two foci, either one can be activated automatically in response to situational demands. For example framing outcomes in terms of gains or non-gains induces promotion concerns, whereas framing the same outcomes in terms of losses or non-losses activates prevention concerns (See e.g. Higgins, Shah & Friedman, 1997). It is important to note, that these regulatory concerns or foci are not seen as bipolar constructs. Individuals and situations may be high on both promotion and prevention focus concerns, or low on both (see Higgins, 2002 for a discussion).

As alluded to before, the regulatory foci differ with respect to the preferred means of goal attainment. A promotion focus typically fits with the use of eagerness and approach means. Eagerness involves ensuring "hits" or successes and not letting potential gains pass. In other words, a concern with the presence and absence of positive outcomes. This is reflected by the relatively risky processing style of people in a promotion focus (see Förster, Higgins & Taylor Bianco, 2003). Conversely, a prevention focus fits with the use of vigilance and avoidance means. These vigilance means ensure correct rejections, avoidance of mistakes and caution. In other words, a concern with both the absence and presence of negative outcomes.

Since there exists such a clear link between regulatory foci and the valence of the outcomes they are concerned with, differential biases for valenced information may exist in the two foci. A motivational focus specifically concerned with outcomes of a certain valence may lead to a sort of expectedness of encountering stimuli of that valence in the environment.

Two different hypotheses may be derived from this reasoning. First, in line with the effects goals have on selective attention (e.g. Moskowitz, 2002), more attention may be dedicated to motivationally relevant stimuli than other stimuli. Merely having a goal is not enough to achieve it; we have to notice the opportunities to accomplish the goal. Goal related stimuli are therefore thought to become more salient (and cognitively accessible), thereby grabbing attention when they are encountered. Noticing and paying attention to goal related stimuli enhances the likelihood that a goal is achieved.

Extending this reasoning to regulatory foci, focus-compatible stimuli should grab more attention and consequently be processed more elaborately than focus-incompatible stimuli. Since positive stimuli are specifically related to a promotion focus and negative stimuli to a prevention focus, more attention should be dedicated to positive stimuli when an individual has an active promotion focus, whereas more attention is dedicated to negative stimuli when a prevention focus is active.

However, an alternative hypothesis may be derived from the cognitive tuning perspective (Schwarz, 2002), which states that our cognitive processes are tuned to situational requirements. If our internal motivational state indicates that outcomes of a certain valence are important in the situation we find ourselves in, it would be functional to be prepared to deal with them. Thus, having a promotion focus active should lead to processing benefits for positive stimuli whereas an active prevention focus should facilitate the processing of negative information. This facilitation does not lead to enhanced attention, but greater processing efficiency for these stimuli. Focus compatible stimuli may thus require less attention to be processed than incompatible stimuli.

Preliminary evidence for this hypothesis is provided by research on motor-compatibility effects (e.g. Förster & Stepper, 2000; Förster & Strack, 1996). In this line of research, compatibility between approach and avoidance related bodily movements or orientations and valenced stimuli facilitates the processing of the valenced stimuli. Compatible stimuli are encoded more easily than incompatible stimuli. For conscious processing then, compatible stimuli require less attention than incompatible stimuli. The same attentional benefits may exist for regulatory foci, and even extend to the processing of compatible stimuli in our environment in general, in addition to occurring for stimuli processed deliberately.

A specific tool that is useful for investigating this idea is an interference task. An interference task (e.g. the Stroop task mentioned before) employs stimuli that have to be judged on some characteristic (color in the Stroop task), which is termed the focal task. However, the stimuli used in the task also differ on a different dimension, for example valence. As stated at the beginning of this introduction, evaluating stimuli present in our environment does not require a specific goal to do so, or even conscious perception of these stimuli: Most of what we perceive is evaluated automatically. Interference tasks make use of this pervasive evaluative propensity. By including positive and negative stimuli in the stimulus set, the amount of distraction from the focal task can be assessed for these valenced stimuli. Since evaluating stimuli is dysfunctional for performance on the focal task, any effects that are found for stimulus valence are thought to result from automatic evaluations and the subsequent allocation of attention to the valenced stimuli.

In Chapter 3, two experiments are reported that explore how attentional biases are influenced by temporary motivational states. Using an interference task, the automatic allocation of attention to positive and negative stimuli is investigated. In both experiments, using different methods, the regulatory focus of participants is manipulated. The amount of distraction from the focal task reflects the amount of attention dedicated to the positive and negative stimuli. In line with the two different hypotheses described earlier, either more or less distraction is expected from compatible stimuli. These different hypotheses are elaborated on and discussed further in Chapter 3.

Personality characteristics of the perceiver

Temporarily, as seen in the previous section, people differ in their regulatory focus, which in turn influences the amount of distraction environmental stimuli may cause. Such distraction is especially unwanted when stressful events occur, or when we find ourselves in challenging situations. Most people encounter these events and situations on a regular basis, and differ in the way they deal with them. A rough distinction can be made between people who prefer to think and those who prefer to act, when faced with obstacles in difficult situations. This distinction is thought to reflect a chronic difference in self-regulation abilities and forms an integral part of the theory of action control (Kuhl, 1994a).

The theory of action control suggests that people chronically differ in the way they execute behavioral control, especially under stressful conditions. On the one hand, an individual may be state-oriented. These individuals respond to stressful situations with persistent negative affect and rumination. On the other hand, an individual may be more action-oriented. This individual is characterized by the down-regulation of negative affect and effective behavioral control under conditions of stress. Action and state-orientations are thought to be integral parts of the cognitive and affective architecture of the brain. As such, these orientations influence the ease or difficulty with which people deal with distractions that interfere with the task they are working on.

In the previous section, the distraction from task performance is thought to be caused by the presence of either compatible or incompatible stimuli in the spatial proximity of the focal task. A different kind of distraction may be found in the temporal proximity of distracting events: Making a mistake on a previous task. Making mistakes has been shown to hinder performance on subsequent tasks, that is, following a mistake performance typically becomes slower or more inaccurate (Rabbitt, 1966; Rabbitt & Rodgers, 1977). Such deteriorated performance is thought to be caused by the allocation of attention to thinking about or processing of the error.

To be more precise, errors are accompanied by negative affect that most likely causes the distraction (see e.g. Luu, Collins & Tucker, 2000). As mentioned before, negative affect functions as a warning signal that informs our brain that something is wrong, potentially leading to more deliberative processing of our environment. The differences in action control suggest that certain individuals are more prone to being distracted by this negative affect accompanying errors, than others.

Especially in demanding situations, state-oriented individuals experience more difficulty with behavior regulation when confronted with negative affect than action-oriented individuals (Koole & Jostman, 2004). State-oriented individuals lack in effective down-regulation of negative affect, leading to distracting rumination. This in turn ties up cognitive resources needed for subsequent behavior regulation. Action-oriented individuals are better able to down-regulate negative affect, thereby freeing up cognitive resources for regulating subsequent behavior. Errors are thus thought to be less of an issue for action-oriented than state-oriented individuals under stressful conditions.

However, looking at dispositional action control does not provide a complete picture of how people regulate their behavior. Next to chronic differences in regulatory abilities, temporarily activated motivational foci influence whether people use a more eager or vigilant strategy in the tasks they are working on. These regulatory foci are therefore expected to interact with dispositional differences in action control.

At a superficial level, there seems to exist a link between action control and regulatory foci. Although both state and action-oriented individuals can activate prevention or promotion foci, a promotion focus may function better in an action-oriented individual. Due to the down-regulation of negative affect and relative disregard for errors, these individuals have better tools for implementing an eager response strategy than others. From this basic rationale it is predicted that action-oriented individuals with an active promotion focus will display optimal performance following errors in demanding situations, in comparison to other combinations of action control and regulatory focus.

Admittedly, this reasoning is rather crude. A more subtle and complete argument is developed in Chapter 4. Furthermore, to study the interaction between chronic differences in action control and the active regulatory focus, a paradigm is devised that requires simple judgments about letter grids. The decisions are to be made in a limited time-span, creating a demanding situation wherein task performance has to take place. Due to the limited time-span, errors of judgments will occur, making it possible to compare post-correct and post-error performance. Since action orientation is a dispositional difference, it is measured, whereas regulatory foci are manipulated in both experiments.

General outline

The following three chapters each deal with one of the three themes that were introduced. In the second chapter, vigilance due to stimulus characteristics is explored. More specifically, movement of a stimulus object toward a perceiver is thought to make this object more relevant for the perceiver. Consequently, the heightened relevance of the stimulus leads to greater allocation of attentional resources for optimal processing of this stimulus. The third chapter looks into attentional biases caused by the motivational orientation of perceivers. In this study, the amount of distraction from a focal task is thought to depend on the presence and automatic processing of motivationally compatible or incompatible stimuli in the environment. In the fourth chapter, distraction due to making mistakes, or suboptimal post-error performance is studied. How an individual is influenced by this distraction is thought to depend on the individual's dispositional action orientation in combination with the active regulatory focus. In the final chapter, the major experimental findings will be outlined and discussed. Furthermore, the empirical chapters are integrated into a single theoretical frame.

Each of the three empirical chapters comprises a published or submitted article and was thus written as a stand-alone research article. As a result, some minor overlap with respect to the theoretical background of the studies may be encountered.

Chapter 2

Vigilance on the Move:

Differential Processing of Valenced Moving Stimuli

Abstract

Although we live in a dynamic environment, most stimulus evaluation research has studied evaluations in static stimulus settings. In the present study, we argue that stimuli moving in the direction of the perceiver are more self-relevant and therefore induce higher vigilance than stimuli moving away. Results of two experiments supported this view. Stimuli approaching the perceiver, specifically positive ones, elicited faster evaluation decisions than stimuli moving away from the perceiver (experiment 2.1). In addition, evaluations were more accurate and less positively biased when stimuli moved towards the perceiver than when they moved away (experiment 2.2). There is evidence in both experiments that a vigilant state, once evoked by approaching stimuli, tends to persist for some time.

Introduction*

Imagine yourself on a poorly lit street, late at night, in the bad part of town. In the distance, you spot a group of people. You can't tell from this distance whether they are a friendly group of psychologists or a bunch of hooligans. What will you do? In this situation, it probably makes a big difference to you if this group is moving towards you or away from you. If the group is moving towards you, chances are you're on the alert and watching out carefully, in order to find out what you're up against. You become vigilant because of the potential for danger inherent in ambiguous stimuli moving towards you. However, if the group moves away from you, it poses no direct threat so you can relax and walk on. This example illustrates the central point we want to make in this paper: Stimuli moving toward a perceiver will induce a more vigilant mode of processing compared to stimuli moving away. With this proposed vigilant mode of processing, we wish to extend existing research on, and definitions of automatic vigilance.

A concise definition of the automatic vigilance mechanism was recently given by Rothermund (2003): " … increased sensitivity for information relating to a current goal or task." (p. 343). Another definition can be found in a paper by Pratto and John (1991): "…a mechanism that serves to direct attentional capacity to undesirable stimuli" (p. 380). Incorporating these definitions into a single theoretical frame, we define automatic vigilance as a mechanism that increases sensitivity towards potentially undesirable stimuli that are chronically or currently relevant to the perceiver. This definition also entails that vigilant processing can be activated by both a perceivers' internal state that defines what is relevant for that perceiver at that moment, and by environmental cues that signal threat. We suggest that these internal and external antecedents of vigilant processing can produce heightened attention for certain stimuli or mobilize resources to process the environment more thoroughly.

Previous research has shown that vigilance may be elicited by stimuli that are potentially threatening, and thus of chronic relevance to a perceiver. For example, Pratto and John (1991) found negative stimuli to be more attention grabbing than positive stimuli. In a Stroop task, naming the color in which negative words were written took longer than naming the color of positive words. Wentura, Rothermund and Bak (2000) later used the same type of Stroop task to investigate the effect that relevance of stimulus words (i.e. traits) has on the perceiver. Wentura et al. found more interference in color naming for

* This chapter is based on De Lange & Van Knippenberg, 2007a.

perceiver-relevant traits (e.g. aggressive, generous) than for possessor-relevant traits (lonely, creative). Thus it seems that only traits that are relevant to the perceiver -- i.e., which may entail either harmful or beneficial effects for the perceiver -- evoke automatic vigilance in the Wentura et al. study.

In the Stroop task, the attention grabbing properties of stimuli become manifest through enhanced interference of these stimuli with the task at hand, i.e. color naming. In other paradigms, vigilant processing may be expressed in facilitated responses. Using a visual search paradigm, Hansen & Hansen, (1988; see also Öhman, Lundqvist, & Esteves, 2001) showed that an emotionally discrepant face in a matrix of identical faces was detected faster when the discrepant face was angry rather than friendly, enabling the perceiver to respond faster to threatening stimuli. Thus, as demonstrated in these experiments, automatic vigilance can also facilitate responses and is not limited to the attention grabbing properties of certain stimuli that interfere with (intended) responses.

As suggested in our introductory paragraph, we assume that the direction of stimulus locomotion affects the relevance of the stimulus for the perceiver. The basic premise behind this hypothesis is that it is more important for the perceiver to pay attention to approaching stimuli than to receding stimuli, primarily because approaching stimuli are likely to affect the perceiver's outcomes to a greater extent. In other words, approaching stimuli are more self-relevant for the perceiver than receding stimuli. Thus, in line with the theoretical argument above, approaching stimuli are more likely to evoke a vigilant mode of processing.

Note that this line of reasoning is different from approach/avoidance accounts of evaluating valenced stimuli. In approach/avoidance studies a compatibility effect between approach and positive stimuli on the one hand, and avoidance and negative stimuli on the other is generally found (for a review, see Strack & Deutsch, 2004). In contrast with stimuli that move, the actual or illusionary locomotion of the perceiver is the source of the experienced increase or decrease in distance between stimulus and perceiver in approach/avoidance effects. For example, Neumann and Strack (2000) demonstrate that the visual illusion of movement of the perceiver toward or away from the computer screen by ways of presenting increasing or decreasing concentric circles, leads to compatibility effects in evaluating stimulus words. When participants had the feeling they were moving toward the screen, evaluations were faster for positive words, whereas evaluations of negative words were faster when participants felt they were moving away from the screen. Neumann and Strack explained this finding by stating that the apparent direction of movement of the perceiver activated a corresponding motivational system, which in turn facilitated the processing of information that fits this motivational system. We think such compatibility effects will not arise when stimuli move toward or away from a perceiver. Approaching (or receding) stimuli will not activate approach/avoidance motivational systems but they are likely to affect a more (or less) vigilant way of processing, caused by the greater relevance and potential for threat inherent to stimuli that approach us compared to receding stimuli.

Specifically, we hypothesize that enhanced vigilance due to approaching stimuli entails faster and more accurate processing of the stimuli involved. First of all, the speed with which a perceiver responds to a stimulus is important. When something moves towards you, there is an urgent need to find out whether it's good or bad before it actually reaches you. It may be argued that in case something positive moves away you must react quickly in order not to lose it. However, a crucial element in the vigilance argument is that in matters of acute self-relevance, safety gains priority over nurturance (see also Cacioppo, Gardner, & Berntson, 1999). Therefore, perceivers have a need to respond faster when stimuli are moving toward them compared to when stimuli move away.

Assuming that, as argued above, perceivers are motivated to respond faster to approaching stimuli, the question arises what *enables* them to respond faster under these conditions. If we contrast a relaxed state with a vigilant state, the former is characterized by suboptimal energy allocation. As a result, the speed with which evaluative decisions are made under these conditions tends to be suboptimal. The organism, however, has spare capacity, i.e., a strategic reserve of energy resources that may be mobilized in case of emergency (cf. Kahneman, 1973). We propose that enhanced vigilance evoked by approaching stimuli is accompanied by mobilization of this spare capacity. This results in increased allocation of resources to the detection of potentially threatening stimuli. Due to such increased allocation of resources, evaluative decisions may become faster. Thus, while the sense of urgency elicited by approaching stimuli motivates perceivers to respond faster, the mobilization of spare capacity enables them to actually make faster evaluative decisions.

A second set of expectations concerns the accuracy of responses and response bias. As argued above, movement of stimuli toward the perceiver will result in a more vigilant processing style compared to movement away from the perceiver. This enhanced vigilance may manifest itself in faster responses in certain settings, but also in more accurate responses (fewer errors) in other situations. This high accuracy in evaluative decisions is more important when something is moving toward you than when something moves away from you, basically because approaching stimuli may affect your outcomes more than stimuli that move away from you. As in the case of speed, the need for enhanced accuracy requires the deployment of spare capacity. Thus, enhanced vigilance is accompanied by the allocation of additional resources to the stimulus detection task, which enables the perceiver to make more accurate evaluative decisions.

