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Diplomarbeit

Titel der Arbeit

I like your smooth move
The influence of visuomotor fluency on liking

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"When a mystery is too overpowering, one dare not disobey."
(Saint-Exupéry, 1995)

3. Introduction

At first glance, the process of decision making may seem trivial: It can be subcategorised into examining the situation and then making the decision. In fact, a lot more parameters than initially thought influence the way and the results of our decisions. Some of those parameters seem to be logical and comprehensible to us, others, as we will see in the present thesis, will not be as obvious.

The process of decision making has been in the focus of research for a long time. Different realms of psychology and other disciplines have investigated the process and the influencing factors which have an impact on our decisions. Within the field of psychology, the approaches to answer the upcoming questions were manifold. If we subsume different focuses in research on decision making, we find two main questions. First, how do people choose one alternative out of a set and second, how do we form decisions and attitudes concerning those alternatives.

Decision, judgments and the process of finding them are important and inescapable topics for everyone. In every day decisions, for all organisms, it can be more or less important to rapidly judge and decide before executing actions. Strictly speaking, everything we do, or forbear needs a decision or judgement first. And in some situations, judgments and decisions need to be more precise and instantaneous than in others, which is only possible because of our evolutionarily improved and selected visuomotor and cognitive system (Hayes et al., 2008).

For decades, psychologist and other professionals have been investigating one of these strong, but not well-known influence factor, namely fluency.

3.1 Fluency

One of the most common and at the same time simple definitions of fluency is for example reported by Oppenheimer (2008): fluency is the subjective experience of ease or difficulty associated with completing or processing a mental task. Not the difficulty of the mental task per se, but the ease of processing information of this mental task leads to a more or less fluent experience (Oppenheimer, 2008). For example, if the mental task would be reading a text in an easy-to-read-font or a hard-to-read-font, it's not the content or the complexity of the text itself which leads to the feeling of fluency, but the amount of cognitive resources one needs to read the easy-to-read rather than the hard-to-read text (e.g. Song & Schwarz, 2008b).

The experience of fluency can only be generated, because "every cognitive task can be described along a continuum from effortless to highly effortful, which produces a corresponding metacognitive experience that ranges from fluent to disfluent" (Alter & Oppenheimer, 2009, p. 219). This means the feeling of fluency, which can be generated as a "byproduct" (Alter & Oppenheimer, 2009, p.222) by probably any cognitive process, informs us about the efficiency and facilitation of the processing (Oppenheimer, 2008).

For example each of our senses, our mood, bodily sensations and any form of thinking can lead to a fluency experience, because solely the later processing of the incoming information, initiate the actual fluency experience. The experienced fluency will then be used as a direct cue for judging and reasoning, as well as helping us indirectly to decide which other cues we use or ignore or on which aspect of a cue we attend (Oppenheimer, 2008).

3.1.1 Fluency and affect

Research on fluency and it's affective influence leads to the common finding that the strong or high experience of fluency is associated with positive affect, whereas a low fluency experience leads to less positive affect (Winkielman et al., 2003). Interestingly, this experience need not necessarily be made consciously to lead to the same positive or negative affect. Hence, fluency is one possible source of information we draw to, when we need to decide or judge, especially when little other information is available, limited cognitive resources or information are at one's disposal or when motivation is lacking (Winkielman et al., 2003). As we will see in the following chapter, higher fluency is associated with many affective qualities, like truth, higher liking, safety, funniness or less distance, but not with negative evaluations. This leads Winkielman et al. (2003) to the suggestion that fluency is hedonically marked and lead therefore selectively to more positive affective evaluations but not to more negative ones.

3.1.1.1 Familiarity and naïve theories

Research literature gives several references that expectations, context and past experiences have an impact on decisions and fluency. People attribute their fluency experiences automatically to an appropriate source and develop naïve theories about them.

If a stimulus is already known, processing of it will be more coherent, facile and faster, than processing of a novel stimulus (Winkielman et al., 2003). Whittlesea and Williams (1998) reported that the feeling of familiarity only excite from unexpected fluent processing. This feeling of familiarity is automatically, but unconsciously, associated with more positive feelings, because of a lower amount of cognitive resources needed for processing, which then leads to a higher fluency experience. Hence, familiarity can serve as a cue for fluency. In contrast to Whittlesea and Williams (1998) e.g. findings from Winkielman et al. (2000) suggest that the experience of fluency arises before it can be mediated by feelings of familiarity.

Additionally we are influenced by our individual naïve theories which have an impact on what people conclude about their experiences (Schwarz, 2004). Our memory, our knowledge and the situation characteristics, also culturally contextualised (Winkielman et al., 2000), influence our naïve theories and how we interpret feelings, incidents or experiences. Well known types of naïve theories are heuristics, such as the representativeness or availability heuristic described by Tversky and Kahneman (1973) or anchoring. Heuristics can be useful most of the time, because they operate like cognitive short cuts and are able to react automatically, but thereby also stereotype, which can be perfectly fitting most of the time, but can lead to misjudgements or misinterpretations as well (Cialdini, 2010; Kirchler, 2003).

3.1.1.2 Discount of fluency experiences

As described earlier, people attribute their fluency experience to an appropriate source, but discount subtle cues, if obvious alternatives for the feeling are available. For example, if one draws the attention of participants to the background music in a room (Winkielman et al., 2003) or other aspects of the condition or the stimuli, such as the fame and not the frequency of names on a list (Oppenheimer, 2008) participants tend to discount their fluency experience and fluency effects will be eliminated (see also Oppenheimer, 2004; Winkielman et al., 2000).

3.1.2 Variety of fluency

As mentioned, fluency can arise from different sources and can therefore be subcategorised into different types of fluency. The difference between the types occurs from the trigger or source which leads to the particular fluency feeling and differs in the consequence which the fluency experience may have. Alter and Oppenheimer (2009) reviewed the past findings and research on fluency and provide a comprehensive model of different types of fluency (Fig. 1).