Another prediction associated with stimulus locomotion concerns response bias: Errors made during vigilant processing will be more evenly distributed over response categories than errors made during less vigilant processing. In everyday life, we perceive the world with a positivity bias; We usually encounter more positive than negative stimuli, use more positive than negative words, expect more positive than negative outcomes and so on (for reviews see Cacioppo, Gardner, & Berntson, 1999; Peeters & Czapinski, 1990; Taylor, 1991). Therefore, in a relaxed state, when presented with an equal number of positive and negative stimuli, people may still expect more positive than negative stimuli. Their responses will tend to match expectancy, meaning that there is a bias to respond positively. Hence, under relaxed conditions (i.e. when stimuli move away) people will make more errors in the proper identification of negative stimuli. However, this asymmetry in evaluation errors changes with stimulus locomotion. When something moves toward you, the cost of error in assessing the valence of stimuli is higher, especially for negative stimuli[1]. More specifically, the potential costs of classifying something as positive while it is negative outweigh the costs of labeling something as negative while it is positive. For example, it is less costly to categorize a rabbit (or a friendly group of people) as dangerous compared to categorizing a lion (or a group of violent hooligans) as harmless by mistake. Thus, we predict that responses become less positively biased, or even negatively biased, when stimuli move towards the perceiver compared to when they move away.

The first experiment was designed to test the 'speed'-hypothesis. Participants simply had to classify valenced moving stimuli as positive and negative as fast and accurately as possible. We hypothesize that faster evaluations will be made for stimuli moving toward the perceiver than for stimuli moving away. The second experiment was directed at response patterns, as expressed by proportions of errors in evaluating moving stimuli. Our prediction in this experiment is that participants will respond more accurately

[1] Subjectively, this will be even more so. As prospect theory (Kahneman & Tversky, 1979) states, chance of a loss is more important than an equal chance of gain. When stimuli move toward perceivers this asymmetry will become more pronounced.

and less positively biased when stimuli move toward them, compared to when stimuli move away.

Experiment 2.1

Method

Participants and design. The participants were 58 students (23 men, 35 women) of the Radboud University of Nijmegen. Their average age was 22 years and they received € 2.50 for participating. The design of the experiment was a 2 (word valence: positive *versus* negative) x 2 (stimulus movement: toward *versus* away) x 2 (movement order: toward-away *versus* away-toward) mixed design. Word valence and stimulus movement were manipulated within subjects, movement order was manipulated between subjects.

Material and stimuli. The experiment was programmed and presented on Apple computers. The words used in the experiment were selected from a set of 146 words, which had been judged as to their valence by 42 participants in a pilot study. All participants unequivocally evaluated the 22 positive and 22 negative words selected for the current experiment as either positive or negative. For the full set of stimulus words, see Appendix 2.1.

Stimulus movement toward (and away from) the perceiver was simulated by the computer by presenting the same word sequentially while the size of the word increased (or decreased). The words that moved toward the perceiver started at font size 11 (approximately 2 millimeters high, at a screen resolution of 640 x 480 pixels) and ended at font size 65 (approximately 18 millimeters high). Movement away from the perceiver started at font size 65 and ended at font size 11. The "Chicago"-font was used throughout the experiment. By presenting the larger (or smaller) sized word directly over the preceding smaller (or larger) word, the illusion of movement was created. The word appeared to grow larger (or smaller) in a smooth movement sequence. One movement sequence, from the smallest to the largest size (or reverse), lasted for approximately 2000 milliseconds and halted once a response was given.

A preliminary test was conducted to investigate a possible confound between size of the stimulus word and speed of the evaluation. For example, it may be argued that large stimuli necessitate multiple eye movements to be read or that smaller stimuli are more frequently encountered on computer screens in everyday life and thus easier to read. Therefore, in a separate study, 42 participants were presented with 22 stimulus words (11 positive and 11 negative) twice, once in a small (font size 14, “Chicago”-font) and once in a large stimulus size (font size 48). Order of the font size and presentation order of the valenced stimuli was randomized. In line with automatic evaluation and vigilance literature (e.g. Dijksterhuis & Aarts, 2003; Pratto & John, 1991) we found higher latencies for the evaluation of negative words (M = 597 ms) compared to positive words (M = 571 ms), F (1, 40) = 13.59, p < .01. However, we found no evidence of faster reactions to either small or large words, F (1, 40) < 1, *ns*. Also, there was no indication of a difference in accuracy in responses to small or large words, F (1, 40) < 1, *ns*. This finding suggests that results following from the use of the moving stimuli paradigm are not attributable to the difference in stimulus size per se, but to the dynamic changing of the size of the stimulus (i.e. perceived movement).

Procedure. Participants were seated in front of a computer individually. The task instructions were presented on the computer screen and explained that the participants were to determine the valence of each presented word. It was stressed that responses were to be made as accurately and quickly as possible. A response was made by pressing one of two keys, marked on the keyboard. As soon as one of these keys was pressed, the trial ended and the computer recorded the response and response latency. After a break of 1000 milliseconds the next trial started.

In the practice phase of the experiment, participants were presented with all the stimulus words once. The words were shown stationary in the centre of the screen (font size 27) and participants were asked to make a valence judgment for every word. This was done in order to weaken any pre-existing word-familiarity effects and to familiarize the participants with the evaluation task. Following this practice phase, the first series of experimental trials was presented, consisting of 44 words moving either toward or away from the participant. Following a self-paced break after the first series, the second series was presented, consisting of 44 words moving in the other direction. Assignment of participants to one of the movement orders, as well as the presentation order of the stimulus words within a series of trials was determined at random by the computer program.

Results and Discussion

Two participants were not included in the analyses. One was not a native speaker of the Dutch language, the other responded incorrectly in over twenty percent of the trials. On average, the remaining participants made few errors in the experimental trials (M = 3.36 in 88 trials). Response latencies of these incorrect answers were filtered from the response latency-analyses (3.8 % of the trials). To correct for the skewed distribution, an inverse transformation was performed on the response latencies before analyses[2]. For the sake of clarity, untransformed means will be reported in milliseconds.

We expected participants to evaluate words faster when these words were moving toward them, compared to words moving away from them. To test this expectation, an analysis of variance (ANOVA) was performed on the average response latencies of the experimental trials.

We found the predicted effect of stimulus movement, which confirmed that words moving toward a perceiver were evaluated faster (M = 785 ms) than words moving away from the perceiver (M = 798 ms), F (1, 54) = 4.85, p < .04. Furthermore, a significant main effect of valence was found. Across movement direction conditions, positive words were evaluated faster (M = 784 ms) than negative words (M = 800 ms), F (1, 54) = 15.04, p < .001. Both these effects were qualified by an interaction of movement direction and valence, F (1, 54) = 8.87, p < .005 (see Table 2.1). When moving away, both positive and negative words were evaluated equally slowly (M = 800 and M = 797 ms respectively), F (1, 54) = 3.07, p = .09. However, when moving towards the perceiver, positive words were evaluated much faster (M = 768 ms) than negative words (M = 803 ms), F (1, 54) = 22.33, p < .001. In other words, positive words moving away were evaluated more slowly than positive words approaching the perceiver, F (1, 54) = 9.60, p < .005. For negative words, movement towards or away from the perceiver did not affect speed of responding, F (1, 54) < 1, *ns.* Thus, the average gain in speed of evaluation for stimuli moving toward the perceiver must be completely ascribed to the positive words.

[2] Following the recommendations of Ratcliff (1993), separate analyses were performed on response latencies after three different transformations; inverse transformation, logarithmic transformation and transforming latencies under 300 milliseconds to 300 milliseconds and those over 3000 milliseconds to 3000 milliseconds. These three analyses all yielded the same results, which suggests that the effects we report are stable and reliable over different transformations.

Table 2.1.

Average response latencies in milliseconds, as a function of valence and movement direction in experiment 2.1.

	Positive	Negative
Toward	768_b	803_a
Away	800_a	797_a

Note. Means with different subscripts differ significantly at $p < .05$.

Also, a marginally significant interaction of movement direction with movement order was found[3], F (1, 54) = 2.99, $p < .10$. This interaction shows that participants who first respond to a block of stimuli moving toward them and subsequently respond to a block of stimuli moving away, maintain the same speed of responding across the two blocks of trials (M = 797 and M = 798 ms respectively), F (1, 55) < 1, *ns*. However, participants starting out with a block of stimuli moving away from them, initially give relatively slow responses but speed up once stimuli start moving towards them (M = 799 and M = 778 ms respectively), F (1, 55) = 10.47, $p < .005$. The latter pattern is in line with our prediction. The former pattern is unexpected, because participants maintain their initial speed of responding even when the direction of stimulus locomotion is reversed. This pattern may be indicative of a prolonged vigilance effect, in which stimuli moving towards a perceiver activate a state of vigilance that endures throughout the second block when stimuli are consistently moving away. This effect will be explored further in experiment 2.2.

More importantly, the results of the first experiment show that in the area of response latencies our expectations were partially confirmed. We expected a main effect of stimulus locomotion, but found this effect to be qualified by an interaction with stimulus valence. Specifically, positive stimuli were evaluated faster while moving toward perceivers, while negative stimuli were evaluated equally fast moving toward and away from perceivers. Thus, the vigilance that is induced by moving stimuli manifests itself in faster responses to positive stimuli only.

An explanation that may account for the faster evaluation of only positive stimuli that approach the participant is that the attention grabbing properties of negative words may have hampered fast responding. Note that this is a common finding in automatic

[3] Although the interaction of movement direction and movement order is only marginally significant, the effect is of interest in the interpretation of similar results in experiment 2.2.

evaluation literature (see Dijksterhuis and Aarts, 2003). Thus, it is conceivable that both positive and negative words are detected faster when approaching the perceiver, but that negative words have a distracting effect on the execution of the response. Despite making fast good/bad decisions for all words, the responses to negative stimuli may have been delayed due to their attention grabbing properties, in the same way as in color naming tasks (Pratto & John, 1991). Thus, evaluative responses may suffer from the attention grabbing properties of negative stimuli.

Possible effects of movement direction on the accuracy or bias of the responses could not be tested using the present data. The experimental paradigm consisted of a relatively easy evaluation task aimed at investigating response latencies, producing a very low number of errors. In addition, participants were explicitly instructed to respond as accurately as possible. Consequently, the accuracy of the participants in the evaluation task was very high. We found no reliable main effects of movement direction on the number of errors, F (1, 54) = 1.91, *ns*, or of the valence of the stimulus words, F (1, 54) < 1, *ns*. Also, the interaction between movement direction and stimulus valence yielded no differences in the number of errors made, F (1, 54) = 1.29, *ns*. To summarize, errors made in the evaluation task were examined, but no conclusions could be drawn due to the specific paradigm used. A second experiment was designed to investigate the number and type of errors made, in a moving stimuli paradigm. This experiment used a more difficult task, designed to increase the number of errors.

Experiment 2.2

In the second experiment a modified version of the paradigm used in the first experiment was employed. More specifically, stimulus presentation was degraded to enhance the difficulty of the evaluation task and obtain higher error percentages, making analysis of response tendencies using signal detection theory possible.

As noted above, we expect that movement of stimuli toward perceivers will make perceivers more vigilant toward these stimuli. For the current experiment we expect perceivers to respond more accurately and less positively biased in an evaluation task when stimuli move toward them, compared to stimuli moving away from them. In signal detection theory this means a higher value for the measure of accuracy (d’), and a lower value for the measure for response bias (log Beta).

Method

Participants and design. The participants were 54 students (15 men, 39 women) of the University of Nijmegen. Their average age was 21 years and they received € 2.50 for participating. Again, the design of the experiment was a 2 (word valence: positive *versus* negative) x 2 (stimulus movement: toward *versus* away) x 2 (movement order: toward-away *versus* away-toward) mixed design. Word valence and stimulus movement were manipulated within subjects, movement order was manipulated between subjects.

Procedure. The second experiment is a modified version of the first experiment. The presentation of the stimulus was degraded by flashing the stimulus word seven times in a sequence alternating with a mask of *X*s. For movement towards the perceiver, the stimulus words and the mask increased from font size 12 to font size 33. For movement away from the perceiver, the stimulus words and the mask decreased from font size 33 through 12 for movement away. A stimulus word was flashed for 16 milliseconds in-between two mask-presentations of approximately 86 milliseconds each. The size of the stimulus word matched the size of the mask preceding it. One movement sequence lasted for 800 milliseconds and consisted of eight mask presentations and seven word flashes. On each trial the participant was asked to indicate, or guess, whether the word that was flashed had a positive or a negative connotation, by pressing one of two marked keys on the keyboard. Once a response was given the next trial appeared on the screen, after a two second interval.

The experiment consisted of two blocks of 44 trials, one block containing movement sequences toward, the other movement sequences away from the participant. Which movement direction participants started with was determined at random by the computer program. The rest of the experiment followed the same procedure as the first experiment.

Results and discussion

To analyze the results we calculated two signal detection measures; d’ as a measure for accuracy and log ν for response bias, as an approximation of log Beta (cf. McNicol, 1972). These two measures were analyzed by means of a repeated measures ANOVA. For the first measure, d', the predicted effect of movement on the accuracy of evaluations was obtained. Participants evaluated stimuli moving towards them more accurately (d' = .90) compared to stimuli moving away (d' = .69), F (1, 52) = 17.61, p <

.001. Thus, movement of stimuli toward perceivers enhances the accuracy of perceivers' judgments as to whether these stimuli are positive or negative.

We also found a significant interaction between movement direction and movement order, F (1, 52) = 28.12, $p < .001$ (see Table 2.2). This interaction showed the same pattern as the interaction found in the first experiment. Participants in the toward-away movement order were consistently accurate across both movement directions (d' respectively .83 and .91), F (1, 53) = .47, *ns*. Participants in the away-toward movement order were relatively inaccurate when stimuli moved away (d' = .35) and became more accurate when stimuli started to move toward them (d' = 1.01), F (1, 53) = 37.06, $p < .001$. This pattern indicates that the vigilance evoked by approaching stimuli is not a transient effect but persists a while, even when the direction of stimulus locomotion changes. Thus, initial stimulus locomotion towards a perceiver evokes a vigilant processing style which remains activated for a considerable period of time, while initial stimulus locomotion away from the perceiver allows for relaxed information processing which changes at the very moment in which stimuli start moving towards the perceiver.

Table 2.2

Accuracy of evaluations (d') as a function of movement direction and movement order in experiment 2.2.

	Toward	Away
Toward-away	$.83_a$	$.91_a$
Away-toward	1.01_a	$.35_b$

Note. Means with different subscripts differ significantly at $p < .05$.

The second measure, log ν as an approximation of response bias was analyzed in the same way as the measure for accuracy. Log ν stands for the preferential evaluation of stimuli as positive, a higher value corresponding to a tendency to label more negative words as positive than vice versa. The expected effect of movement direction on response bias was found, F (1, 52) = 6.29, $p < .02$. Perceivers evaluating stimuli moving away from them showed a greater response bias (Mean log ν = .11), compared to perceivers evaluating stimuli moving toward them (Mean log ν = .04). This means that perceivers confronted with stimuli moving towards them were less biased with respect to evaluating stimuli as positive compared to perceivers confronted with stimuli moving away from them. No interaction between movement direction and movement order was found, $F(1, 52) = .23$, *ns*. Our expectation with respect to response bias was thus confirmed; the positive response bias that exists when stimuli move away from perceivers decreases when stimuli start moving towards them. Thus, perceivers in a vigilant processing style do not only become more accurate, they are also less positively biased toward their environment.

General discussion

Taken together, the current experiments demonstrate that stimulus movement has very distinct effects on the perception and evaluation of stimuli. When stimuli move toward a perceiver, this perceiver becomes more vigilant in assessing the valence of the object perceived. In the first experiment, this is apparent by faster evaluations of positive stimuli that move toward perceivers. In the second experiment, evaluations of stimuli moving toward perceivers are made more accurately and less positively biased compared to evaluations of stimuli moving away from perceivers. Future exploration of this effect is necessary to integrate these findings and devise a paradigm that lends itself better for analyzing the effects of motion perception both on accuracy and on speed in a single study. The current choice of paradigms did not allow for such an integration.

An additional interesting result of the present study is that more vigilant processing, instigated by stimuli moving toward perceivers, has a prolonged effect. Vigilant processing is not determined by the movement direction a perceiver is seeing at a certain moment, but by whether the vigilant processing has been activated by stimuli moving toward the perceiver in the recent past. In the first experiment this was apparent in the speed of reactions. When evaluations were made during or after stimulus movement toward the perceiver, these evaluations were made faster than when they were made for stimulus movement away from the perceiver. In the second experiment there was a clear gain in accuracy for evaluations made after and during movement of stimuli toward perceivers compared to movement away. The enduring vigilance that is caused by stimuli moving toward a perceiver fits with an adaptive interpretation of our results. It has obvious advantages to any organism to stay attentive for a while after something has threatened it.

With the current study, we provide preliminary evidence for the idea that stimuli moving toward perceivers activate a vigilant processing state, which has different effects for the processing of positive and negative information. The vigilant state is different from other attentional effects that are evoked by specific stimulus characteristics (like valence and relevance), but the adaptive framework used by studies investigating these effects is comparable. Vigilant processing styles were presumably developed by organisms to enhance chances of survival. As Pratto and John (1991) point out, the value of automatic vigilance lies in making the perceiver aware of things in the environment that may require fast responses. This is most certainly the case for moving stimuli. As we perceive stimuli in the distance moving toward us, we become aware very quickly and accurately whether these stimuli represent a threat or not.