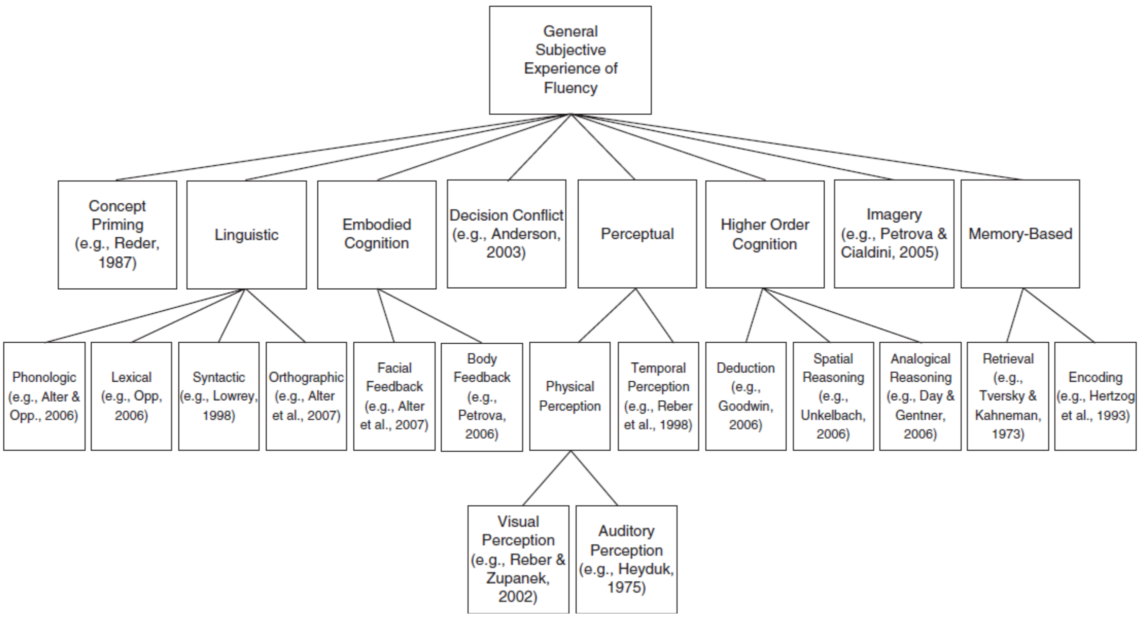


Fig. 1: A comprehensive catalogue of the various instantiations of fluency (Alter & Oppenheimer, 2009).

A helpful discrimination about fluency is between perceptual and conceptual fluency. Although perceptual and conceptual fluency usually support each other and have similar effects, this discrimination helps to understand the triggers, effects and influences of fluency.

3.1.2.1 Perceptual fluency

Winkielman et al. (2003) describe perceptual fluency as based on features of a stimulus or its perception, such as contrast, repetition or clarity. Manipulations on perceptual fluency influence the speed and accuracy of perceptual identification.

Manipulations of easy-to-read versus hard-to-read fonts (Alter & Oppenheimer, 2008; Alter *et al.*, 2007; Cho & Schwarz, 2006; Novemsky *et al.*, 2007; Shah & Oppenheimer, 2007; Song & Schwarz, 2008a, 2008b), hence, manipulations of the ease with which a text can be read, resulted in expected findings: easy-to-read fonts resulted in more favourable judgments (for example liking, innovativeness), but, interestingly, also in a higher willingness to execute the described actions, thought that the hard-to-read instruction would take more time to execute and would need more skills (Song & Schwarz, 2008b). In the study of Alter and Oppenheimer (2008) the font manipulation had an influence on the estimation of distances between cities (hard-to-read cities were associated with a larger distance, than easy-to-read). Shah and Oppenheimer (2007) give support that participants weight fluent presented information as a more important cue.

Other common and well researched perception manipulations were changes of figure-ground contrast (Reber & Schwarz, 1999; Reber *et al.*, 1998) or manipulations of presentation duration (e.g. Reber et al., 1998; Winkielman & Cacioppo, 2001). Higher contrast, as well as longer presentation duration leads to a higher fluency experience and therefore to more positive affective evaluations. The longer a stimuli is presented, the more information can be extracted, which leads to an easier to process feeling (Reber et al., 1998). Researchers have also investigated if the presentation duration has an impact on which manipulations of fluency have an effect. Figure-ground contrast influences fluency only when the task depends on brief presentation duration, whereas font manipulations only serves as a fluency cue, when present for a longer time (Reber *et al.*, 2004).

Semantic fluency, in terms of word pronunciations has as well an impact on fluency experiences. Alter and Oppenheimer (2006) and Song and Schwarz (2009) give interesting proof to the fluency-affective-linkage in judgments of risk and performance.

3.1.2.2 Mere exposure effect and priming

Initially inspiring research on fluency were findings from Zajonc (1968) on the mere exposure effect. Zajonc (1968, 2001) found that repeated stimuli presentation enhances liking of the stimuli. This effect seems to be very robust, intercultural and can be found in studies with both humans (also prenatally) and animals (Zajonc, 2001). Interestingly, the effect is also independent from the presented stimuli (meaningful stimuli versus nonsense stimuli) and independent if participants were aware of the repetition and even more when they were not (subliminal) (Zajonc, 2001). It seems as if we like already seen stimuli more than novel ones. As described earlier, facilitation in processing, less cognitive resource requirements and a feeling of safety, because of the feeling of familiarity, leads to more positive effects, than novel stimuli. Jacoby and Dallas (Jacoby & Dallas, 1981 as cited in Hayes et al., 2008) found that people identify already seen stimuli faster because of facilitation of processing already seen stimuli. Zajonc (2001) found that participants in repetition conditions were in a slightly better mood, which can as well be misattributed to the presented stimuli and can be responsible for more positive evaluations of repeated stimuli. Zajonc (2001) compared mere exposure with classical conditioning. However, repetition of stimuli is only one of many possible fluency manipulations.

Similarly, priming of a stimulus is a frequently used fluency manipulation. A previously seen or even subliminal presented stimuli lead to a more positive affect than novel stimuli (Winkielman & Cacioppo, 2001; Winkielman *et al.*, 2006).

3.1.2.3 Conceptual fluency

Conceptual fluency is based on the categorisation of the stimulus or its meaning, such as semantic priming, rhymes or context congruity (Winkielman et al., 2003).

The most common way to manipulate conceptual fluency is with semantic priming. As described, conceptual fluency manipulations lead to parallel results as perceptual fluency manipulations. Enhanced fluency experience can be observed when stimuli were previously semantically primed (Labroo *et al.*, 2008; Topolinski & Strack, 2009; Winkielman et al., 2006), embedded in predictive context (Whittlesea, 1993) or rhymed (McGlone & Tofighbakhsh, 2000). Enhanced liking can not only be served with direct priming of the stimuli, but also with priming concepts of the stimuli, for example priming watch-related words increases the liking of watch-stimuli (Labroo et al., 2008). Hence, increasing conceptual fluency leads to more positive affective evaluations.

3.1.2.4 Embodied fluency

Fluency experiences activated by different body states or muscle activation can be subsumed under the notion *embodied fluency* (Alter & Oppenheimer, 2009). When we speak about perception, we probable should not restrain ourselves to cognitive process only, because motor processes and from them induced perceptions and sensations need to be integrated when investigate fluency influencing parameters. Hence, the main research question of embodied fluency is, whether “the quality of our motor interaction with an object influence how we feel about the object” (Hayes et al., 2008, p.467). Subsequently, selections of five research advantages are described, which can be examined as pioneers of the present thesis.

3.1.2.4.1Facial feedback

Early studies from Strack et al. (1988) concerning the facial feedback hypothesis revealed one of the first interesting motor fluency results. The underlying hypothesis is that facial activation can have an effect on affective responses. Strack et al. (1988) demonstrated in two experiments that manipulation of facial activity, without telling participants the intended special emotional expression, leads to enhanced positive affect. In this study the researchers asked for the funniness in cartoons. To distract participants from the original purpose of the study, they told participants they would participate in a psychomotoric experiment. Facial activation was achieved through two conditions: participants had to hold a pen only with their teeth, which would contract facial muscles responsible for smiling, or hold the pen only with their lips, which would make smiling impossible and therefore represents the inhibition of smiling condition. The findings of Strack et al. (1988) give valid support to the facial feedback hypothesis. Activation of the muscles responsible for smiling lead to an enhancement of funniness judgments, without telling people in advance which feeling should be induced. Against the background of fluency research, these findings emphasize the argumentation that different facial activations, similar to analogous facial feeling expressions, without consciously knowing, can enhance a positive affect.

3.1.2.4.2 Motor fluency

Förster and Strack (1996) investigated the impact of head movements, nodding or shaking the head, while encoding words. Nodding, which is associated with approval, leads to a more likely detection of positive valence words, while shaking the head leads to the contrary effect of detecting more negatively valenced words. Those expectations were approved in their first two experiments. Their third experiment implied that performing incompatible motor movements combined with a mental task required a larger amount of cognitive resources, than compatible motoric and mental trials, which was tested by an additional dexterity task. Better results at the dexterity task were reached, when motor and mental task were compatible (positive valence words and nodding or negative valence words with shaking the head). These findings show that more fluent presentation and activation (compatible tasks) need less cognitive resources, were easier to process and therefore lead to an enhanced fluency experience.

Förster (2004) published another study concerning head movements and affective consumer decisions on products. Participants had to follow a product moving on a computer screen in either a horizontal or vertical movement. Participants had to follow the movement with their head, which either resulted in nodding or shaking of the head. As expected, products in the nodding-condition were judged more positively by affect than products in the head shaking-condition. In his second experiment of this study he could replicate his findings through different arm-positions (arm flexion versus arm extension). A more comfortable arm position (arm flexion) leads to more positive judgments than a non-comfortable arm position (arm extension).

Motor fluency was also successfully described in a study from Hayes et al. (2008). In three different experiments, the researchers investigated if self-produced and passively observed actions have the same effect on affective judgments. The motor task included a self-produced action, where the participant moved a household product on a table from position A to B, either with an obstacle in the middle (non-fluent condition) or without (fluent condition). The self-produced action gave evidence to the well-known fluency affective link. Fluent moving tasks lead to enhanced positive product evaluations and faster execution times. In the second and third experiment participants watched a series of movements of another person performing the same motor task as in experiment one. The difference between the two conditions was the camera angle. In experiment two, participants could see the person moving the objects and their line of sight. In experiment three the visual angle was chosen in a way that the head of the executing person was not visible. Experiment two revealed similar results to experiment one, experiment three did not. The researchers explained these results with the absence of the other person’s gaze, which serves as a fluency cue likewise. Passively observed fluent motor actions lead to an enhanced positive affect when we have the additional cue of the executing person’s gaze. This is essential in order to share the actor’s affective state, because looking towards an object and not away from it serves as a cue for liking.

Findings of Beilock and Holt (2007) back up these results, which state that only imagining a motor action in a fluent or non-fluent way can enhance preference or not.

3.1.2.4.3 Visuomotor fluency

In a recent study of visuomotor fluency, Topolinski investigated if training a specific eye movement by moving the head with stationary eyes, can result in enhanced positive affect, without seeing the particular movement of the stimulus. If a participant makes a downward head movement with stationary eyes, from the perspective of eye muscles, it can be considered the same movement as if the eyes make an upwards movement with a stationary head. By training the extraocular muscles (EOMs) with only head movements (and stationary eyes), he was able to train a specific eye movement, without participants being aware of it. The results of his first experiment were as expected: in matching trails, when the dot moving on the computer screen and the head movement were compatible, dot movements were liked more, than in mismatching conditions. In his second and third experiment he slightly changed the movements of the first experiment. In his first experiment, the head and dot movements always make a 90° movement (e.g. up and right or down and left). In his second experiment he rotated the dot, but not the head movements 25° clockwise. This slight change in the visual movement resulted again in expected findings that matching trials enhanced the positive affect towards the dot movements. The researcher interpreted this finding as proof that motor matching and not perceptual matching entailed the fluency effect. In his third experiment he varied the angles of the dot trajectory again resulting in a slight (80° instead 90°) and a strong (53° instead 90°) deviation (Fig. 2). The slight deviation resulted in enhanced positive affect, as expected, but reduced the liking effect by half. The strong deviation destroyed the liking effect, because the visual and motor matching was too marginal.

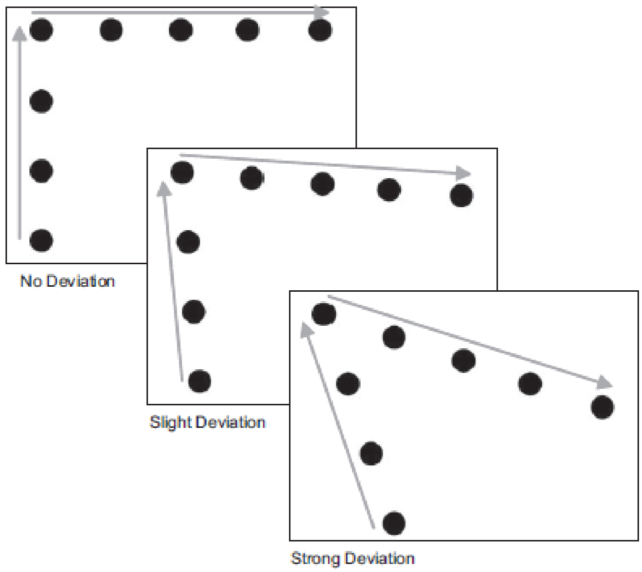


Fig. 2: Dot trajectories of experiment 3 (Topolinski, 2010).

3.1.2.5 Conclusion

If we subsume these results, we can see that fluency does not only have an impact on liking decisions but rather on a broad range of affective and cognitive decisions and questions. When designing an experiment, researchers probable should focus on (hidden) fluency effects, which may influence their experiments, without purpose – “trivial decisions that researchers make when designing their studies can have nontrivial influences on their results” (Oppenheimer, 2008, p. 240).