Appendix 2.1

Stimuli used in experiment 2.1 and 2.2

Positive		Negative	
vriend (friend)	goed (good)	slecht (bad)	haat (hatred)
mooi (beautiful)	liefde (love)	vijand (enemy)	ziek (sick)
geluk (luck)	vrij (free)	oorlog (war)	gemeen (mean)
zon (sun)	fijn (lovely , nice)	kanker (cancer)	tering (damned)
leuk (fun, nice)	aardig (friendly)	ramp (disaster)	kots (vomit)
kus (kiss)	vrolijk (happy)	hel (hell)	graf (grave)
eerlijk (honest)	plezier (fun)	kwaad (evil, angry)	gierig (greedy)
lente (spring)	feest (party)	woede (wrath)	etter (puss, bastard)
schat (darling)	zomer (summer)	dood (death)	vrek (miser)
prettig (pleasant)	oprecht (sincere)	vals (vicious)	angst (fear)
slim (smart)	lekker (tasty)	wapen (weapon)	schuld (blame, fault)

Chapter 3

Going Against the Grain:
Regulatory Focus and Interference by Task-irrelevant Information

Abstract

In this study it is argued that a perceiver's regulatory focus (promotion or prevention) influences the amount of attention allocated to processing stimuli from the environment. Results of two experiments, employing an interference task and using different manipulations of regulatory focus, supported this idea. More attention was allocated to stimuli incompatible with the activated focus (promotion – negative stimuli, prevention – positive stimuli). The incompatible stimuli therefore interfered more with an ongoing task than compatible stimuli. These results are discussed in terms of processing efficiency and integrated with motor-compatibility effects.

Introduction*

Almost every sane person is motivated to approach pleasure and positive things and to avoid pain and negative things. In the field of social psychology there are many different theoretical perspectives that elaborate on this hedonic principle, regulatory focus theory being one of them. According to regulatory focus theory (Higgins, 1997), self-regulation works in two distinct ways, either through a promotion focus or through a prevention focus. In a promotion focus, people aim for accomplishments and achievement, or in other words, positive outcomes. In a prevention focus, people focus on safety and responsibilities. The main focus, then, is on preventing negative outcomes.

Experimental studies applying regulatory focus theory have yielded interesting results, among others in a study by Shah and Higgins (2001). These authors looked at the efficiency of judging whether a certain emotion is applicable to a certain attitude object. The results of the study show that a judgment made on an emotional dimension congruent to the activated regulatory focus is easier and thus more efficiently made than when the emotional dimension does not fit the focus. In a promotion focus, the dimension that fits is cheerfulness/dejection, whereas in a prevention focus quiescence/agitation fits better. This study by Shah and Higgins (2001) can be interpreted as an example of differential processing of stimuli that is dependent on the active regulatory focus. Each regulatory focus has a distinct fitting emotional dimension on which it is easier to judge stimuli. In this paper we want to expand on this theme and look at a more basic level of processing stimuli from our environment: i.e. the amount of attention that is dedicated to specific stimuli.

We view regulatory focus as a part of the cognitive architecture with implications for the processing of valenced stimuli[4]. In a specific regulatory focus, the cognitive system of the perceiver is attuned to the kind of stimuli that fit that particular regulatory focus, thereby facilitating the processing of these stimuli (cf. compatibility hypothesis, Strack & Deutsch, 2004, see also Barsalou, Niedenthal, Barbey & Rupert, 2003). In other words, a specific regulatory focus influences the amount of attention that is allocated to the processing of certain types of stimuli. When stimuli fit the active regulatory focus, less attention is needed to process these stimuli. Stimuli that do not fit (are incompatible with)

* This chapter is based on De Lange & Van Knippenberg, 2007b.

4 Note that when we refer to an *"active"* regulatory focus, a promotion or prevention *mindset* is implicated. The active regulatory focus should not be interpreted as an active motive or goal to seek either nurturance or security. This mindset may alternatively be construed as a form of cognitive tuning of ones processing style (see e.g. Friedman & Förster, 2001).

the active focus require more attention to be processed. An important feature that determines whether stimuli fit a specific regulatory focus is valence. More specifically, in a promotion focus people focus on the absence or presence of positive outcomes, whereas in a prevention focus, people focus on the absence and presence of negative outcomes. Therefore, we expect compatibility to exist between a promotion focus and positivity, and between a prevention focus and negativity.

Note that this type of fit between valence and regulatory focus is fundamentally different from the fit between focus and emotional dimensions (Shah & Higgins, 2001). Ratings on an emotional dimension reflect the outcome of a judgmental process, and therefore need to encompass labels for both positive and negative events in both regulatory foci. The origin of these positive or negative emotions is either the absence or the presence of an outcome of a certain valence. The most positively valued event in a promotion focus is the presence of a positive outcome; the most negative event is the absence of such a positive outcome. In a prevention focus, the reverse is true for negative outcomes. Thus, both in a promotion and prevention focus, positive and negative emotions fit either the absence or presence of certain outcomes. However, when it comes to compatibility of foci with stimuli on the perceptual or automatic level, there is a single valence that will fit each focus. A promotion focus is compatible with positive outcomes or stimuli; a prevention focus fits with negative stimuli.

This compatibility argument converges with studies in the field of embodied cognition by Förster and colleagues (Förster & Stepper, 2000; Förster & Strack, 1996; see also Neumann & Strack, 2000). In these studies, compatibility between bodily movements (head shaking or nodding) or body postures (standing upright or kneeling) and valenced words affected the amount of attention (or cognitive capacity) required for the learning of these stimuli. Compatible stimuli (nodding/standing upright and positive words, head shaking/kneeling and negative words) required less attention than incompatible stimuli, as measured by a secondary task involving manual dexterity. Diminished performance on this secondary task indicated that there was less residual attention when stimuli were presented that were incompatible with bodily movements or postures.

Förster and Stepper (2000) conceptualized these bodily postures as a method of activating either the approach (standing upright) or the avoidance (kneeling) system. Compatibility is thus proposed to exist between the approach and avoidance systems and positive and negative stimuli respectively. This system-valence compatibility has implications for encoding: Compatible stimuli can be encoded more easily, requiring less attentional resources. Compatibility therefore facilitates secondary task performance. It is important to note that participants received explicit instructions to learn the words they were presented with in these studies. The conscious processing and encoding of the valenced words affected the secondary task. This then leaves the question as to what will happen if the valenced stimuli are not themselves part of the focal task, but are merely present in the context of a focal task.

Recently, Gawronski and colleagues (Gawronski, Deutsch & Strack, 2005) followed up on these compatibility studies by demonstrating that memorizing stimuli is easier in an orientation-congruent than incongruent context. In this study (exp. 1) participants memorized neutral stimuli in the context of positive or negative pictures, while executing approach or avoidance muscle contractions (arm flexion or extension). In the following recognition task, participants showed better recognition for neutral stimuli that were presented in a congruent context (although only in the approach condition). The explanation for these findings forwarded by the authors is that orientation-incongruent pictures have a stronger attention grabbing power, and therefore interfere more with memorization than orientation-congruent pictures. However, although presented as an automatic effect in terms of the spontaneity and uncontrollability of the effect, the trials (consisting of one neutral stimulus and three positive or negative pictures) were presented for 4000 ms. We think this time frame provided participants with ample opportunity to process all stimuli thoroughly and that the effects of valenced distractor items on memory performance may thus be due to other factors than automatic attention allocation.

Like Gawronski and colleagues, we assume that the compatibility effects found in encoding tasks are mirrored by incompatibility effects in attention allocation in interference tasks. Stimuli related to a motivational orientation or regulatory focus, either compatible or incompatible, will influence attention allocation more than unrelated stimuli, and thus interfere more with performance on the interference task. However, when these distracting stimuli are incompatible with the active regulatory focus, even more attentional resources will be needed to (automatically) process these stimuli. Since the encoding of incompatible stimuli requires more attention than the encoding of compatible stimuli, these stimuli should also interfere more with other ongoing tasks that require attention.

Present research

In the current study, we aim to extend existing research by looking directly at the automatic direction of attentional capacity to motivationally compatible and incompatible stimuli that are merely present in the environment of another focal task. Furthermore, we do not look at the effects of incompatible stimuli from the perspective of physically induced approach and avoidance orientations but from a motivational perspective. However, we do derive the hypotheses of the current experiments from the embodied cognition framework.

The active regulatory focus is compatible with stimuli of a certain valence, similar to the well-established approach/avoidance motor-compatibility (see Strack & Deutsch, 2004). Furthermore, (in)compatibility between automatically evaluated stimuli and regulatory focus influences the amount of attention needed for the processing or categorization of these stimuli. This should become apparent in an interference task, using valenced stimuli as distractor items. Distracting stimuli that are incongruent with the active regulatory focus will interfere more with the focal task than compatible stimuli. This effect is probably smaller in automatic perception than in more elaborate conscious processing, but it should nevertheless be detectable in the response latencies of an interference paradigm.

To test this hypothesis, a promotion or prevention focus was activated in participants in both studies. Participants were then presented with stimulus words written in either upper case or lower case letters. These stimulus words were positively or negatively valenced. The participants were asked to indicate whether the words presented were written in upper or lower case letters. Response latencies on this focal task are indicative of the amount of attention allocated to the valenced distractor words. For participants in a promotion focus, we expect negative words to produce more interference than positive words. Conversely, for participants in a prevention focus, we expect positive words to produce more interference than negative words. Note that interference in the current study is not to be taken as absolute interference. Since no neutral baseline is established, the findings may only be interpreted as more or less interference by one category of distractor stimuli than the other category.

Experiment 3.1

Method

Participants and design. Forty-seven students (11 men, 36 women) from the Radboud University of Nijmegen participated and received one euro as compensation. The design of the experiment was a 2 (word valence: positive vs. negative) x 2 (regulatory focus: promotion vs. prevention) mixed design. Word valence was manipulated within subjects[5]; regulatory focus was manipulated between subjects.

Procedure. Prior to the interference task, participants were presented with a maze task that activated either a promotion or a prevention focus (Friedman & Förster, 2001). This task was presented as a pilot study, unrelated to the actual experiment. In both conditions, a pencil and paper maze task was presented with a mouse situated in the middle of the maze. Participants were simply asked to solve this maze by finding the way out for the mouse. In the promotion maze, a piece of cheese was depicted outside of the maze near the exit, in front of a brick wall containing a hole for the mouse. Working on this maze task activated 'seeking nurturance' and gaining a desired end state. In the prevention condition, the same maze was used but instead of the cheese, an owl was depicted as hovering over the maze. Escaping the maze now activated 'seeking security' and preventing a negative end state (i.e. being caught by the owl; see Friedman & Förster, 2001, for validation of this task).

After the maze task, participants continued with a computerized interference task. Instructions for this task appeared on the screen, explaining that words written in either upper case or lower case letters would be shown on the screen. The participants were asked to indicate in which case a word was written by pressing one of two buttons, marked on the keyboard. The intertrial interval was varied between 1 and 4 seconds to force participants to keep their attention on the screen in order to respond as quickly as possible. This variable intertrial interval was used to prevent response strategies.

Following the instructions, participants were presented with 40 experimental trials that consisted of ten positive (e.g. sun, humor, success) and ten negative words (e.g. wrong, ugly, angry). Every word was presented once in upper case and once in lower case letters. Presentation order of the stimulus words with respect to valence and upper

[5] For exploratory reasons, we also included the factor specificity of the stimulus words in the experiments. Both global positive and negative words, and positive and negative words specifically related to one of the regulatory foci were used (e.g. gain, loss). We found no effects of this factor. This means that the effects we found are caused by the valence of the stimulus words, not the applicability of the words to one of the two foci. Results concerning this specificity factor will not be reported any further

or lower case was determined at random by the computer program. When no response was registered within 1500 milliseconds, a warning appeared on the screen that responses should be made faster. Upon completion of the interference task participants were asked to answer some demographic questions, probed for suspicions, paid and thanked for their participation.

Results and discussion

Due to the lack of a practice phase, participants had to familiarize themselves with the experimental task during the first trials. Therefore, response latencies of the first four trials were not included in the analyses. On average, relatively few errors were made in the remaining trials (M = 2.1 %) and few response latencies exceeded the window of 1500 milliseconds (M = 0.5 %). Latencies of responses outside this window and latencies of the incorrect trials were filtered from the analyses (2.6 % of the trials). To correct for the skewed distribution, a logarithmic transformation was performed on the latencies before analyses.[6] For the sake of clarity, untransformed means will be reported in milliseconds.

We expected more interference on the upper/lower case task when stimulus words were incompatible with the induced regulatory focus with respect to valence. To test this prediction, response latencies on the interference task were averaged per level of valence, and subjected to a regulatory focus (promotion versus prevention) by valence (positive versus negative) analysis of variance (ANOVA) with the latter factor within subjects.

We found the predicted interaction of valence and regulatory focus, F (1, 45) = 6.53, $p < .02$, $\eta_p^2 = .13$. No other significant effects were obtained.[7] The interaction effect of valence and regulatory focus is displayed in figure 3.1. Analysis of simple effects showed marginally significant effects in the expected direction. Participants in a promotion focus demonstrated a tendency to respond faster to positive stimuli (M = 567 ms, SD = 63

[6] In both experiments, the response latency analyses were also performed after an inverse transformation and after removal of latencies that deviated more than three standard deviations from the mean latency per participant. The same effects reached significance in all three analyses. This implies that the effects we found are not influenced by the type of skewness correction used (Ratcliff, 1993).

[7] As can be seen in figure 3.1, however, there is a trend ($p < .08$) suggesting faster responses by participants in a promotion focus than in a prevention focus. An ad-hoc explanation for this trend is an increased need for accuracy of prevention-focused individuals as compared to promotion-focused individuals. Higher accuracy usually leads to slower responses (the well known speed-accuracy trade-off). This explanation is also supported by regulatory focus theory (see e.g. Förster, Higgins & Taylor Bianco, 2003); in a prevention focus, behaviour is usually aimed at avoiding mistakes and vigilance whereas in a promotion focus people aim for hits and are more or less unconcerned with errors. The current data supports this proposition by another marginal trend ($p < .09$), indicating that participants in a prevention focus make fewer errors than participants in a promotion focus.

ms) than to negative stimuli (*M* = 586 ms, *SD* = 76 ms), *F* (1, 45) = 3.54, *p* < .07, η_p^2 = .07. Participants in a prevention focus appeared to react faster to negative stimuli (*M* = 612 ms, *SD* = 77) compared to positive stimuli (*M* = 633 ms, *SD* = 111 ms), *F* (1, 45) = 3.00, *p* = .09, η_p^2 = .06.

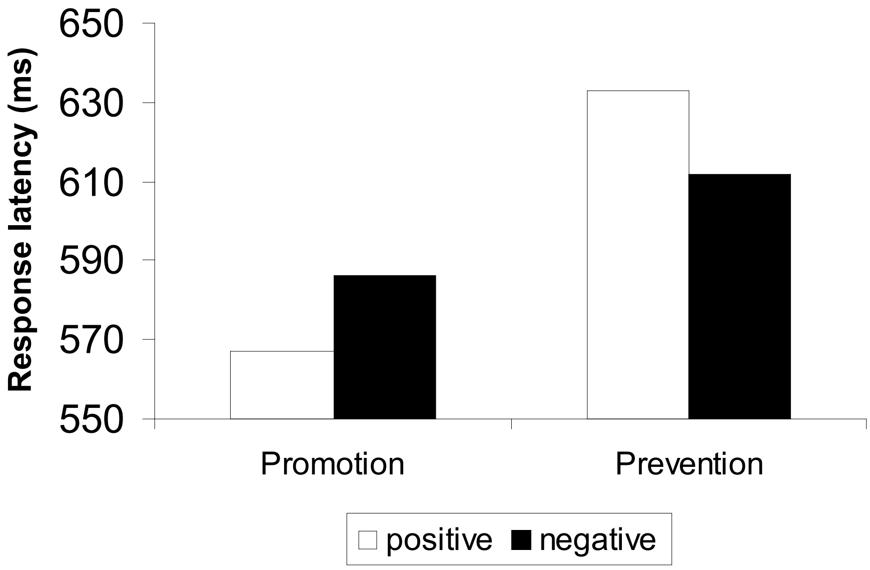

Figure 3.1.
Response latencies in milliseconds as a function of regulatory focus and stimulus valence in experiment 3.1.

These results support the hypothesized incompatibility effect. Stimuli that are incompatible with the activated regulatory focus cause more interference on the upper/lower case task than compatible stimuli. This interference is caused by greater allocation of attention to focus-incompatible stimuli. A second experiment to test the incompatibility effect was designed for two reasons. First, the simple effects within each regulatory focus condition failed to reach significance, so more data supporting our hypothesis are required to demonstrate the reliability and robustness of the effect. Second, by using a different manipulation of regulatory focus we aim to increase the generalisability and validity of our findings.