3.1.3 Measuring fluency

Usually reaction times were used to measure the grade of fluency (e.g. Hayes et al., 2008; Oppenheimer, 2008; Winkielman *et al.*, 2000). Because a more fluent process is an easier and more effortless process, people are able to react or recognise faster and more precisely, which is measurable by the speed and accuracy of their behavior. In order to investigate the affect of fluent or non-fluent experiences, self-reports or selection tasks were used, which are less reliable than reaction times, because of the possibility of purpose fraud. To increase reliability it can be useful to combine reaction tasks with affective decisions. When participants have to rate their affective state very quickly, the probability of distorted answers can be reduced (Winkielman et al., 2003).

Another way to measure fluency more objectively is to use psychophysiological methods like facial EMG (electromyography). As used and demonstrated in many studies and experiments (Winkielman & Cacioppo, 2001; Winkielman et al., 2006), the common results are that positive affect and therefore fluency will arise in a facial EMG in a greater activation of the "smiling muscle" (region of zygomaticus major), whereas negative feelings would arise in a greater activation of the "frowning muscle", the region of corrugator supercilii (Winkielman & Cacioppo, 2001).

It should be noted that already known limitations about not slowing the reaction times when reducing fluency have been found (e.g. Tourangeau & Ellsworth, 1979, as cited in Oppenheimer, 2008). Furthermore more specific limitations were pointed out, such as the fact that people sometimes prefer novel over familiar stimuli or shorter over longer presentation durations (Winkielman & Cacioppo, 2001). Further research will be necessary to investigate these limitations, especially if reaction time is or is not an objective valid measurement of fluency.

The following studies of this thesis try to expand the recent findings on visuomotor fluency and integrate the moderating effect of visual displacements. Therefore, different types of eye movements as well as visual displacements were introduced subsequently.

3.2 Eye movements

As regards eye movements two principle types can be differentiated (e.g. Bruce *et al.*, 2003; Burke & Barnes, 2008; Xivry & Lefèvre, 2007). Slow and continuous eye movements, especially when tracking a moving object, were so-called *smooth pursuit eye movements*. In contrast, *saccadic eye movements* were rapid and volatile eye movements, which leap among different points to fixate a target. Because with saccadic eye movements targets were visually caught very quickly, they were also called *catch-up saccades*.

3.3 Visual displacement

Visual displacement, in general, means a memorised mislocalisation of the final position of a previously moving target which vanished (e.g. Freyd & Finke, 1984; Hubbard, 2005). These mislocalisations obey specific rules and ought to be known and considered when designing and executing visuomotor experiments. Four different displacements were discriminated, which were easy to understand if we imagine an object fulfil the movement in reality and convey the same physical rules to the man-made visual situation. Below, the four displacements are described, as well as influencing and limiting parameters. The impact of such visual displacements on visuomotor fluency and on that account on the present thesis will be elucidated in the subsequent chapter (see chapter 3.4).

3.3.1 Representational momentum

Representational momentum means a forward displacement of the memorised final position of a moving target, which was initially described by Freyd and Finke (1984) and replicated in many experiments (e.g. Hubbard & Bharucha, 1988). Fig. 3 shows the actual and judged target position and illustrates clearly that forward displacement, means forward in initial moving direction, and is not even applicable for all directions.

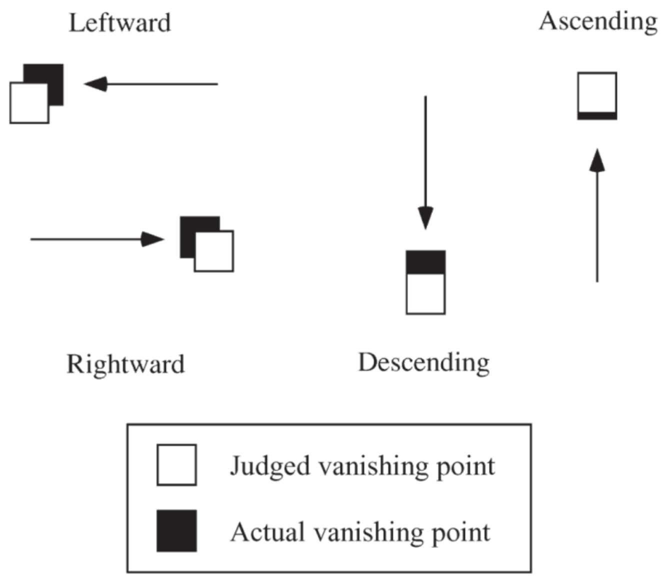


Fig. 3: Effects of implied momentum and implied gravity (Hubbard, 2005).

Forward displacements from horizontal movements were identical for right to left or left to right movements. Although Halpern and Kelly (1993) reported a difference in forward displacements of horizontal directions, namely that left to right movements lead to greater forward displacements than the counterpart, other researchers found no consistent evidence for a difference in right- or leftward movements (for a review see Hubbard, 2005).

3.3.2 Representational gravity

Fig. 3 also shows the effect of representational gravity. Comparable to the physical gravity we know and undergo in everyday life, the final target position of a moving object that suddenly vanishes is memorised displaced (e.g. Hubbard, 2005; Hubbard & Bharucha, 1988). For horizontal movements the memorised target position slides down. For vertical movements, equal to the physical rules, for ascending movements the representation gravity leads to smaller forward displacements in moving direction, than for descending movements (for a review see Hubbard, 2005). Fig. 3 clearly shows that effects of representational momentum and gravity do not exclude but complement each other.

3.3.3 Representational friction

Described effects of representational momentum and gravity were reported for blank backgrounds. Hubbard (1995) found the mediating role of different backgrounds in three experiments, which suggest that the moving target was either sliding along or above a surface as well as between two surfaces or compressing a surface (see Fig. 4). The forward as well as the downward displacement decreased when friction of target on the bar was implied. Nevertheless, representational momentum and gravity still have the reported effect on the moving and then vanishing target, but depending on the background and surface, can be powerfully moderated by the impression of friction.

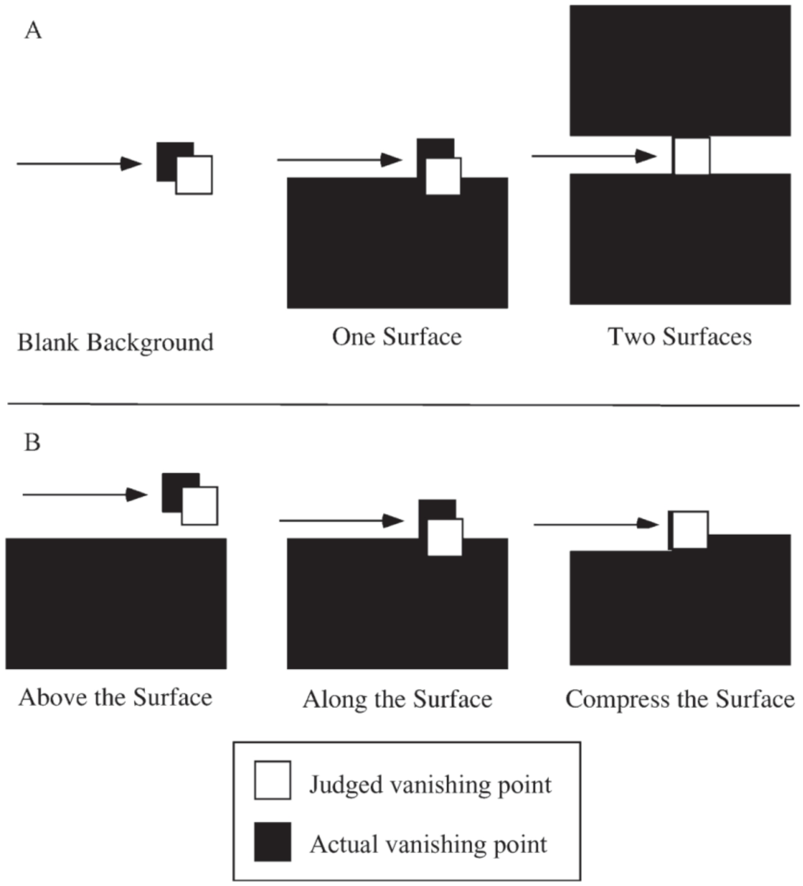


Fig. 4: Effects of implied momentum and implied friction (Hubbard, 2005).

3.3.4 Representational centripetal force

Finally, for curved moving targets the centripetal force influences the memory of the final target position. The displacement arises “forward along the tangent to the orbit and inward toward the focus of that orbit” (Hubbard, 2005, p. 826) and increases proportionally with angular velocity and radius length. Similarly to representational friction, representational centripetal force moderates the effect of representational momentum and gravity, and ought to be understood as addendum not as exclusion (for a review see Hubbard, 2005).

Hubbard (2005) described these displacements as a reflex, which forms a bridge between the gap of perception and action. These displacements might facilitate rapid motor responses by foresighted memorise the latter position of the target.

3.3.5 Influencing and limiting parameters on visual displacements

In his review Hubbard (1995, 2005) described four main influencing characteristics (target, display, context and observer), which moderate or eliminate the described representational effects. Three influencing factors, potentially important for the present thesis, will be described subsequently in regard of their prospective impacts.

3.3.5.1 Target velocity

In his review studies, Hubbard (2005) reported a greater forward displacement for faster velocities, when target velocity was held constant (see also Getzmann & Lewald, 2009). Ascending movements lead to greater forward displacement than descending movements (Shyi, 1986 as cited in Hubbard, 2005). For the present thesis only constant velocity was used.

3.3.5.2 Direction of target motion

The effect of representational gravity demonstrated that vertical movements lead to smaller forward displacements, than horizontal movements do. Additionally, the effect is an observation of ascending movements leading to smaller forward displacement than descending ones. Halpern and Kelly (1993) found that for right handed participants rightward movements lead to larger forward displacements than leftwards or for left handed. Hubbard (2005) reported in his review studies which found no consistent difference for horizontal target motions left- or rightwards as reported by Halpern and Kelly (1993). As a precaution handedness will be monitored in the present thesis.

3.3.5.3 Eye movements

Kerzel (2000) and Kerzel et al. (2001) found a visuomotor overshoot of pursuit eye movements, when tracking a moving target equivalent to the memorised forward displacement of representational momentum. This memorised forward displacement was not displayed if the participants instead of tracking the moving object fixated a stationary point aside the moving target. In the present thesis, eye movements of participants were monitored with an eye tracker to ensure that participants trace the moving object. This is necessary for the fact that a visuomotor overshoot occurs when tracking a moving object, which unexpectedly vanishes, stops or changes its direction.

3.4 Fusion: state of the science and present thesis

However, little research has examined the role that oculomotor plays on perception and information processing. One study, Topolinski (2010), examined the influence of training ocular-muscles and the effect of affective judgments, but not eye movements per se. Therefore, the present thesis investigates if a change in visuomotor and not oculomotor as well may influence the affective state through facilitating the processing of information and hence the experience of fluency.

The Pilot Study tested the impact of faster and slower target velocity on fluency judgments. Faster velocities should on the one hand lead to greater forward displacements and on the other hand should be more difficult to follow. The reported larger forward displacement in faster conditions may amplify the fluency and non-fluency experience. It may further be possible that faster velocities per se lead to a lower fluency experience which might lead to general less positive evaluations.

Study 1 tested the impact of representational momentum and gravity on visuomotor fluency on a blank background with linear movements. Hence, effects of representational friction as well as centripetal force did not have an influence on Study 1. As noted in chapter 3.3.5.3 a visuomotor overshoot happens, when a previously traced moving object unexpectedly vanishes, stops or changes its direction. The different *Levels of Fluency* described subsequently (see Fig. 8) result from the grade of overshoot (representational momentum and gravity) after the target changes direction in combination with the distance which needs to be covered to re-catch the target. The greater the distance, the less fluently the movement should be experienced, which moreover should result in less positive affect and greater reaction times.

In Study 2 the influence of a visual obstacle (black cross) was added, which separated the visual background in 4 parts. Therefore, representational friction might have an influence on Study 2. Experience of fluency was similarly manipulated to Study 1 with visuomotor overshoot in combination with the distance which needs to be covered to re-catch the target. The target could, after passing the obstacle, move on in the expected direction (fluent condition) or appear in a different, not expected part of the display (non-fluent condition) and need to be visually re-caught. Additionally, because the target moves behind the obstacle, effects of representational friction may occur. The obstacle may slow the target down or even bring it to a standstill. Simultaneously to the effect of representational friction, a smaller forward displacement may results. Xivry et al. (2008) investigated the influence of transiently occluded moving targets on the visuomotor system. They found an internal representation of the trajectory, even if occluded, exists and is necessary and that occlusions were most of the time accompanied by at least one catch saccade. This is important to ensure that during occlusion the eyes still track the invisible target, because it’s probable trajectory and velocity is available due the internal representation.

4. Hypotheses

Based on the outlined assumptions, the following main hypothesis is examined:

H1 (1): Visuomotor fluency enlarges perceptual fluency and in so doing processing fluency.

> H1 (1.a): Stimuli in fluent conditions are liked better than stimuli in non-fluent conditions.
>
> H1 (1.b): Stimuli in fluent conditions can be judged more quickly than stimuli in non-fluent conditions.

Additionally, three hypotheses regarding different combinations of directions were examined:

H1 (2): Vertical vs. horizontal conditions are different in terms of (a) object-liking and in terms of (b) reaction time.