Experiment 3.2

Method

Participants and design. Fifty-two students (15 men en 37 women) from the Radboud University of Nijmegen participated. Participants were rewarded for their participation by one or two euros (see below). The design of this study was similar to that of the first experiment, a 2 (word valence: positive vs. negative) x 2 (regulatory focus: promotion vs. prevention) design. Word valence was manipulated within subjects; regulatory focus was manipulated between subjects.

Procedure. This second experiment followed the same procedure as the first experiment to a large extent; only changes to the procedure of experiment 3.1 will be described. Regulatory focus was manipulated by means of a short instruction, presented after ten practice trials. The promotion focus instructions were: "*You will receive one euro for this experiment, however: If you score with the fastest 20 percent of all participants until now, you will win one extra euro! If you do not score with the fastest 20 percent, you will not win an extra euro*." The prevention focus instructions were: "*You will receive two euros for this experiment, however: If you do not score with the fastest 20 percent of all participants until now, you will lose one euro! If you do score with the fastest 20 percent, you will not lose one euro.*" These instructions have previously been validated and used to induce regulatory focus in several studies (e.g., Higgins, Shah, & Friedman, 1997).

After the instructions, another ten practice trials followed by 64 experimental trials were presented to the participants. These experimental trials consisted of 16 positive and 16 negative words, presented in both upper and lower case letters. The rest of the experiment followed the same procedure as the first experiment.

At the end of the experiment, participants were shown their average response latency and were informed whether this average latency fell within the 20 percent limit or not. Dependent on the speed of responding in the interference task participants were paid one or two euros. The 20 percent limit that was used was calculated on the basis of the average response latencies in experiment 3.1.

Results and discussion

On average, few errors were made (M = 3.1 %) and few response latencies were outside the window of 1500 milliseconds (M = 0.2 %). Latencies that fell above this window and those of incorrect responses were not included in the analyses (3.3 % of the trials). To correct for the skewed distribution of the response latencies, a logarithmic transformation was used.

These data were subjected to a regulatory focus (promotion versus prevention) by valence (positive versus negative) analysis of variance (ANOVA), with the latter factor within subjects. The expected interaction of valence and regulatory focus was reliable, $F(1, 50) = 11.58$, $p < .01$, $\eta_p^2 = .19$. As can been seen in figure 3.2, the pattern of the interaction is similar to the pattern that was found in the first experiment. Analysis of simple effects showed that participants in a promotion focus reacted slower to negative stimuli (M = 562 ms, SD = 88 ms) than to positive stimuli (M = 547, SD = 79 ms), $F(1, 50) = 7.62$, $p < .01$, $\eta_p^2 = .13$. Participants in a prevention focus reacted slower to positive stimuli (M = 537 ms, SD = 52 ms), compared to negative stimuli (M = 527, SD = 53 ms), $F(1, 50) = 4.16$, $p < .05$, $\eta_p^2 = .08$.

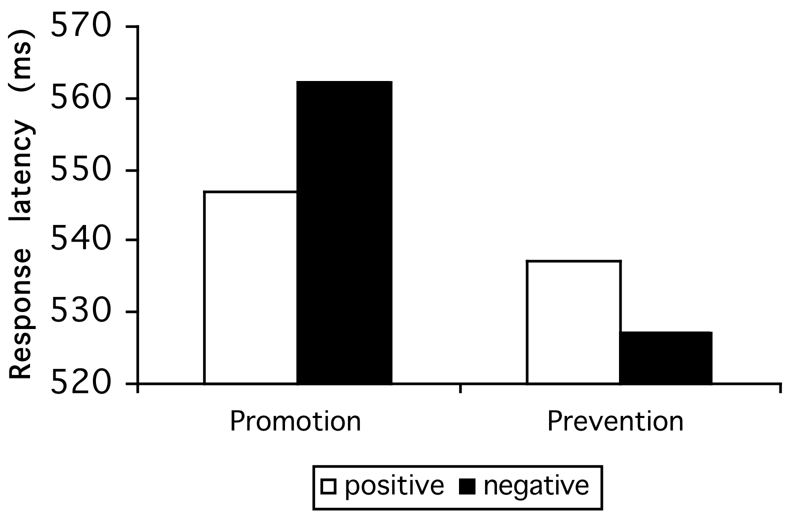

Figure 3.2.
Response latencies in milliseconds as a function of regulatory focus and stimulus valence in experiment 3.2.

As in the first experiment, the results support the hypothesized incompatibility effect. Incompatible stimuli with regard to the activated regulatory focus cause more interference on the upper/lower case task than compatible stimuli. In our view, these results demonstrate that regulatory focus affects the amount of attention allocated to incompatible and compatible stimuli, presumably because incompatible stimuli require more attention for categorization and encoding and therefore cause more interference on a focal task than compatible stimuli.

Meta Analysis

The patterns of the results of the two studies are not identical. We think this is mainly due to the different manipulations of regulatory focus. By using a gain/loss manipulation in the second experiment, thereby introducing a monetary reward for fast responses, participants were more motivated to respond as quickly as possible. This caused a decrease in response latencies of about 55 milliseconds on average in the second experiment, compared to the first experiment. Importantly however, this decrease in response latency did not influence the incompatibility effect.

To investigate the differences between the results of the two studies we performed a meta analysis on the data of the two experiments, adding the factor study as a between subject factor to the design. Predictably, the interaction of valence and regulatory focus in the aggregated data was highly significant, F (1, 95) = 15.59, $p < .01$, partial $\eta^2 = .14$. There was no interaction of this effect with the factor study, confirming that the incompatibility effect is similar in both studies. Also, the simple effects within each regulatory focus condition were significant. In a promotion focus, participants reacted faster to positive stimuli than to negative stimuli (F (1, 95) = 9.19, $p < .01$, $\eta_p^2 = .09$), whereas participants in a prevention focus reacted faster to negative stimuli than to positive stimuli (F (1, 95) = 6.53, $p < .02$, $\eta_p^2 = .06$).

We also found a main effect of study, F (1, 95) = 14.42, $p < .01$, $\eta_p^2 = .13$, showing faster reactions in the second study than in the first (*M*'s respectively 536 and 591 ms). However, an interaction of study and focus further qualified this result, F (1, 95) = 4.17, $p < .05$, $\eta_p^2 = .04$, showing a significant increase in speed by participants in a prevention focus (ΔM = 90 ms, F (1, 95) = 16.87, $p < .01$) but not by participants in a promotion focus (ΔM = 23 ms, F (1, 95) = 1.56, $p = .21$).

This difference is likely to be caused by the manipulations we used in the two experiments. In the first study we induced a regulatory focus using the maze task, which led participants in a promotion focus to respond with eagerness (high speed) and participants in a prevention focus to respond with vigilance (few mistakes). This is demonstrated by the somewhat slower but more accurate responses (see footnote 7). In the second study, regulatory focus was manipulated by a gain/loss instruction whereby money could be lost (or not gained) when performance was slow. This instruction did not make a big difference for participants in a promotion focus, who still responded with the same eagerness. But, it did make a difference for participants in a prevention focus, who were now vigilant with respect to late responses, leading to faster reactions but also as many errors as participants in a promotion focus. The difference in the pattern of results between the two studies can thus be explained by a change in what prevention-focused participants were vigilant towards, either errors (study 3.1) or late responses (study 3.2).

General discussion

The results of the present studies offer clear support for the notion that self-regulatory focus affects the allocation of attention to stimuli that are merely present in our environment. In two experiments, using two different manipulations of regulatory focus, it was shown that more interference was elicited by stimuli with a valence incompatible with the activated regulatory focus than by focus-compatible stimuli. These differences in interference result from differential automatic allocation of attention to compatible and incompatible stimuli.

The current findings mirror results obtained in motor-compatibility studies (Förster & Stepper, 2000; Förster & Strack, 1996). In these studies, words compatible to the participant's bodily condition or posture required less attention to be learned, which leads to better performance on a simultaneously executed dexterity task compared to incompatible words. In the present study a similar effect was obtained (incompatible words take more attention to be spontaneously processed and therefore hinder performance on a simultaneously executed focal task), but under very different experimental conditions.

First, we used a manipulation of regulatory focus instead of a bodily manipulation of approach/avoidance orientation. Rather than activating a physical state that is associated with positivity or negativity, we induced a motivational state more directly. Second, the participants in the motor-compatibility studies engaged in the physical movements or held the posture during the entire experiment, whereas we only induced the regulatory focus once. Finally, a very important difference between these studies lies in the use of paradigms. Förster and colleagues employed paradigms investigating conscious encoding in which the adopted posture or movement could facilitate the processing of compatible stimuli (see Gawronski et al., 2005 for encoding in the presence of valenced distractors). In these encoding paradigms, participants were asked to learn words, which were consciously processed. The current studies employed an interference paradigm, which is more suited to look at attentional processes. In this paradigm, the meaning and valence of the stimulus words was irrelevant to the execution of the experimental task and served as a distraction for a focal task. This suggests a more spontaneous effect of the compatibility of the stimulus words on the focal task.

Usually, the effects found in encoding and interference paradigms are interpreted using different explanations. For example, interference effects are explained by the amount of attention that is grabbed or held by certain stimuli, commonly determined by their relevance or salience to the perceiver. In encoding paradigms on the other hand, effects may be explained by compatibility benefits at encoding. It would be interesting to formulate one overarching theoretical frame to accommodate the effects of both paradigms (see also Gawronski et al., 2005). Below, we propose such a theoretical explanation.

The key concept we introduce to achieve this overarching frame is processing efficiency. Processing efficiency can be defined as the amount of attentional resources required to process (encode, store) specific stimuli. More efficient processing of a stimulus lowers the amount of attention needed. The advantage of using the processing efficiency concept is that it is capable of explaining both superior encoding of compatible stimuli in encoding paradigms, as well as less distraction from compatible stimuli in distraction or interference paradigms, compared to incompatible stimuli. In encoding paradigms, compatible stimuli are processed more efficiently and, therefore, are processed more quickly (e.g. Neumann & Strack, 2000), and encoded better which leads to better memory for these stimuli (e.g. Förster & Stepper, 2000; Förster & Strack, 1996), than incompatible stimuli. Similarly, in interference paradigms, compatible distractor stimuli are processed (categorized, encoded) more efficiently and therefore take away less attentional resources from the focal task, which leads to better (less disrupted) performance on the focal task, than incompatible distractor stimuli (e.g. Gawronski et al, 2005; the present study).

To predict whether compatibility or incompatibility effects will occur, one needs to take into account the choice of experimental paradigms and the specific process that is under investigation. When using a task to study encoding effects of (in)compatibility of the motivational orientation with features of focal stimuli to be processed (e.g. when studying posture effects on memory of presented stimuli as the focal task), then effects may theoretically range from facilitation (i.e. better performance than baseline) to inhibition (i.e. worse performance than baseline). Although it will often not be self-evident how the appropriate baseline must be defined, it is quite conceivable that encoding benefits for a class of stimuli may stem from postures or movements that have been associated with this class of stimuli in the past. Conversely, it is also conceivable that stimulus encoding is hampered when movement and postures induce afferent affective information that is contrary to the affective valence of the stimulus. Whether or not each of these effects will be obtained, crucially depends on the degree to which the motivational orientation actually enhances processing efficiency (e.g. nodding when processing a positive stimulus) compared to a neutral state (stationary head position), or hamper processing efficiency (e.g. head shaking when processing a positive stimulus) compared to the same neutral state. This line of argument, based on embodied cognition theory (Barsalou et al., 2003; Niedenthal et al., 2005) specifically applies to experimental paradigms in which the stimuli to be processed concern the focal task (e.g. an explicit memory task involving these stimuli).

When using interference paradigms that focus on automatic attention allocation, the focal task usually concerns a specific performance (e.g. color naming) while task-irrelevant stimuli are present in the context (e.g. words) that may potentially distract from the focal task (e.g. when reading the words leads to slower or incorrect responses). In this class of paradigms, the level of distraction engendered by the task-irrelevant stimulus in general can only reduce performance on the focal task – at best, it may leave task performance unaffected – but it will not enhance task performance[8]. Thus, it may be argued that in the domain of interference paradigms, effects range from zero to maximally disruptive, i.e. from no effect to an incompatibility effect. The degree of compatibility between distracting stimuli and the motivation or bodily condition again determines processing efficiency. The more efficient processing of task irrelevant stimuli, the less

[8] This is not meant to imply that peripheral stimuli can never enhance task performance. It is quite conceivable that contextual stimuli enhance task motivation or performance efficiency, in the sense that e.g. motivational primes with the word “fast” may lead to faster responses on a focal task (see Dijksterhuis, Spears, Postmes, Stapel, Koomen, Van Knippenberg & Scheepers, 1998 for a related argument).

interference with the focal task. Thus, whether compatibility or incompatibility effects of motivational orientation are found is mainly due to the specific process that is under investigation and the choice of paradigm, but is in either case determined by processing efficiency.

Note that the processing efficiency explanation is parsimonious. It is capable of explaining both the findings from encoding and interference paradigms under the same theoretical frame and fits well within the existing theoretical framework of embodied cognition (e.g. Barsalou et al., 2003; Niedenthal, Barsalou, Winkielman, Krauth-Gruber & Ric, 2005). Also, despite the fact that the term processing efficiency is not used explicitly in previous studies, it is implicated in a number of studies. For example, Förster and Stepper (2000) write, “compatibility … requires less cognitive resources than a condition of incompatibility” (p.806). And Förster and Strack (1996) note that the execution of incompatible behaviors requires more mental capacity than the execution of compatible behaviors. Our use of processing efficiency as an explanatory concept is thus not at variance with the motor-compatibility literature.

In some studies using interference paradigms, findings are reported that seem inconsistent with our present theoretical proposal. Specifically, in studies using a Stroop task it was found that priming of semantically related colored stimulus words enhanced color-naming latencies (Warren, 1974). On closer inspection, however, this finding may not really conflict with the proposed framework. Although priming indeed enhances the accessibility of the primed concept – and thus enhances processing efficiency – it also, at the same time, enhances the salience of the stimulus word, which as such enhances its interference with color naming. Priming renders the distracting stimulus word more conspicuous, and therefore enhances its attention-grabbing potential. For example, “butter” interferes more with color naming when primed with “bread”, than when not primed, because after the “bread” prime it becomes more compelling to read “butter” than when not primed. Thus, it is the enhanced salience (or conspicuousness) of the word that causes enhanced interference, not the enhanced processing efficiency.

Another seemingly contradictory finding would be Moskowitz’ (2002) demonstration that accessible goals enhance the interference of goal-relevant items in a Stroop task. At first glance these findings do not fit the processing efficiency framework, since it predicts more efficient processing of motivation compatible stimuli. However, like in the previous example, other features of the stimuli, besides processing efficiency explain these results. Goal relevant items become salient because they fit the current goal of the perceiver. Since they fit the goal, these items are extremely self-relevant for the perceiver and therefore particularly attention grabbing. Hence, these stimuli interfere more with color naming than stimuli unrelated to active goals. Again, it is not the enhanced processing efficiency, or accessibility *per se*, but another feature of the stimulus that enhances its position in the participant's processing priorities. Furthermore, in the current studies – as well as in studies on the motor-compatibility effect – all stimuli that are used are relevant to the participant. Both congruent and incongruent stimuli are relevant for the active motivational orientation. Therefore, in contrast to the study by Moskowitz, relevance (and therefore salience) of the stimuli used in the current study does not differ between the stimulus categories and thus does not influence the amount of interference.

As these examples demonstrate, there is another mechanism responsible for interference, aside from a lack of processing efficiency. This mechanism can be referred to as "attention grabbingness" or "attentional direction" (i.e. the extent to which the stimulus is salient to the perceiver). Features affecting this process may be novelty, self-relevance, goal relatedness and priming. To distinguish processing efficiency from this mechanism in an interference task, certain features of the stimuli like self-relevance need to be kept constant over stimulus categories. Under these circumstances, less interference will be found when stimuli can be processed more efficiently.

On a functional level, the expenditure of additional attentional resources on incompatible stimuli may serve as a higher order regulation mechanism. As argued in the present paper, the cognitive system attunes itself to the current situation, but higher order monitoring of the environment is needed as well to function effectively (see Derryberry & Tucker, 1994; Rothermund, 2003, for similar arguments concerning feedback). Of course, it is functional to process compatible stimuli efficiently in order to proceed with attaining a positive end state or avoiding a negative one, depending on the active regulatory focus. However, it would not be functional to be (relatively) blind for environmental cues that might signal incompatibility between what is perceived and the active motivational orientation. To illustrate, when a promotion focus is active and the emphasis is on gain and attaining positive end states, it would prove very dysfunctional to ignore cues that signal loss or negativity. Conversely, in a prevention focus, keeping an eye out for positivity would ensure that one does not become stuck in trying to preventing negative outcomes and creates the possibility to switch to pursuing gains and adopting a promotion focus.