H1 (3): Left to right vs. right to left conditions are different in terms of (a) object-liking and in terms of (b) reaction time.

H1 (4): Bottom to top vs. top to bottom conditions are different in terms of (a) object-liking and in terms of (b) reaction time.

Finally, the final hypothesis refers to the independency of fluency effects of used stimulus material:

H0 (5): The influence of visuomotor fluency on liking is independent of used stimuli.

The main focus of this thesis is on the object liking. The present work did not aim nor could guarantee that participants acted correctly in respect of reaction time enquiries. Therefore, results of reaction time analyses were reported, but only used as an additional indicator for further explanations of evaluative findings.

5. Method - Pilot Study

5.1 Aim of Pilot Study

The Pilot Study aimed to distinguish fluent from non-fluent movement patterns in two different speed conditions (slow and fast condition). Furthermore, the Pilot Study intended to get basic liking rates for two different types of stimuli: Kanji letters and Mondrian images.

5.2 Participants

The participants were 15 female undergraduate students (mean age: 21.4, SD=3.42) of the University of Vienna. They volunteered to attend the Pilot Study in exchange for course credit. Participants were tested individually in a quiet room at the Faculty of Psychology. All participants were right-handed, had normal or corrected-to-normal vision and were naive to the purpose of the testing.

5.3 Materials

5.3.1 Apparatus

The presentation of the Pilot Study and recording of participants' responses including reaction times were conducted on a PC with a screen resolution of 1280x1024 pixels, 60 Hz and 32 bit colour depth. The width between the start and end positions of the moving objects, measured by the object-centre, was 21 cm on the computer monitor, which was viewed at a distance of approximately 57 cm with a 20.9° visual angle. The study was programmed with Experiment Builder® (SR Research 1.6.121). Stimulus presentation and randomisation were also controlled with Experiment Builder.

5.3.2 Stimulus material

5.3.2.1 Condition slow, condition fast

The stimulus material for the slow and the fast condition consisted of a grey (RGB 136, 136, 136) square sized to 80x80 pixels (Fig. 5).

Fig. 5: Grey square stimulus of Pilot Study.

5.3.2.2 Condition Kanji

The stimulus material for the Kanji condition consisted of 99 black and white Japanese characters (Kanjis) (Fig. 6). Each character had ten strokes, font Arial and was sized to 80x80 pixels. Those stimuli were created with Microsoft Office Word 2007® and Paint.NET v3.5.5®.

Fig. 6: Examples of Japanese characters (Kanjis).

5.3.2.3 Condition Mondrian

The stimulus material the Mondrian condition consisted of 93 coloured Mondrians sized to 80x80 pixels. Each Mondrian consisted of 5x5 squares in 10 different colours. The colours of each Mondrian were randomly selected and located. There were two different types of Mondrians: 47 with sharp lines and edges and 46 with wavy lines and edges (Fig. 7).

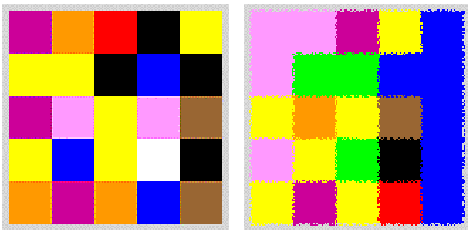


Fig. 7: Examples of sharp and wavy Mondrian stimuli.

5.3.3 Movement Patterns

In Pilot Study conditions slow and fast, 28 movement patterns were used. These were divided into four levels of fluency conditions. Level 1 included four different movement patterns; Levels 2-4 each included eight movement patterns (Fig. 8).

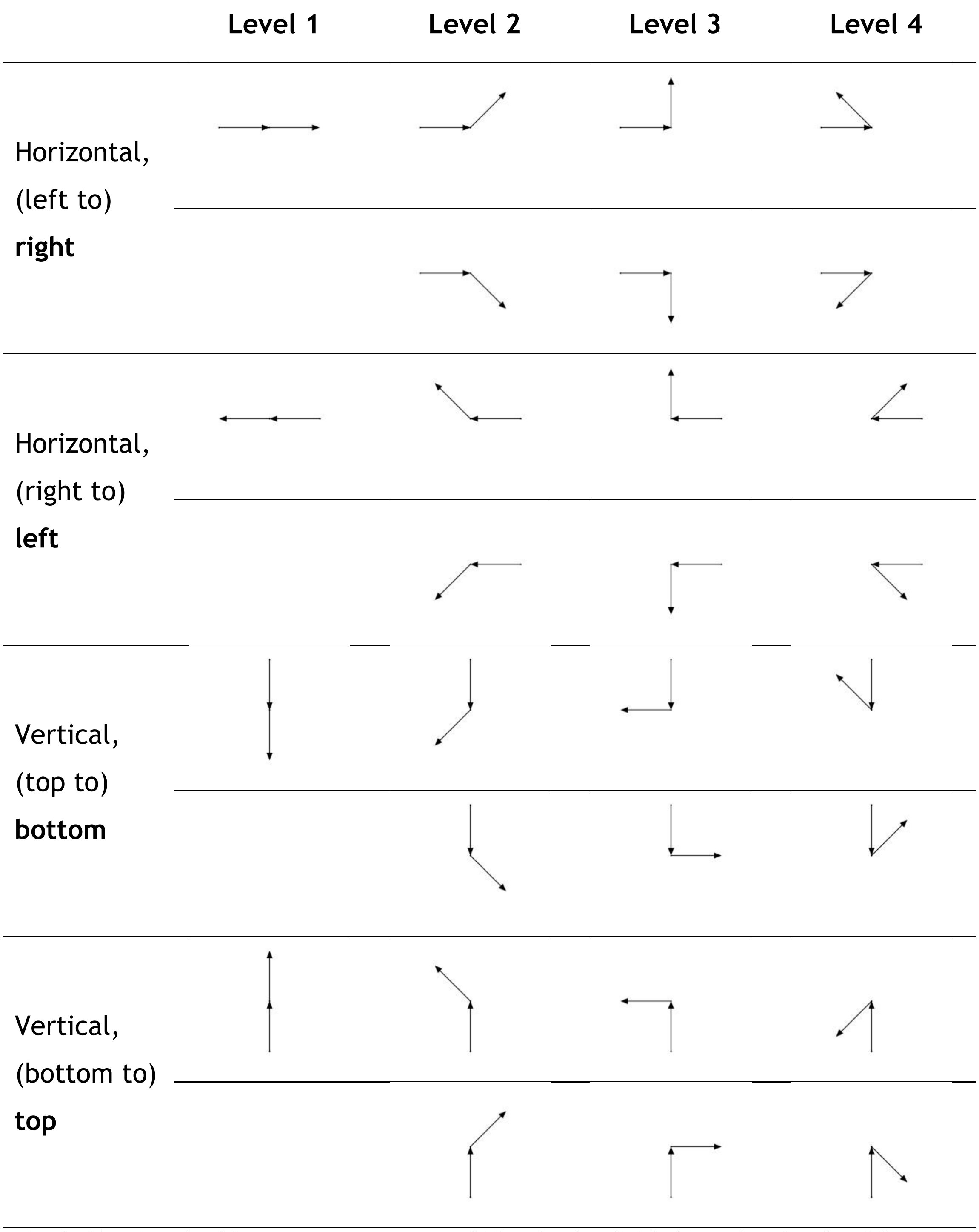


Fig. 8: Showing the 28 movement patterns of Pilot Study, divided into four levels of fluency.

Based on the findings of Kerzel (2000; Kerzel et al., 2001) it was expected, that Level 1 would represent the most fluent condition because no direction change in visuomotor is needed to follow the target. From Level 2, then Level 3 and Level 4 larger catch saccades were needed to re-catch the target, which changed its direction in the centre of the screen. Hence, Level 4 would represent the least fluent condition (see chapter 3.3.5.3).

5.4 Design

5.4.1 Dependent Variables

5.4.1.1 All conditions (slow, fast, Kanji, Mondrian)

DV1: Liking Judgments: The measure of liking judgement was represented by participant responses on a 7-point Likert scale. The scale was ranging from "1=I don't like it at all" to "7=I like it very much" for Kanji and Mondrian conditions and from "1=not fluent" to "7=very fluent" in the different speed conditions.

5.4.2 Independent Variables

5.4.2.1 Conditions slow and fast

IV1: Fluency: Two different fluency conditions (fluent versus non-fluent) based on the four Levels of Fluency (Fig. 8) represent the independent variable 1 Fluency.

5.5 Procedure

Participants were told that they were taking part in an experiment called "Movements". Participants were also told that the study included four different parts, which were in the same order for every participant. Every part ended with a "thank you" screen and the next would be started by the experimenter. They were told that during no part of the experiment would it be possible to take a break, but between the different parts it would be possible. Afterwards, participants were told to follow the instructions presented on the computer screen (see appendix 15.3). These instructions were prepared in advance so that participants were able to carry out the whole experiment without any further verbal instructions or input from the experimenter, as to eliminate interferences by the experimenter.

5.5.1 Conditions slow and fast

The sequence of events for the slow and fast condition is shown in Fig. 9.

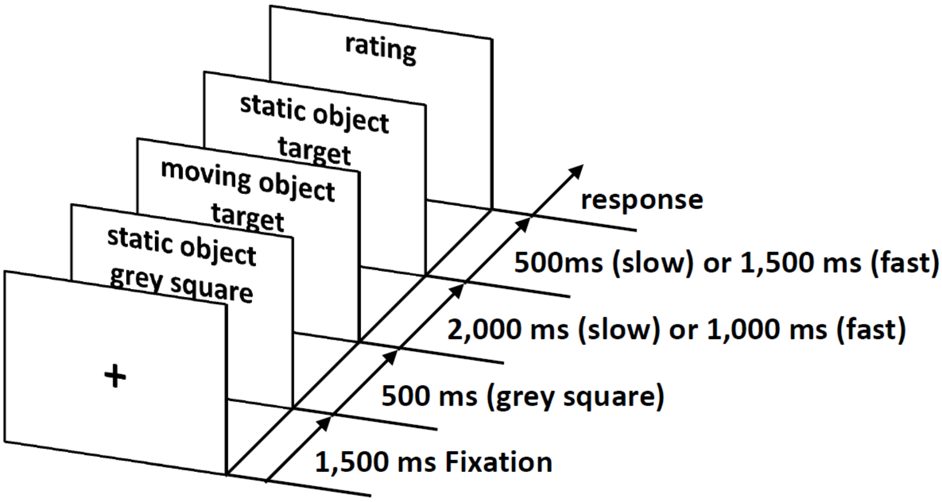


Fig. 9: Sequence of events for Pilot Study slow and fast condition.

Each condition began with an on-screen-instruction. Participants were told to follow the moving objects on the screen only with their eyes. To ensure that participants only followed the movements with their eyes and not with their head and body, their head had been fixed on a chinrest. For each trial the fixation cross was presented for 1,500 ms and could appear at four defined screen-positions (starting positions: TM, BM, RM LM; see Fig. 10).

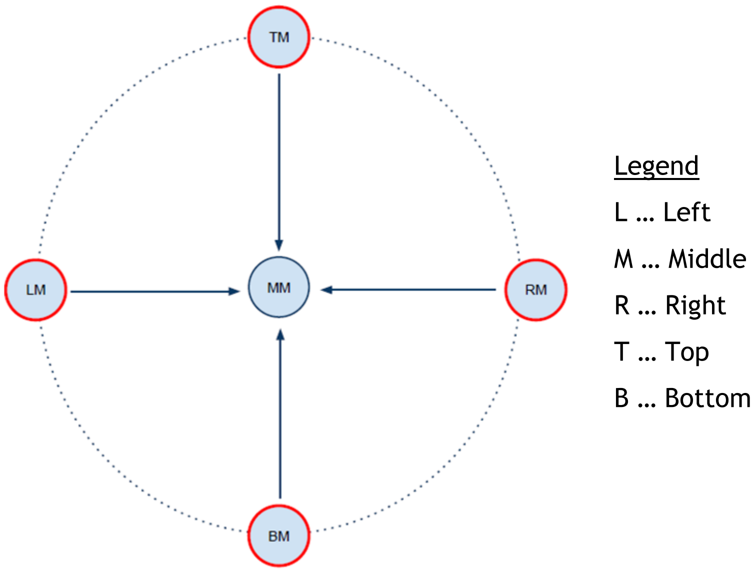


Fig. 10: Four possible starting-positions (marked red).

The fixation cross was replaced by a grey square, which was stationary for 500 ms. Afterwards, the grey square moved at a constant speed for 2,000 ms in condition slow and for 1,000 ms in condition fast to one of seven allowed end positions via the mid-point (Fig. 8). After the object had stopped, it was stationary for 500 ms in condition slow and for 1,500 ms in condition fast. The difference in presentation time of the stationary object resulted from the different moving time of the object. Subsequently, the text to rate how fluent the movement was appeared where the object had previously disappeared. The measure of liking judgement was represented by participant responses on a 7-point Likert scale ranging from “1=not fluent” to “7=very fluent”.

Each movement pattern was shown in a random order design five times. Hence, each participant rated 140 trials.

5.5.2 Condition Mondrians and Kanjis

The sequence of the events for the Mondrian and Kanji condition is shown in Fig. 11.