Thus, higher evoked attention for incompatible stimuli can be functional because these stimuli may signal that the environment does not fit the way information is being processed. When exposed to strong enough cues that signal such incompatibility, a change of focus may occur automatically. However, this does not happen easily lest the organism becomes a playing ball of its environment. Spontaneous allocation of attention to incompatible distracting stimuli leads to dismissal of these stimuli most of the time. For example, being exposed to multiple compatible and incompatible stimuli (as in the current study) or being exposed to relative mildly incompatible stimuli should not elicit a change of focus. In the case of gross or enduring incompatibility between environment and mental focus, however, a monitoring system can produce adaptive switching of the organism’s regulatory foci to suit a changed environment. If what we perceive is going against the grain, it may not be very efficient to process, but important to monitor nonetheless.

Chapter 4

To Err is Human:
How Regulatory Focus and Action Orientation
Predict Performance following Errors

Abstract

In the current study, the authors hypothesize that post-error performance is influenced by individual differences in action orientation and situationally induced regulatory focus. Two experiments employing a time pressured flanker-like task, measured participants’ dispositional action orientation and manipulated regulatory focus. All participants showed slower responses following erroneous trials, compared to correct previous trials, in line with previous research demonstrating post-error slowing. As expected, accuracy of the responses following errors was reduced for all participants except for action-oriented participants in a promotion focus. The latter participants are assumed to down-regulate error-related negative affect, thereby saving resources for subsequent performance. Promotion focus was assumed to facilitate the optimal use of these resources.

Introduction[*]

"Errare Humanum Est"

- Seneca

Making mistakes can be very unpleasant, but happens to all of us. As the quote from Seneca in the motto above aptly states: To err is human. Consolation may be found in the suggestion that it is often not the mistake but the response to the mistake that matters. In this light, it seems very unfortunate that mistakes tend to bring about more mistakes. Surprisingly, behavioral scientists rarely investigate what impact erroneous responses have on subsequent performance. Furthermore, little is known about why some people appear to suffer less from making mistakes than others. In the current paper we investigate how a dispositional manner of dealing with stressful situations combined with an individual's motivational orientation interact to overcome the detrimental influence that making a mistake may have on subsequent performance.

The origin of poor performance following mistakes may be found in a lack of resources available for post-error processing. Following an error, even though a response has already been given, the brain continues task processing (see also Kleiter & Schwarzenbacher, 1989). The resulting diminution of cognitive resources leads to suboptimal performance, such as slower or less accurate performance on subsequent tasks. Research has demonstrated that post-error responses are indeed characterized by slowing (Rabbitt, 1966, see also Fairweather, 1978) and inaccuracy (Rabbitt & Rodgers, 1977). These effects have been mainly found in speeded response tasks, but there is some evidence of post-error slowing in the slower paced judgments of verbal analogies (Kleiter & Schwarzenbacher, 1989).

In what way the lack of resources impairs post-error performance (slowing, error-correcting responses, inaccuracy etc.) seems to depend on the specific experimental paradigm employed. For example, in paradigms employing a small inter-trial delay but no time pressure, we may expect slowing following errors. Participants normally strive to give correct answers and take more time to be able to give these answers following errors. Inaccuracy seems more likely in tasks with inherent time pressure. Given time pressure, post-error slowing may not be an option, in which case deteriorated post-error processing is likely to enhance incorrect responding.

[*] This chapter is based on De Lange & Van Knippenberg, 2007c.

Related to this reasoning is the notion that making an error is accompanied by aversive affect (e.g. Luu, Collins & Tucker, 2000; see also recent research on unintentional processing of motivational valence by Moors, De Houwer, Hermans & Eelen, 2005). The negative affect activated by making an error may cause problems with the attentional disengagement from the erroneous trial (Van der Wulp, Semin, Galucci & Finkenauer, 2007), thereby explaining the diminished resources in the following trial. This is not to say that activation of negative affect is dysfunctional. It may well be very functional, as it provides a cue for detailed, bottom up processing (see e.g. Bless & Schwarz, 1999), which may be needed for a careful analysis of the committed error in certain tasks and situations. However, this mode of processing proves detrimental in situations requiring rapid changes in behavioral responses or speeded response tasks.

A different way of looking at post-error processes may be found in the psychophysiological literature on action monitoring, which has explored how errors influence brain activity. Typically, a neural response to an error is found in the medio frontal cortex, consisting of a sharp negative deflection in the event-related brain potential (ERP). This neural response reaches its peak approximately 100 ms following making an error and is termed error-related negativity (ERN or Ne; Falkenstein, Hohnsbein, Hoorman, & Blanke, 1990; Gehring, Goss, Coles, Meyer, & Donchin, 1993). Although the exact interpretation of what ERN reflects remains a matter of discussion (e.g. an affective response to an error, the outcome of a generic error detection system or a response conflict; for a review and integration see Yeung, 2004), it is clear that errors (as well as feedback indicating errors; Miltner, Braun, & Coles, 1997) evoke brain activity generated in the anterior cingulate cortex that may be responsible for subsequent deteriorated performance.

In these studies on ERN behavioral measures are not the main interest, however, post-error slowing is sometimes reported (e.g. De Bruin, Mars & Hulstijn, 2004; Hajcak, McDonald & Simmons, 2003, Holroyd, Yeung, Coles & Cohen, 2005). Studies on ERN usually focus on the amplitude of the ERN as a measure of the impact an error has on the individual. For example, the amplitude of the ERN increases when errors are more significant, for instance when accuracy is important (e.g. Hajcak, Moser, Yeung & Simons, 2005). Also, ERN-amplitude following errors has been shown to be moderated by individual differences. For example, larger ERN amplitudes were found for students scoring high on negative affect (Hajcak et al., 2004; Luu et al., 2000), neuroticism (Luu et al., 2000) and for students scoring high on anxiety and worry scales (Hajcak et al., 2003) or obsessive-compulsiveness (Hajcak & Simons, 2002).

It is important to note that behavioral effects of making a mistake take place much later than ERN. The ERN takes place roughly 100 ms. following an error whereas behavioral effects may well take place over 1500 ms. following that error. Whether ERN-amplitude is related to post-error slowing or other behavioral measures is unclear at this time. None of the studies reporting post-error slowing mentioned above demonstrate a link between ERN-amplitude and behavioral effects, leaving the possibility that they may very well be dependent on completely different processes. It is therefore also unclear if the individual differences mentioned in ERN-studies have any effect on post-error behavior. In the current paper, we address this issue by focusing specifically on individual differences in post-error performance.

Inspired by the psycho-physiological literature, we think that the reaction to making a mistake is dependent on dispositional factors of the individual committing the mistake. It is interesting to note that the factors reported to affect ERN (e.g. anxiety, worry, neuroticism, obsessive-compulsiveness) all relate to one specific theory of self-regulation, i.e. the theory of action orientation (Kuhl, 1981; 1994a). This theory, which focuses on dispositional cognitive and affective dynamics within the individual, differentiates between a state-oriented and an action-oriented mode of behavioral control. How negative affect that accompanies errors is regulated may be predicted by the individual’s dispositional action or state orientation (Kuhl, 1994a; 2000). Neuroticism, Obsessive-Compulsive disorder, high worry etc. all are related to a chronic high state-oriented mode of control (Kuhl, 1994a, but see Baumann & Kuhl, 2002, for the complex relationship between state orientation and neuroticism).

The action or state orientation of an individual is comprised of an over-learned set of routines used to cope with demanding situations and the aversive affect that accompanies them. Action-oriented individuals are characterized by down-regulation of the aversive affect evoked by stressful events and rapid mobilization of cognitive control resources. State-oriented individuals on the other hand, tend to ruminate on negative events. It is assumed that “state-oriented individuals will respond to stressful conditions with persistent negative affect, negative rumination and inhibited self-regulation” (Koole & Jostmann, 2004, pp. 975-976).[9] Research has indeed demonstrated that following failure

[9] Note that a state orientation disrupts task performance only during stressful or very demanding conditions. Performance does not suffer disruption under normal conditions wherein state-oriented individuals may even

in a training phase, performance decrements on a complex cognitive task were found for state-oriented, but not for action-oriented participants (Kuhl, 1981). Likewise, induction of stress leads to diminished cognitive control among state-oriented individuals, but not among their action-oriented counterparts (Jostmann & Koole, 2005). Furthermore, the down-regulation of negative affect responsible for these differences in performance was demonstrated to occur only for action-oriented individuals in demanding contexts (Koole & Jostmann, 2004).

Thus, in relatively stressful situations (e.g. fast paced tasks), action orientation theory predicts different reactions to committing an error. State-oriented individuals will have difficulty down-regulating the accompanying negative affect and are thus inclined to ruminate about their mistake, thereby hampering post-error performance. Action-oriented individuals disengage from their mistake by the effective down-regulation of the associated negative affect and are able to perform post-error behavior relatively normally. However, this dispositional difference in dealing with errors is only part of the picture. Next to the stable ways of handling stressful situations, people are continuously influenced by temporary, more dynamic motivational factors.

The pleasure principle is thought to be one of the most basic motivational forces guiding behavior. This principle entails that people approach what they desire and avoid what appears threatening. This basic mechanism has lead to a substantial amount of research demonstrating that positivity is associated with approach movements and negativity with avoidance movements and vice versa (e.g. Cacioppo, Priester, & Berntson, 1993; Chen & Bargh, 1999; Solarz, 1960). These movements or bodily orientations may also be construed as fitting a higher order motivational system, described by regulatory focus theory (Higgins, 1997). This theory posits that (goal directed) behavior is guided by either a promotion or a prevention focus, which influences a host of cognitive processes. Regulatory foci have been shown to influence (among others) the interpretation of affective states (Shah & Higgins, 2001), the amount of attention dedicated to valenced stimuli (De Lange & Van Knippenberg, 2007b), creativity (Friedman & Förster, 2001) and the effects of success and failure feedback on motivational strength (Förster, Grant, Chen Idson, & Higgins, 2001).

Although people may differ as to which focus is preferred chronically, both foci are present in our behavioral repertoire and situational cues have been shown to activate the suitable regulatory focus in a wide variety of both judgmental en behavioral tasks (see e.g.

outperform action-oriented individuals (Koole, Kuhl, Jostmann & Vohs, 2005; see also Diefendorff, Hall, Lord & Strean, 2000).

Higgins & Spiegel, 2004, for a review). The focus that is activated is obviously one fitting the specific situation, in terms of response strategy or processing style. In a promotion focus, people aim for gains, nurturance and there is a general eagerness to score results. In this focus, people tend to use approach means and “risky” response strategies or processing styles. In contrast, people in a prevention focus are concerned with (preventing) losses, security and are vigilant with regard to failure. In this motivational focus, the emphasis is on avoidance means and a more conservative response strategy. In general then, making of an error should be more aversive for people in a prevention focus.

However, action and state orientated individuals may differ in the extent to which they are able to use their regulatory foci, especially when regulation of affect that follows errors is involved. First, although state-oriented individuals are able to activate both promotion and prevention foci, their affect regulation skills may cause difficulty in certain situations. People with a dispositional state orientation are chronically overconcerned with the mistakes they make, even in conditions in which their focus is on gaining rewards (i.e. a promotion focus). The negative affect accompanying mistakes leads to rumination, thereby interfering with the eager response strategy activated by a promotion focus. Thus, state-oriented individuals can be motivated to look for hits, but they are dispositionally constrained to reflect on losses as soon as they occur. For state-oriented individuals then, performance following errors in fast paced response tasks will be hampered irrespective of which regulatory focus is active.

Action-oriented individuals are more flexible with regard to the influence of motivational orientations in these situations. The action orientation ensures the individual of the down-regulation of the negative affect associated with making errors and freeing up resources to help task performance. An active prevention focus with its loss-aversive, vigilant response strategy makes the action-oriented individual more cautious following an error, thereby hampering post-error performance, especially in time pressured tasks. However, a promotion focus complements the action orientation by providing an eager response strategy, putting to work the available resources. Thus, only the conjoint occurrence of both an action orientation and a promotion focus will lead to optimal performance following errors in situations where speeded responses are required.

Present research

The present research was designed to specifically investigate the behavioral effects of making a mistake in a time-pressured task. We hypothesize that post-error performance will be hampered (compared to post-correct response performance), except for action-oriented individuals in a promotion focus. In two experiments, participants performed a cognitively demanding task wherein regulatory focus was manipulated using different procedures. Action orientation was measured using the preoccupation or failure related subscale (AOF) and the prospective or decision-related subscale (AOD) of the Action Control Scale (Kuhl, 1994b). Since the present research is concerned with errors, we expect to find effects of action orientation as measured by the failure related subscale (see Kuhl, 1994a).

Experiment 4.1

Method

Participants and design. Sixty-one students (46 female) from the Radboud University of Nijmegen participated and received 1 or 2 euros (see below) as compensation. The design of the experiment was a 2 (result of previous trial: correct vs. incorrect) x 2 (regulatory focus: promotion vs. prevention) x 2 (AOF: action vs. state) mixed design. Result of the previous trial was a within subjects' factor whereas regulatory focus and action orientation were between subjects' factors. The dependent measure consisted of the proportion of correct responses on the current trial.

Experimental task. The task used in this experiment is based on the Eriksen Flanker task (Eriksen & Eriksen, 1974), which is commonly used to investigate error-related negativity. In the classic flanker paradigm, participants are presented with a string of five symbols or letters (e.g. <<><< or SSHSS) and are asked to indicate what the middle symbol is (in these examples > and H). The symbols surrounding the middle symbol are irrelevant to the task, but do influence the speed and accuracy of responses. Congruency between the flankers and the middle, target symbol heightens accuracy and leads to faster responses than incongruency.[10] The task we designed for the current

[10] In preliminary studies, we employed the classic flanker paradigm to investigate the effects of motivation and action orientation on performance following errors. We found the typical flanker effects, but in no study did we find effects on performance following errors. The flanker task is probably too easy to leave room for the

experiment required a similar, but more complex processing of the flanking stimuli. Participants were presented with a grid of 3 x 3 letters (S and H) and were asked to indicate whether or not the middle, target letter corresponded with three of the four corner letters. Examples of the letter grids that were used in experiment 4.1 and 4.2 are presented in figure 4.1. All grids consisted of the letters S and H (nine letters in total, four of one letter, five of the other), and there existed either congruency or incongruency between the target and three corner letters. The grids were presented randomly with respect to their configuration, target letter and congruency. Congruent and incongruent grids were presented equally often for both target letters. There was no influence of the target letter (S or H) on any of our analyses; this variable will therefore not be discussed any further.

H	S	H		H	S	S		H	S	S		H	H	S
S	H	S		H	S	H		H	H	H		H	S	H
S	S	H		S	H	S		S	S	H		H	S	S

Congruent grids | Incongruent grids

Figure 4.1. Examples of letter grids used in experiment 4.1 and 4.2.

Each letter grid was preceded by a fixation point for 400 ms., and was presented to the participants for 900 ms. The presentation ended after a response was given or after the 900 ms. expired. A response was given by pressing one of two marked keys on the keyboard (the “A” and “6” key on the numerical pad”) that corresponded with either incongruency or congruency between the target letter and three corner letters. Upon completion of each trial, participants received feedback on their performance. One of three types of feedback was displayed on the screen, depending on the performance of the participant. Either the word “goed” (right) in the color green, “fout” (wrong) in red or “te

influence of motivation and/or dispositional factors. We therefore devised a more difficult adaptation of the flanker paradigm, with a more complex decision criterion and longer inter-trial intervals.

laat" (too late) in blue. This feedback remained on the screen for 1000 ms., followed by an inter-trial interval of 1500 ms.

Procedure. Upon arrival in the laboratory, participants were seated in individual cubicles containing a computer. On the computer screen, detailed instructions regarding the experimental task were presented and participants were shown examples of experimental trials. Following the instructions, participants were presented with 20 practice trials to familiarize themselves with the experimental task and to practice responding within the 900 ms. response window.

Upon completion of the practice trials, half of the participants received instructions that induced a promotion focus, the other half received prevention focus inducing instructions. The promotion focus instructions were: "*You will receive one euro for this experiment, however: If you score amongst the 20 percent of all participants until now who make the smallest number of errors, you will win one extra euro! If you do not score amongst the 20 percent who make the smallest number errors, you will not win an extra euro*." The prevention focus instructions were: "*You will receive two euros for this experiment, however: If you do not score amongst the 20 percent of all participants until now who make the smallest number of errors, you will lose one euro! If you do score amongst the 20 percent who make the smallest number of errors, you will not lose one euro.*" Similar instructions have previously been validated and used to induce regulatory focus in several studies (e.g., De Lange & Van Knippenberg, 2007b; Higgins, Shah, & Friedman, 1997).

The experimental trials followed the induction of regulatory focus and consisted of two blocks of 60 trials, each preceded by four practice trials. In-between the two blocks, participants were shown their results so far (number of correct, false and too late responses) and presented with the promotion or prevention instructions as a reminder. Following the experimental trials, participants were asked to answer some demographic questions and to fill out a Dutch translation of the AOF and AOD subscales of the Action Control Scale (Kuhl, 1994b). Since action and state orientation are thought to be mutually exclusive, participants were coded as either predominantly action-oriented or state-oriented (cf. Kuhl, 1994b). To code participants, they were split at the conceptual midpoint of the AOF scale (which also corresponded with a median split). Participant who gave six or more action-oriented responses were coded as action-oriented, participants who gave less than six action- oriented responses were coded as state-oriented. As hypothesized, participants' scores on the AOD subscale did not significantly influence performance following errors alone or in interaction with regulatory focus. Therefore, only analyses with action orientation as measured by the AOF will be reported.

At the end of the experiment, participants were shown percentages of the trials in which they reacted correctly, falsely or too late and informed whether their performance fell within the 20 percent limit or not. Dependent on their accuracy, participants were paid one or two euros. The 20 percent limit that was used was calculated on the basis of a pilot study.

Results and discussion

The proportions of correct responses following correct responses and following incorrect responses were calculated. Note that participants could make two different errors: Giving the wrong response or not giving a response within the time window. However, there was no significant difference in the pattern of results for responding incorrectly or responding late on the previous trial. These two prior responses were therefore pooled into one measure of responding incorrectly. To examine the optimal combination of action orientation and regulatory focus for performing the experimental task, the proportions of correct responses were subjected to a repeated measures ANOVA with the results of the previous trial (within participants), regulatory focus and action orientation (both between participants) as factors.

This analysis revealed the predicted interaction of the result of the previous trial with regulatory focus and action orientation, F (1, 57) = 6.51, $p < .02$, partial $\eta^2 = .10$. As predicted, this interaction was not significant for the responses made after a correct trial, F (1, 57) = 0.51, *ns*. Post-correct performance was not influenced by action orientation, regulatory focus or by a combination of both. However, when participants responded incorrectly in the previous trial, a significant interaction between regulatory focus and action orientation emerged, F (1, 59) = 5.64, $p = .02$, partial $\eta^2 = .09$. Simple effect tests show that action-oriented participants in a promotion focus gave significantly more correct responses than action-oriented participants in a prevention focus (F (1, 57) = 5.72, p = .02) or state-oriented participants with a promotion focus (F (1, 57) = 3.96, p = .05; see Table 4.1 for means). Additionally, accuracy did not differ for state-oriented individuals in a promotion or prevention focus (F < 1, *ns.*), nor for participants in a prevention focus who were either action-or state-orientated (F (1, 57) = 1.45, p > .20). No main effects of either action orientation or regulatory focus were found (both Fs < 1.5, *ns*.). These results support our hypothesis regarding post-error performance. Action-oriented participants in a promotion focus demonstrate superior performance following errors compared to all other participants.

Table 4.1

Mean proportion of correct responses on the current trial following incorrect or correct responses on the previous trial as a function of regulatory focus and action orientation in Study 4.1 (with standard deviations in parentheses)

	Following incorrect responses		Following correct responses	
	State	Action	State	Action
Promotion	58 (20)	71 (18)	70 (15)	72 (14)
Prevention	63 (14)	56 (16)	67 (11)	65 (14)

Furthermore, a one sided t-test demonstrated that for action-oriented participants in a promotion focus, the decrease in accuracy following errors and following correct responses did not differ from zero, t (12) = .32, *ns* (see Table 4.1). For action-oriented participants in a prevention focus this decrease was significant, (t (14) = 3.57, p < .01), as it was for state-oriented participants in a promotion focus (t (17) = 2.94, p < .01) and marginally so for those in a prevention focus (t (14) = 1.58, p < .07). Thus, action-oriented participants in a promotion focus do not only perform better than other participants following errors, they also perform as accurately following errors as following correct responses.

Although the current paradigm employed a response window, we did analyze response latencies to check for post-error slowing. Indeed, reactions following errors (669 ms) are somewhat slower than reactions following correct responses (657 ms; F (1, 57) = 7.62, p < .01). This effect was not influenced by either action orientation or regulatory focus. Although any effects of errors on response latencies are not directly comparable to effects found in paradigms without a response window, this result does point to post-error slowing. Interestingly, unlike the effects on accuracy, this effect on response latencies is not influenced by dispositional or motivational factors.

The participants' action orientation was measured at the end of the experiment, thereby risking contamination of this measure by the induced regulatory focus. Although we found no effect of the regulatory focus manipulation on the measured action orientation, F (1, 59) = 0.14, *ns*., this methodological flaw is remedied in the second experiment.

Experiment 4.2

Because we predict an interaction between three variables in a study employing a newly developed paradigm and a rather complex design, a replication of the results is in order to substantiate our findings. Thus, in the second experiment, we aim to replicate the superior post-error performance by action-oriented individuals with an active promotion focus. In this replication, we use a different method to induce regulatory focus to test the robustness of our findings. In addition, a third block of trials is added in an attempt to gain more power for statistical analyses.

Method

Participants and design. Sixty-two students (48 female) from the Radboud University of Nijmegen participated and received between 1.8 to 2.8 euros (see below) as compensation. The design of this experiment was a 2 (result of previous trial: correct vs. incorrect) x 2 (regulatory focus: promotion vs. prevention) x 2 (action orientation: action vs. state) mixed design. Result of the previous trial is a within subjects factor whereas regulatory focus and action orientation are between subjects factors.

Procedure. Experiment 4.2 employed the same methodology as experiment 4.1, with three exceptions. The first change was the time of measuring the participants' action orientation. This was done by presenting them with the Action Control Scale (Kuhl, 1994b) at the start, rather than at the end of the experiment. Again, the AOD subscale did not yield significant interactions with the dependent measures and is therefore not considered any further. The second change in methodology was the number of experimental trials. In the second experiment the participants completed three blocks of 60 trials, totaling 180 experimental trials.

The third change concerns the manner of manipulating regulatory focus. Participants received the same task instructions and practice phase as in experiment 4.1.

However, the instructions manipulating regulatory focus differed. A promotion focus was induced by explaining that money could be gained or not gained per trial, whereas a prevention focus was induced by similar instructions explaining that money could be lost or not lost per trial. All participants were told that they would receive 1 euro for the experiment, irrespective of their performance. However, participants in a promotion focus were told that they could gain another conditional 1.80 euros. For every correct response they would gain 0.01 euro, for every false or late response they would not gain money. This was also reflected by the feedback these participants received after each trial. When a correct response was given, feedback consisted of "+ 0.01 €" written in a green color, whereas feedback consisted of "+ 0.00 €" written in red when no or a false response was given. A prevention focus was induced by explaining participants that they would receive a conditional 1.80 euros for the experiment on top of the unconditional euro, but that they would lose 0.01 euro for every false or late response, and not lose any money for every correct response. The feedback for prevention focused participants consisted of "- 0.00 €" in green when a correct response was given and "- 0.01 €" in red when no or a false response was given. After each block of 60 trials, participants were informed of their performance so far and shown the amount of money gained/not lost. At the end of the experiment, participants were informed of their total performance and paid out the amount of money they earned in the experiment, rounded up to the nearest 10-cent amount.

Results and discussion

As in experiment 4.1, the proportion of correct responses was calculated, both following correct responses on the previous trial and following incorrect responses, or missing responses on the previous trial. Again, no difference was found in the pattern of results for responding incorrectly or not responding on the previous trial. These two prior responses were therefore pooled into one measure of responding incorrectly.

In contrast to the first experiment, we did not find a significant interaction between the result of the previous trial with regulatory focus and action orientation, F (1, 58) = 1.16, p = .29.[11] Guided by our more specific hypotheses regarding responses made after an erroneous trial, we tested the more specific interactions after correct and incorrect trials. As predicted, the interaction between regulatory focus and action orientation was not

[11] Note that failure to find the expected interaction was not due to the lack of the predicted pattern of results in post error performance. Rather, a similar, though non-significant pattern following correct trials was apparent in our results, explaining the lack of the expected three-way interaction (see also Table 4.2).

significant for the responses made after a correct trial, F (1, 58) = 2.66, p = .11. However, this interaction did reach significance when participants responded incorrectly in the previous trial, F (1, 58) = 4.40, p = .04, partial η^2 = .07. Simple effect tests show a similar pattern of responding following errors as found in the previous experiment: Action-oriented participants in a promotion focus gave significantly more correct responses than either action-oriented participants in a prevention focus (F (1, 60) = 4.62, p < .04) or state-oriented participants in a promotion focus (F (1, 60) = 9.04, p < .01; see Table 4.2 for means). No differences in accuracy were found for state-oriented participants in either a promotion or prevention focus (F < 1, *ns*.), nor for participants in a prevention focus who were either action-or state-oriented (F < .1, *ns*.).

Table 4.2

Mean proportion of correct responses on the current trial following an incorrect response on the previous trial as a function of regulatory focus and action orientation in Study 4.2 (with standard deviations in parentheses)

	Following incorrect responses		Following correct responses	
	State	Action	State	Action
Promotion	61 (20)	77 (14)	66 (17)	78 (10)
Prevention	67 (15)	66 (13)	73 (16)	73 (12)

Again, action-oriented participants in a promotion focus did not suffer a loss of accuracy following errors compared to following correct responses (t (16) = .41, *ns*.). Action-oriented participants in a prevention focus did show a loss of accuracy, (t (10) = 2.03, p < .04), as did state-oriented participants in a promotion focus (t (14) = 1.72, p < .06) and those in a prevention focus (t (18) = 3.38, p < .01). Action-oriented participants in a promotion focus performed as accurately following errors as following correct responses, whereas the accuracy of other participants decreases.

Additionally, like in the previous experiment, we found an effect on response latencies indicative of post-error slowing. Responses following errors were slower (673 ms) than responses following correct trials (658 ms; *F*, (1, 58) = 6.98, $p < .02$, partial η^2 = .11).

These results seem to be very much in line with the results of the first experiment. In both experiments, action-oriented participants with an active promotion focus were most accurate in their post-error performance. To further look at the similarity in results between the two experiments we performed a meta analysis on these results.

Meta analysis

The data of the two experiments were pooled (N = 123) and analyzed in the same manner as reported above, with the addition of the between subjects factor study (4.1 vs. 4.2). Supporting our hypothesis, the interaction of result on the previous trial with regulatory focus and action orientation (AOF) was highly significant (F (1, 115) = 7.22, $p < .01$, partial η^2 = .06). The specific study did not have an effect on this interaction (F (1,115) = 1.94, p = .17, partial η^2 = .02), indicating that the effects found in study 4.1 and 4.2 do not differ. The three-way interaction was due to the interaction between regulatory focus and action orientation following incorrect trials (F (1, 115) = 10.04, $p < .01$, partial η^2 = .08). This interaction was not significant after correct responses (F (1, 115) = 2.77, p = .10). Following incorrect trials, task performance by action-oriented participants with an active promotion focus was significantly better than the performance by action-oriented participants with an active prevention focus (F (1, 121) = 11.50, $p < .01$) and better also than the performance of state-oriented participants in a promotion focus (F (1, 121) = 13.14, $p < .01$). Post-error performance did not differ for state-oriented participants in either a promotion or a prevention focus (F (1, 121) = 1.89, $p > .17$), nor for prevention focused participants who were either action-or state-oriented (F (1, 121) = 1.10, $p > .29$).

Additionally, simple effects analyses showed that action-oriented individuals in a promotion focus do not suffer a loss of accuracy following incorrect trials. Accuracy following incorrect trials (.74) was as high as accuracy following correct trials (.75; t (29) = .50, *ns.*). All other combinations of action orientation and regulatory focus did lead to significant losses in accuracy following incorrect trials (all t's > 3.36, all p's < .01). No differences of any kind were found for performance following correct answers.[12]

[12] Analyses using signal detection measures produced similar results. Following errors, action orientation interacts with regulatory focus to predict accuracy (F (1, 123) = 3.28, $p < .08$). Action-oriented participants in a

The meta analysis further revealed post-error slowing; task performance following incorrect responses was slower (*M* = 671 ms) than performance following correct responses (*M* = 658 ms; F (1, 115) = 14.49, $p < .01$, partial $\eta^2 = .11$). Furthermore, an interaction between performance on the previous trial, action orientation and regulatory focus emerged (F (1, 115) = 5.73, $p < .02$, partial $\eta^2 = .05$). Following correct trials, action-oriented individuals with a promotion focus appeared to respond somewhat faster than others. Following incorrect trials, state-oriented individuals with a prevention focus appeared to respond somewhat slower than others. However, none of the simple effects reached significance (all *p*'s > .10).

General discussion

Seneca's full quote about erring reads “Errare humanum est. Perseverare diabolicum” or to err is human, to persist is diabolical. Seneca notwithstanding, the current study demonstrates that to persist in making mistakes is a very human property, at least in the domain of tasks requiring fast responses. Unless, that is, if you happen to be an action-oriented individual with a promotion focus. This specific combination of dispositional affect regulation skills and active motivational orientation ensures optimal performance following errors when fast responses are required. To be more precise, in the current study, making an error decreases speed of responding on the following trial. More importantly, the accuracy of responses on this post-error trial diminishes, except for action-oriented individuals with a promotion focus who respond as accurately as following a correct trial.

The cause for the degraded performance in post error performance is thought to reside in the negative affect accompanying the error. Making a mistake activates negative affect, which makes attentional disengagement from the situation associated with the negative affect (i.e. the previous trial) difficult. This impedes good performance in subsequent trials by occupying resources needed for task processing. It follows that there are two prerequisites to perform well despite making mistakes in time-pressured tasks. First, one needs effective affect regulatory skills to down-regulate the activated negative affect, thereby freeing resources for subsequent task performance. Secondly, to effectively use these resources, motivation to achieve hits (and thereby being relatively

promotion focus were more accurate (*d'* = 1.66) than other participants (*d'*s .69, .86 and .90) following errors. There were no effects found following correct trials. Also, response bias (β) was not influenced by any of the studied variables.

unconcerned with mistakes) is needed. As the current study suggests, the unique combination providing these prerequisites is an action orientation combined with a promotion focus. Note that these results are restricted to the domain of time-pressured tasks, or those requiring quick changes in behavior. The negative affect activated by making mistakes may be very functional in other situations where one is able to analyze the cause of the mistake and possible correct it (see also Koole, Kuhl, Jostmann & Vohs, 2005).

Behind this explanation lies the assumption that action- and state-oriented individuals differ in their flexibility regarding regulatory foci. Both state- and action-oriented individuals may activate either a promotion or a prevention focus, but it depends on specific situations how effective this motivational orientation is. For state- oriented individuals, a promotion focus may provide the eagerness to score hits, but this will be functional only in relatively relaxed situations. In stressful situations, involving the activation of negative affect, a promotion focus may be active, but is likely to be ineffective. The activated negative affect is not down-regulated effectively by state-oriented individuals, leading to distraction and rumination or at least attentional distraction from the task at hand. In time-pressured tasks, such distraction clearly interferes with the eagerness of the active promotion focus leading to suboptimal performance. As the current research illustrates, action-oriented individuals are more flexible under stressful conditions. They are able to use the eager response strategy of an active promotion focus because of the effective affect regulation, which prevents a lack of resources in post-error trials.

One might say that, at least in stressful situations, we found a kind of regulatory fit to exist between an action orientation and a promotion focus. It may well be the case that regulatory fit also exists between a state orientation and a prevention focus, but in different situations. This fit between action orientation and regulatory focus could be of special importance when it comes to maintaining the active regulatory focus. Recent research suggests that eagerness to achieve a promotion goal is prolonged following success and diminished following failure, whereas the reverse holds for vigilance, a strategy for achieving prevention goals (see Förster et al., 2001; Idson, Liberman & Higgins, 2000). An action orientation may thus protect a promotion focus by down-regulating negative affect.

Likewise, a state orientation may keep a prevention focus alive by eliciting rumination on events that are accompanied by negative affect. This fit between how one can and wants to regulate behavior may prove instrumental in maintaining a motivational focus. Though the existence of this specific type of regulatory fit is hypothetical at the moment, the importance of regulatory fit has been demonstrated in other domains. For example, fit between motivational focus and certain task characteristics has been shown to lead to higher efficiency of appraisals (Shah & Higgins, 2001), stronger motivation during goal pursuit (Higgins, 2000) and enjoyment of goal directed action (Freitas & Higgins, 2002). We tentatively suggest that not just certain tasks may fit a certain regulatory focus, but that the regulatory focus may fit certain individuals.

On the experimental level, we think the current behavioral effects, moderated by action orientation and motivational focus, may be linked to Error Related Negativity (ERN). As indicated in the introduction, ERN amplitude is influenced by personality factors associated with high levels of state orientation. This provides at least suggestive evidence for the idea that the concept of action orientation is useful in thinking about post-error processes, both in the form of brain activity and behavior. Action orientation may actually be more useful in studying task related post-error processes than the more broad personality factors used thus far, since it is assumed to be more closely tied to performance (see e.g. Diefendorff, Hall, Lord & Strean, 2000). Although the post-error slowing is found in both the current and ERN studies, the question remains whether ERN-amplitude is involved in behavioral effects of erring. The specific paradigm we used may prove useful to further investigate the relation between individual differences, ERN and the behavioral consequences of making mistakes.

Coda

The current study has demonstrated that errors do not affect every person in the same manner. Dispositional differences in action orientation and situationally activated regulatory focus interact in predicting post-error performance. Though some may be destined to dwell on their mistakes and on that account suffer future performance deficits, others more readily move on and, given the right motivation, keep performing at the peak of their ability.

Chapter 5

General Discussion and Integration

The main purpose of this dissertation was to explore origins of heightened attention (vigilance) and distraction. To this end, the influences of stimulus characteristics (movement), motivational states (regulatory focus) and perceiver characteristics (action orientation) on attention allocation were studied. The aim of this final chapter is twofold. First, an overview of the results of the three empirical chapters is provided and the outcomes are discussed in relation to recent theorizing and research. Second, the three empirical chapters are integrated into a single theoretical frame and general conclusions are drawn.

Overview and discussion

Stimulus characteristics

The first empirical part of this dissertation explored a particularly salient characteristic of stimuli that we may encounter: Movement. Two experiments were designed to test the hypothesis that movement toward perceivers causes more vigilant processing than movement away. By presenting words in increasingly larger font sizes, movement toward the participant was simulated. Movement away from the participant was simulated by presenting words that decreased in font size.

The first experiment investigated the speed with which evaluative judgments about moving stimuli are made. As predicted, stimuli moving toward a perceiver elicited faster evaluation decisions than stimuli moving away from a perceiver. However, this main effect of movement was qualified by an interaction with valence, showing that the effect was mainly due to positive stimuli. Negative stimuli were evaluated equally fast when they moved away or toward perceivers.

In the second experiment, the accuracy and bias in evaluating stimuli were studied. The same basic method was used to present stimuli that appear to move, only now the presentation of stimuli was degraded (by flashing the experimental stimuli in-between moving letter strings) to enhance the difficulty of the task and increase the number of evaluation errors. A clear effect of stimulus movement was found. Accuracy was significantly higher for evaluations of stimuli moving toward perceivers than for stimuli moving away, confirming the expectations regarding evaluative accuracy.

In the current research paradigm, response bias refers to the preferential evaluation of stimuli as positive, which is assumed to be a default strategy. Indeed, evaluations of stimuli moving away from perceivers appeared to be positively biased. However, this positivity bias significantly decreased, and even disappeared, when stimuli moved towards perceivers. Taken together, these results show the more vigilant evaluative decisions regarding stimuli moving toward perceivers compared to stimuli moving away. Greater attentiveness in evaluative decisions increases accuracy and at the same time reduces the positivity bias.

Additionally, an effect of movement order was found in both experiments. This effect suggests that as soon as perceivers encounter stimuli that move toward them, they adopt a vigilant response strategy. In the first experiment, the speed with which evaluations were made increased when stimuli start moving toward perceivers following movement away. However, speed did not decrease for evaluations of stimuli moving away, when these occurred after stimuli moved toward the perceiver. A comparable, but more revealing pattern of movement order emerged in experiment 2.2: Evaluative accuracy increased when stimuli moved toward perceivers following movement way, whereas accuracy remained high following movement toward perceivers. In both studies, movement towards the perceivers instigated vigilant processing, which persisted even when movement towards changed into movement away.

This effect of movement order is indicative of the prolonged duration that movement-induced vigilance has. Although stimuli may have stopped moving towards perceivers, the vigilant processing state remains active to ensure careful processing. The results are explained by the assumption that remaining attentive for a while has clear adaptive value, once an individual has been confronted with threatening events, like moving stimuli in the environment. In other words, vigilant processing is more easily switched on than off.

Although they provide new and important results regarding the processing of moving stimuli, the current experiments and findings are limited in some respects. First, in the first experiment, the increase in speed of evaluations was only found to occur for positive stimuli. In Chapter 2, I argued that an explanation for the general slower responses to negative stimuli may be found in the automatic vigilance mechanism, which entails that negative stimuli automatically grab and hold attention longer than positive stimuli (see Pratto & John, 1991; Dijksterhuis & Aarts, 2003). Negative stimuli may be detected fast, but they require more time (attentional resources) to be processed than positive stimuli. In my opinion, the most likely explanation for the lack of faster evaluations of negative stimuli has to do with the holding of attention by these stimuli, due to more effortful processing (cf. van der Wulp et al., 2007). Movement toward perceivers does make the detection of both positive and negative stimuli faster. However, negative stimuli hold attention and therefore have a distracting effect on the execution of a response. Hence, speed benefits in evaluative decisions are only found for positive stimuli moving towards perceivers.

A second potential problem concerning the two experiments is the difficulty of integrating the results. The conclusion drawn in Chapter 2 is that movement of stimuli toward perceivers causes evaluations of those stimuli to be faster and more accurate. Hypothetically, however, one would expect a trade-off between speed and accuracy. Thus, higher accuracy for stimuli that move toward perceivers, as found in experiment 2.2, would necessitate slower responses. But, the faster responses found in experiment 2.1, would imply more incorrect evaluations.

These results are not necessarily incompatible, when one takes into account the different paradigms used in the two experiments. In general, it is plausible to assume that the differences in how performance is affected by vigilant processing will likely depend on the difficulty of what an individual is doing. In simple tasks, where few mistakes are to be expected, performance may be enhanced by faster responses. In difficult tasks, the accuracy of behavior and decisions may be improved. Thus, in the current experiments, task characteristics may have determined whether speed or accuracy benefits of stimulus movement were found. The relatively simple evaluation task of the first experiment allowed for faster responses, whereas the more difficult valence detection task, with its higher error rate, allowed for an increase in accuracy instead.

To summarize, Chapter 2 explored movement as a stimulus characteristic that may influence information processing. It is clear from the results of the experiments that were performed that movement of stimuli influences the way we process these stimuli. The study provided an initial exploration of the effects of stimulus movement, which lead to the conclusion that people devote more attention to evaluating stimuli that move toward them, compared to stimuli moving away. The more vigilant processing heightens the accuracy and in some cases the speed of these initial evaluations.

Motivational states

The third chapter of this dissertation dealt with the distracting influence incidental stimuli may have on task performance. Specifically, it was argued that stimuli that are compatible with an individual's regulatory focus are processed more efficiently than incompatible stimuli. More efficient processing means that less attentional resources are needed and thus that performance on a focal task will suffer less from the distraction caused by the processing of incidental stimuli.

Two experiments, using different manipulations of regulatory focus, provided support for this idea. As expected, performance on the focal task was disrupted less when stimulus words were compatible (promotion focus – positive stimuli, prevention focus – negative stimuli) rather than incompatible with the active regulatory focus. A meta-analysis on the results of the two experiments confirmed that this compatibility effect occurred both for participants in a promotion focus and for those in a prevention focus.

These results may be viewed as seemingly inconsistent with the automatic vigilance literature, wherein negative stimuli are thought to always grab more attention than positive stimuli. However, next to the current research, other recent research has also shown that this negativity bias may be conditional on an individual's affective context (Smith, Larsen, Chartrand, Cacioppo, Katafiasz and Moran, 2006). Smith and colleagues found that a person's affective context (i.e. activated constructs) may attenuate and even eliminate the attentional bias for negative information. A Stroop task preceded by the priming of positive information (or by a positive social interaction) lead to reduction of the negativity bias due to greater allocation of attention to positive information. In other words, making positivity salient leads to more attention for positive information. This study demonstrates that the temporary state of an individual may influence the attentional bias towards valenced stimuli.

Note that the results of the study by Smith and colleagues are in the opposite direction of the compatibility effect obtained in Chapter 3. These diverging findings are illustrative, however, of the salience versus processing efficiency distinction referred to earlier. As mentioned in the introduction of this dissertation, two predictions can be made for the effects temporary motivational or cognitive states have on the processing of environmental stimuli. On the basis of salience one would expect greater interference by compatible stimuli, on the basis of processing efficiency less interference is expected. These different predictions are borne out in the current study (Chapter 3) and the study by Smith et al. (2006).

In the latter study, participants were primed with negative or positive information, making one of these categories more salient for these participants. Higher salience in this regard may also be construed as a signal for the perceiver that this type of information is relevant to him or her. As a consequence, information that is of the same valence as the affective context grabs more attention than other information, thereby distracting the individual from the focal task.

For a motivational orientation, like a regulatory focus, both positive and negative stimuli are of importance, neither category is more salient than the other. However, stimuli of a valence that is compatible to the active regulatory focus are processed more efficiently due to the tuning of the cognitive system. The regulatory focus thus makes it easier to encode compatible information, without enhancing its salience to us. The current study and the work by Smith et al. (2006) both demonstrate that attentional biases are malleable by an individual’s internal state. The nature of this internal state predicts whether compatible stimuli require less attention for processing or hold attention due to their salience.

In Chapter 3, it was demonstrated that the fit between the active regulatory focus and valence of incidental stimuli makes processing of these stimuli more efficient. Thus, information present in the immediate surroundings of tasks we work on distracts us less when it is compatible with our regulatory focus, simply because it is the kind of information we expect to encounter. As a consequence, we are prepared, by the tuning of our cognitive system, to process compatible information.

Perceiver characteristics

The third empirical part of this dissertation dealt with a different kind of distraction from the tasks we are working on. Whereas the previous part looked at distraction by stimuli in the spatial proximity of the focal task, the fourth chapter was concerned with individual differences in the distraction by events in the temporal proximity. More precisely, dispositional action orientation in combination with regulatory focus was thought to predict performance following errors.

The specific combination of a dispositional action orientation, which predicts effective down-regulation of negative affect, and an active promotion focus is thought to predict superior performance following errors, compared to other combinations. This hypothesis was put to the test in two experiments. In both experiments, participants’ dispositional action orientation was measured. Regulatory focus was manipulated by means of a general gain/loss instruction applicable to the entire study (exp. 4.1) or by trial-to-trial gains/losses (exp. 4.2). Following this manipulation, participants made judgments about letter grids under time pressure.

The results of both experiments supported the prediction regarding post-error performance. Following correct responses, no significant effects on performance were found for differences in action orientation, regulatory focus or a combination of both. Following incorrect responses, accuracy dwindled for all participants, except for the dispositionally action-oriented participants with an active promotion focus. These participants appeared to suffer no detrimental effects of making mistakes on subsequent decisional accuracy.

This study pioneers the exploration of the combination of two theoretical views on behavior regulation that are extensively documented separately. Dispositionally, individuals differ in action control, which indicates how these individuals can, or are likely to, behave under stressful circumstances. Additionally, a temporarily active regulatory focus determines the specific strategy they use when performing behavior. The current study demonstrates that specific combinations of action control and regulatory focus may fit better than others and predict superior task performance.

Performance benefits of the co-occurrence of action orientation and promotion focus were demonstrated under the specific task conditions studied (performance under time-pressure), in comparison with other combinations of action control and regulatory focus. These other combinations, however, may prove to hold comparable benefits in different situations, where the behavior or task that is to be performed has distinct constraints.

For example, state-oriented individuals are thought to be susceptible to behavioral inaction and rumination when confronted with situations in which negative affect is activated. These situations commonly indicate that something is not right in the environment. In this case, state-oriented individuals may benefit from an active prevention focus, when it comes to analyzing this environment and protecting themselves. The state orientation provides a favorable disposition towards analyzing the causes of experienced negative affects and is complemented by the cautious response strategy inherent to a prevention focus. This combination of ability and motivation should therefore benefit individuals especially well in situations wherein mistakes are extremely costly, provided that the required response time isn’t severely constrained.

To summarize, Chapter 4 provides a new look on behavior regulation by combining action control and regulatory focus. So far, these two theories have not been explicitly linked or investigated in the same context before. In the current experiments, a fit between dispositional action orientation and situationally induced regulatory focus lead to superior performance. Thus, the abilities an individual has to deal with demanding situations may be complemented by, and benefit from, compatible response strategies.

Integration

Although the three empirical chapters of this dissertation differ considerably in their research questions, experimental paradigms used, and theoretical rationale, a common theme links them nonetheless. Distraction from the focal task an individual is working on, caused by factors that are irrelevant to the execution of this task, can be observed in every chapter. ‘Distraction’ is therefore presented as the concept unifying all three empirical chapters.

The most clear illustration of the distracting influence irrelevant stimuli may have is provided in Chapter 3. Events (stimuli) discrepant from our internal motivational state are processed less efficiently than more congruent events. The former are assumed to hold attention more than the latter, thereby limiting the amount of attention that can be allocated to task performance. The holding of attention can accordingly be construed as a distraction from the task an individual is working on.

In Chapter 4, it is demonstrated that most people are particularly susceptible to the distraction that making mistakes may cause. Mistakes and failure may be viewed as threats to the self; the individual fails to achieve a match between the actual behavior and the required behavior. This mismatch may lead to rumination about what went wrong and behavioral inaction. Again, attention is held by an event (failure on a previous task) that is in principle irrelevant to performance on the current task. As the research in Chapter 4 demonstrated, people differ in how susceptible they are to this distracting influence: State-oriented individuals in general suffer greater distraction by errors than action-oriented individuals. Moreover, for action-oriented individuals, the temporarily active regulatory focus influences the level of distraction

When it comes to evaluating moving stimuli, there is a general slowing down of the evaluative response in comparison with static stimuli. Movement in itself thus has an attention holding influence, which distracts individuals from the evaluation task. As seen in Chapter 2, the level of distraction caused by movement towards and away from the perceivers differs. Less attention is held (or more attentional resources are mobilized; see Chapter 2) by stimuli moving toward perceivers, which enhances the speed of evaluating positive stimuli, relative to stimuli moving away. Negative stimuli, however, hold attention out of their own right, thereby impeding faster responses.

Nonetheless, the enhanced mobilization of attentional resources in case of movement toward perceivers does benefit the processing of negative stimuli by allowing greater accuracy and a reduced response bias in the evaluation task. In experiment 2.2, this is apparent in the greater gain in accuracy in evaluating negative compared to positive approaching stimuli. Although accuracy is enhanced for the evaluations in general, the reduction of the positivity bias implies that particularly less negative stimuli are erroneously labeled positive.

Another recurring theme of the present dissertation is the distinction between salience and processing efficiency. In the discussion section of Chapter 3, this distinction is elucidated in relation to the experiments reported in that chapter. The integration in terms of distraction presented above may also be construed in terms of salience and processing efficiency. This distinction is therefore briefly discussed in relation to all empirical chapters.

The distraction that moving stimuli pose is thought to be caused by their attentional holding characteristics. Another way of framing this hypothesis is that moving stimuli are more salient to perceivers. The higher salience of moving stimuli means that more attention is dedicated to processing them, causing greater distraction from the focal task the perceiver is working on. In this case the focal task was an evaluation or valence detection task.[13]

Likewise, failure or making a mistake is salient to most individuals. The salience of the error, or the negative affect accompanying it, again causes attention to be held, leaving limited attentional resources for performance on the focal or next task. However, for some individuals the salience of errors is mitigated, due to the down-regulation of the

[13] It may seem odd to discuss an evaluation or valence detection task in terms of distraction or interference since the evaluative nature of the stimulus rightly influences the evaluation or choice. Next to the direction of the choice (good versus bad), however, there is no inherent reason for the evaluative nature of the stimulus to influence the speed of the decision. Thus, any delay in responses may be viewed as interference of stimulus characteristics with performance on the evaluation task.

negative affect accompanying these errors, which effectively frees cognitive resources (i.e. attention) for task performance.

Chapters 2 and 4 provide examples of how the salience of task-irrelevant events may influence the amount of distraction that an individual experiences. Chapter 3 demonstrates that the level of distraction may also be influenced by the efficiency with which environmental events or stimuli are processed. The greater the processing efficiency, the less attention is required for processing. Less attention dedicated to task irrelevant events means less distraction. To summarize, with regards to environmental events, greater processing efficiency means less distraction, higher salience means more distraction.

Conclusion

The studies presented in this dissertation each deal with a separate research domain, each with its own theoretical background. This is not to say that there is no overlap between them. All three are concerned with distraction and attention allocation and the effects this has on task performance.

In Chapter 2 this is apparent in attentiveness towards stimuli that are of greater relevance to perceivers (i.e. those moving towards them). The extra attention that is allocated to these stimuli leads to more accurate and in some cases faster evaluations. The third chapter does not look at the attention dedicated to the processing of relevant stimuli, but rather the attention needed for processing irrelevant stimuli. If stimuli we perceive in the environment of the task we are working on are compatible with our regulatory focus, they are easier to process and to disengage from. That means these stimuli will cause less distraction from the task we're working on. Note that a significant difference between Chapters 2 and 3 is that the former is concerned with focal stimuli, whereas the latter is concerned with peripheral ones. Finally, in Chapter 4, the impact making mistakes has on the tying up of attentional resources, or distracting us, is shown to depend on individual differences in self-regulation in combination with the active regulatory focus.

The research into the allocation of attention extends over many fields of research. On February 1 of 2007, a search using *attention* as keyword in the psychological literature yielded 104817 hits. This staggering number of publications concerned with attention shows perhaps how important and fundamental attentional processes are when it comes to predicting and studying human behavior. The three research lines dealing with distraction reported in this dissertation add to this field of research. Each of the chapters has dealt with new or previously unexplored questions regarding the origins of heightened attention and distraction. By investigating these topics, I hope to have contributed to our understanding of how attention and distraction influence information processing.

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Nederlandse Samenvatting

Dit proefschrift gaat over het verwerken van wat we waarnemen in onze omgeving. Over het algemeen zijn wij mensen bijzonder vaardig in het efficiënt verwerken van wat we zien of meemaken. Mochten we bijvoorbeeld een wandeling in een tropisch regenwoud maken dan hebben we niet alleen oog voor de vele prachtige planten en bloemen, maar ook voor eventuele gevaren die, al dan niet letterlijk, op de loer liggen. Zodra een gevaar, of iets negatiefs wordt waargenomen, dan zal dit direct onze aandacht trekken, wat onze overlevingskansen ten goede komt. Dat negatieve zaken snel onze aandacht trekken wordt ook wel *automatische waakzaamheid* genoemd. Met andere woorden, we worden van datgene waar we mee bezig zijn afgeleid door zaken die mogelijk van belang zijn. Afleiding wordt in dit proefschrift gedefinieerd als de toewijzing van aandacht aan zaken die ongerelateerd zijn aan de taak die op dat moment uitgevoerd wordt.

Hieruit volgt al dat niet alles wat waargenomen wordt even grondig door het cognitieve systeem wordt verwerkt. De capaciteit van het cognitieve systeem is beperkt, waardoor onze aandacht met name gericht wordt op zaken die voor ons relevant of interessant zijn. Dit is bijzonder functioneel aangezien het ons onder meer kan helpen bij het bereiken van onze doelen, zonder onnodig afgeleid te worden.

Eén van de meest basale doelen die de meeste levende organismen nastreven is overleven. Voor het nastreven van dit doel is het van belang om goed op de hoogte te blijven van eventuele bedreigende of negatieve zaken in de omgeving. Vandaar dat automatische waakzaamheid als een bijzonder functioneel mechanisme wordt gezien.

In het tweede hoofdstuk van dit proefschrift wordt verondersteld dat naast negativiteit ook beweging van wat we zien tot *automatische waakzaamheid* kan leiden. Meer specifiek wordt gesteld dat iets dat op ons afkomt meer bedreigend is dan iets dat van ons weg beweegt. De hogere dreiging maakt deze stimulus belangrijker voor de waarnemer waardoor deze op een meer waakzame manier informatie zal gaan verwerken. Deze waakzame manier van informatieverwerking zal moeten leiden tot een snellere en/of meer betrouwbare beoordeling van de stimulus die zich op ons af beweegt.

In hoofdstuk 2 worden twee experimenten gerapporteerd waarin deze veronderstelling nader onderzocht is. In beide experimenten werd een deelnemer op een computerbeeldscherm geconfronteerd met woorden die groter of kleiner leken te worden, wat de illusie van beweging van deze woorden veroorzaakte. De woorden die gebruikt werden waren positief of negatief. De taak van de deelnemer in het eerste experiment (exp. 2.1) was om deze woorden zo snel mogelijk te evalueren als positief of negatief. Uit de resultaten van dit experiment bleek dat stimuli die op de waarnemer afkwamen sneller geëvalueerd werden dan stimuli die van de waarnemer af bewogen. Dit effect werd echter veroorzaakt door de snellere evaluaties van positieve woorden die op de waarnemer afkwamen. De resultaten laten verder zien dat de evaluatietaak langzamer uitgevoerd lijkt te worden met bewegende dan stilstaande stimuli. Dit suggereert dat beweging op zich aandacht trekt en dus de waarnemer afleidt van de evaluatietaak.

In het tweede experiment (exp. 2.2) kregen deelnemers een rij letters te zien die van hen af of naar hen toe leek te bewegen. Tijdens deze beweging werd heel kort, enkele malen een woord gepresenteerd dat daardoor moeilijk te lezen was. Aan de deelnemers werd gevraagd aan te geven of er een positief of negatief woord gepresenteerd werd. Door het moeilijk te maken om het woord waar te nemen kon de accuraatheid van het waarnemen van positiviteit en negativiteit bekeken worden. De resultaten van dit experiment lieten zien dat stimuli die naar een waarnemer toe bewogen accurater werden beoordeeld dan wanneer ze van diegene af bewogen.

Naast deze effecten op snelheid en accuraatheid van evaluaties werd in beide experimenten een effect van de volgorde van bewegen gevonden. Het lijkt erop dat beweging van stimuli naar een waarnemer toe voor een langdurige waakzame staat van informatieverwerking zorgt. Samengevat wijzen de resultaten van deze studie erop dat (hoewel beweging op zich aandacht vast lijkt te houden en daardoor het waarnemen van de stimuli die bewegen bemoeilijkt) naar de waarnemer toe bewegende stimuli een waarnemer waakzamer maken dan van de waarnemer af bewegende stimuli. Deze waakzaamheid zorgt voor het toewijzen van extra aandacht aan deze stimuli die daardoor accurater en in sommige gevallen sneller herkend worden als positief of negatief.

Niet enkel zaken die belangrijk zijn voor ons overleven zijn van invloed op aandachtstoewijzing, ook de actieve motivationele staat van een individu heeft hier effect op. Stimuli die compatibel zijn met onze motivationele staat zouden efficiënter te verwerken moeten zijn dan incompatibele stimuli. Anders gezegd bereidt de motivationele staat ons voor op wat er komen gaat. Dus, wanneer iets waargenomen wordt dat niet past bij de motivationele staat dan zal dit meer afleiden dan iets dat wel past.

In het derde hoofdstuk wordt dit idee onderzocht met behulp van een promotie- of preventie focus als motivationele staat. Een promotiefocus is een motivationele staat die voornamelijk te maken heeft met het streven naar positieve uitkomsten, terwijl een preventiefocus motiveert om negatieve uitkomsten te voorkomen. Deze motivationele foci kunnen bij ieder individu onder andere geactiveerd worden door de situatie waarin hij of zij zich bevindt. De verwachting is dat niet enkel positieve en negatieve uitkomsten gerelateerd zijn aan de motivationele foci, maar ook aan positieve en negatieve stimuli in het algemeen.

Om te onderzoeken of de actieve motivationele focus automatisch de hoeveelheid aandacht beïnvloedt die gericht wordt op focuscompatibele en -incompatibele stimuli werd allereerst in beide experimenten (3.1 en 3.2) een promotiefocus of preventiefocus geactiveerd bij de deelnemers. In het eerste experiment gebeurde dit door deelnemers een doolhoftaak op te laten lossen waarin een beloning verkregen kon worden (promotiefocus) of waarin een bedreiging ontvlucht moest worden (preventiefocus). In het tweede experiment werd de motivationele focus gemanipuleerd door deelnemers de mogelijkheid te geven geld extra te verdienen (promotiefocus) of geld te kunnen verliezen (preventiefocus). Na de manipulatie van motivatie volgde een interferentietaak met de positieve en negatieve lading van stimuli als afleiding. De taak van de deelnemer bestond uit het zo snel mogelijk aangeven of positieve en negatieve woorden die gepresenteerd werden in hoofdletters of kleine letters geschreven stonden. Hoe langzamer de reactie op deze taak, hoe meer aandacht er gericht wordt op de inhoud van het woord.

De resultaten van beide experimenten lieten zien dat woorden die passen bij de motivationele staat van de deelnemer (promotie-positief en preventie-negatief) minder aandacht nodig hadden om verwerkt te worden. De grootste hoeveelheid interferentie werd gevonden voor de woorden die motivationeel incompatibel waren. Deze bevinding kan worden verklaard door de efficiëntie van verwerking. Hoe meer de taakirrelevante stimuli overeenkomen met onze interne motivationele staat, hoe makkelijker deze zaken door ons cognitieve systeem te verwerken zijn. Door het efficiënter verwerken van motivationeel compatibele stimuli die we tegenkomen worden we minder afgeleid van de taak waar we mee bezig zijn.

Aan de andere kant zou het niet functioneel zijn als ons cognitieve systeem blind zou zijn voor stimuli die aan kunnen geven dat onze motivationele staat niet de meest geschikte is voor de huidige omgeving. Met andere woorden, als we ons in een staat bevinden waarin we voornamelijk gericht zijn op positieve uitkomsten, terwijl onze omgeving vooral gevaren en andere negatieve zaken bevat, kan het besteden van aandacht aan de negatieve zaken juist fungeren als teken dat we onze motivationele staat bij moeten stellen.

De motivationele staat van een persoon is onderdeel van een groter geheel aan factoren die onze aandachtssturing beïnvloeden. In hoofdstuk 4 wordt gekeken naar hoe de eerder besproken motivationele staat interacteert met verschillen tussen mensen in de manier waarop zij gedrag reguleren bij het toewijzen van aandacht aan afleidende gebeurtenissen. De verschillen in gedragsregulatie hebben te maken met de mate van actie controle. Enerzijds kunnen mensen *state-oriented* zijn, wat inhoudt dat ze onder moeilijke omstandigheden negatief affect ervaren en gaan piekeren. Anderzijds, kan men *action-oriented* zijn, wat inhoudt dat het negatieve affect dat moeilijke situaties vergezelt weg gereguleerd wordt. Het weg reguleren van negatief affect zorgt voor meer effectieve gedragscontrole. Deze oriëntaties worden verondersteld het gemak waarmee mensen met afleiding omgaan te beïnvloeden.

In hoofdstuk 4 wordt in twee studies bij mensen die verschillen in actie controle onderzocht in hoeverre zij afgeleid worden van een experimentele taak door het maken van fouten. De theorie van actie controle voorspelt dat *action-oriented* mensen minder moeite zouden moeten hebben met het afgeleid worden door fouten dan *state-oriented* mensen. Echter, naast dit verschil in dispositionele zelfregulatie is ook motivatie van belang bij het omgaan met gemaakte fouten. Verondersteld wordt dat zowel *action*- als *state*-georiënteerde mensen een promotie of preventie focus kunnen activeren, maar dat in bepaalde situaties een bepaalde motivatie beter samengaat met een *action*- of *state*-oriëntatie.

Verwacht wordt dat mensen met een *state*-oriëntatie, ongeacht de motivationele focus afgeleid zullen worden van de taak waar ze mee bezig zijn als ze fouten maken. Voor *action-oriented* mensen met een preventie focus geldt hetzelfde. Door de *action*-oriëntatie zijn ze wel in staat om het negatieve affect dat bij het maken van een fout hoort weg te reguleren, maar bij een preventie focus horende gevoeligheid voor fouten zorgt er voor dat aandacht afgeleid wordt door fouten. De *action-oriented* mensen met een promotiefocus zijn in dit geval de groep met een ideale combinatie tussen actie controle en motivationele focus. De *action*-oriëntatie zorgt voor effectieve gedragscontrole door het wegreguleren van negatief affect, wat de motivationele strategie om te streven naar positieve uitkomsten beter uitvoerbaar maakt.

Resultaten van de twee studies die in hoofdstuk 4 worden gerapporteerd laten zien dat deze gedachte bevestigd wordt. Na correcte reacties op de experimentele taak werden geen verschillen tussen verschillende groepen deelnemers gevonden. Echter, de accuraatheid van reacties na het maken van een fout daalde voor alle deelnemers, behalve voor diegenen met een *action*-oriëntatie en een actieve promotie focus. Deze *action-oriented* mensen met een promotiefocus lijken geen negatieve gevolgen te ervaren van het maken van fouten, en de daarmee samenhangende afleiding. Wat deze studie demonstreert is dat niet enkel verschillen in zelfregulatie of motivatie van belang zijn bij het voorspellen van omgaan met afleidende gebeurtenissen, maar dat juist de combinatie van deze factoren de mate van afleiding kan voorspellen.

De drie empirische gedeelten van dit proefschrift verschillen danig in onderzoeksvragen en theoretische achtergrond. Toch is er een overkoepelend thema dat ze samenbindt. In ieder hoofdstuk neemt afleiding van een focale taak waaraan een persoon werkt, die veroorzaakt wordt door factoren die irrelevant zijn voor die taak, een centrale plaats in.

In hoofdstuk 2 komt dit naar voren door de afleiding die bewegende stimuli veroorzaken in vergelijking met stilstaande stimuli. Door het toewijzen van extra aandacht aan de meest relevante stimuli (die naar de waarnemer toe bewegen) wordt deze afleiding tegengegaan. In hoofdstuk 3 bestaat de afleiding uit het compatibel of incompatibel zijn van stimuluskenmerken met de motivationele focus. Compatibele stimuli zijn makkelijker te verwerken waardoor ze minder afleiden, zelfs wanneer deze stimuli irrelevant zijn voor de taak die uitgevoerd wordt. In hoofdstuk 4 wordt gedemonstreerd dat de impact die het maken van fouten heeft op het vasthouden van aandacht (ofwel de mate van afleiding) afhangt van een combinatie van dispositionele zelfregulatie en motivationele focus.

Elke studie heeft een nieuwe of niet eerder bekeken onderzoeksvraag experimenteel getoetst. Gezamenlijk laten de drie hoofdstukken zien dat zowel eigenschappen van de stimulus, als motivatie van de waarnemer, als de dispositionele zelfregulatie van de waarnemer van belang zijn voor het omgaan met afleiding en het toewijzen van aandacht.

Dankwoord

Er zijn uiteraard meerdere mensen die op één of andere manier betrokken zijn geweest bij de totstandkoming van dit proefschrift en het onderzoek dat ik de afgelopen jaren heb mogen doen. Alvast mijn excuses wanneer je naam niet expliciet genoemd wordt, je vriendschap/hulp/inspiratie heb ik desondanks zeer gewaardeerd. Bedankt.

Met naam wil ik allereerst graag mijn promotor, Ad van Knippenberg, noemen. Ad, je hebt me de afgelopen jaren geïnspireerd met je bijna rücksichtsloze wetenschappelijke kijk op menselijk gedrag. Daarnaast heb je me de ruimte en vrijheid gegeven om mijn eigen onderzoek uit te voeren. Je hebt als begeleider een ideale omgeving gecreëerd om mij als onderzoeker te laten leren en groeien. Bedankt daarvoor.

Ook wil ik graag Daniël Wigboldus bedanken voor het vertrouwen en de steun in de vorm van onderwijsaanstellingen die zeker een faciliterende rol gespeeld hebben in de voltooiing van dit proefschrift.

In het bijzonder wil ik Harm Veling en Aafje Brandt bedanken voor de inmiddels 8 jaren waarin wij gezamenlijk met de sociale psychologie bezig zijn, zowel op de universiteit in Nijmegen, als in diverse andere gelegenheden in diverse andere plaatsen. Ik heb het een hele fijne tijd gevonden en hoop dat we deze nog even voort kunnen zetten. Harm, ontzettend bedankt voor alles wat we de afgelopen jaren samen hebben gedeeld, van congreskamers tot concertbezoek. Door je nieuwe baan zal ik je dagelijkse aanwezigheid zeker missen.

Rick van Baaren krijgt hierbij een eervolle vermelding als succesvol koppelaar, maar ook zeker als meest geschikte buurman, mentor en personal coach.

Ook wil ik Marijke Crum bedanken, zonder wie de vakgroep niet hetzelfde was geweest.

Verder bedank ik de gehele vakgroep sociale psychologie (met alle bijkomende en vertrekkende leden van de afgelopen jaren) voor de open deuren, inhoud en gezelligheid. Met name Ron en Matthijs bedankt voor de afleiding na het werk... en vaak ook tijdens.

Op het landelijk vlak wil ik graag de leden van de KLI sociale cognitie themagroepen bedanken voor de informatieve en leerzame bijeenkomsten, en het bijbehorende horecabezoek. Er was altijd genoeg om over te praten, al dan niet relevant.

Andere namen die hier niet mogen ontbreken zijn die van Ewout, Koen, Harald, Adri, Dimitry en andere veteranen. Bedankt voor de koffie, road trips, het zeilen en ander vermaak, maar vooral bedankt voor jullie vriendschap. Speciale dank aan Jos van Helvoirt die me meer heeft leren relativeren dan wie dan ook.

Niet in de laatste plaats wil ik mijn ouders, Wichert en Marian, bedanken voor hun onvoorwaardelijke steun in mooie én moeilijke tijden.

Maar het meest van allen...
mijn ware liefde, Peggy,
en onze prachtige dochter, Lara.

Martijn
Nijmegen, april 2007

Curriculum Vitae

Martijn Alexander de Lange werd op 20 september 1976 geboren te Utrecht. Na korte tijd in ’t Goy en enkele jaren in Werkendam gewoond te hebben, vestigden zijn ouders zich met hem nabij Nijmegen, in welke stad hij later het voorbereidend wetenschappelijk onderwijs volgde. In 1994 behaalde hij zijn diploma en begon met een studie Economie aan de toenmalige Katholieke Universiteit Brabant. Hoewel deze studie hem zeker boeide, vond Martijn hierin niet zijn roeping en keerde terug naar Nijmegen om daar, na enige tijd in de horeca, psychologie te gaan studeren. In 2001 studeerde hij cum laude af bij de vakgroep sociale psychologie en begon direct als AiO bij dezelfde vakgroep. Martijn combineert inmiddels het vaderschap met een baan als docent aan de Radboud Universiteit Nijmegen.