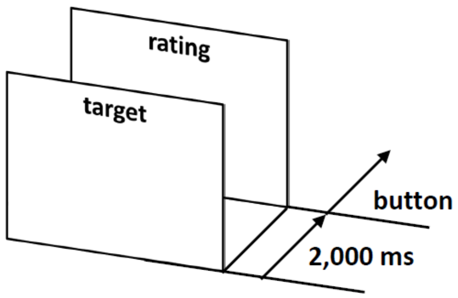


Fig. 11: Sequence of events for Pilot Study Conditions Kanjis and Mondrians.

Each condition began with an on-screen-instruction and one example target which was not part of the stimuli set. Participants were told to look at the target on the screen. Each target was shown stationary for 2,000 ms. Subsequently the text to rate how participants liked the target appeared where the target had previously disappeared. The measure of liking judgement was represented by participant responses on a 7-point Likert scale ranging from “1=I don’t like it at all” to “7=I like it very much”.

Each target appeared singularly in a random order design. In the Mondrian condition each participant rated 93 targets (sharp and wavy Mondrians), in the Kanji condition 99 targets (Kanjis).

5.6 Other considerations

Motivation, tiredness and participants' familiarity with the stimuli or the design might have had a significant influence on the preference and fluency judgements. In order to minimise the possibility of confounding variables, all participants were tested during the daytime (09:30-18:30) and were naive to the purpose of the experiment, but they were informed that they were participating in an important scientific study. To reduce familiarity effects, only participants who never participated in any other fluency study and who could not read nor understand Japanese characters, were tested. The participants purposefully experienced the stimuli as nonsense-material. At the end of the experiment participants were interviewed and none of them were able to report the purpose of the study.

6. Results and Discussion – Pilot Study

6.1 Main Analysis slow and fast conditions

The research question of Pilot Study conditions Mondrian and Kanji asked if there was a significant difference between the four different Levels of Fluency (Fig. 8). It had been expected, that Level 1 would show the highest fluency ratings, then Level 2, followed by Level 3 then Level 4. Hence, Level 4 would show the lowest fluency ratings.

A repeated measurement ANOVA was carried out with one within-subjects repeated measure variable (fluency). The variable fluency represented the four Levels of Fluency as described earlier.

6.1.1 Slow condition

To explore main effects of fluency Mauchly's test indicated that the assumption of sphericity for Fluency had been violated ($x^2(5)=20.57$, $p<.05$). Therefore degrees of freedom were corrected using Greenhouse-Geisser's estimates of sphericity ($\varepsilon=.50$). The results showed a significant main effect for fluency ($F(1.49, 52.84)=21.88$, $p<.01$, $\eta_p^2=.61$). As expected Level 1 of fluency was rated most fluent (*M*=6.33) and Level 4 least fluent (*M*=3.57).

6.1.2 Fast condition

To explore main effects of fluency Mauchly's test indicated that the assumption of sphericity for Fluency had been violated ($x^2(5)=33.85$, $p<.05$). Therefore degrees of freedom were corrected using Greenhouse-Geisser's estimates of sphericity ($\varepsilon=.43$). The results showed a significant main effect for fluency ($F(1.28, 42.85)=47.17$, $p<.01$, $\eta_p^2=.77$). As expected Level 1 of fluency was rated most fluent (*M*=6.18). Contra expectation, Level 4 was not rated least fluent (*M*=4.63), but Level 3 was (*M*=3.06). Table 1 shows the means and standard deviations for fluency.

Table 1: Means and standard deviations of fluency ratings of the Pilot Study for slow and fast conditions.

	condition slow		condition fast	
	M	SD	M	SD
Level 1	6.33	.26	6.18	.18
Level 2	5.14	.18	3.86	.31
Level 3	4.02	.38	3.06	.39
Level 4	3.57	.45	4.63	.19
Total	4.76	.24	4.43	.23

6.2 Main Analysis Mondrian and Kanji conditions

The aim of these conditions was to obtain base rates of liking for Mondrian stimuli as well as Kanji stimuli and consequently to obtain a base for choosing 88 Mondrians and 88 Kanjis for Study 1. The means and standard deviations for liking ratings of Mondrians and Kanjis are shown in Table 2.

Table 2: Means and standard deviations for liking ratings of Mondrians and Kanjis of the Pilot Study.

	M	SD
Mondrians	3.42	1.51
Kanjis	3.65	1.55

Consequently, 88 Mondrians (43 sharp and 45 wavy) as well as 88 Kanjis were selected, evenly distributed around the total means. Two wavy and four sharp Mondrians will not be used in Study 1 and neither will 11 Kanjis.

6.3 Discussion

The results of the analysis of slow and fast conditions demonstrated that there was a significant difference between the four Levels of Fluency. The slow condition brought about the expected results. Level 1 was rated most fluent, then Level 2, followed by Level 3 followed by Level 4. Hence, Level 4 was rated least fluent. The fast condition presented some unexpected results. Although Level 1 was rated most fluent, Level 4 was not rated least fluent, but Level 3 was rated least fluent. Those unexpected results can be explained by some confounding variables. First, as mentioned earlier (see also chapter 3.3.5.1), the movement speed was probably too fast for participants to follow the target accurately and led to a less positive and consistent affect. Second, most of the participants showed lack of motivation and reported tiredness at the end of the Pilot Study. Third, participants were already familiar with the task when the fast condition started. In addition, some participants reported after the experiment, that they had changed their answering behaviour during the fast condition, for no certain reason. Therefore, results of the fast condition cannot be proven to be reliable. For these reasons, the specifications of the slow condition, where none of the mentioned confounding interferences were assumed, were selected for Study 1.

7. Method – Study 1

7.1 Aim of Study 1

The aim of Study 1 was to investigate if a change in visuomotor fluency has an influence on liking ratings and reaction times. Because this fluency effect should be independent of used stimuli, two different types of stimuli were used to validate this hypothesis. The two Levels of Fluency were compared in two stimuli conditions: one with Kanji and one with Mondrian stimuli.

7.2 Participants

The participants were 30 female undergraduate students, 10 for Condition Kanjis (mean age: 21.5, SD=2.88) and 20 for Condition Mondrians (mean age: 35.35, SD=3.48) of the University of Vienna. After finishing a complete run with 10 participants of Condition Mondrians, ten more female undergraduate students were tested because the not averaged data of the first ten participants sounded promising. Subsequently, the results for the 20 participants of Condition Mondrians were reported together. They volunteered to attend the study in exchange for course credit. Participants were tested individually in a quiet room at the Faculty of Psychology. Because Halpern and Kelly (1993) found differences for the evaluation of right to left versus left to right movements for right handed participants, this variable was controlled in all studies. Mainly right-handed persons participated, even though other studies found no consistent differences as described by Halpern and Kelly (1993). For Study 1, all participants were right handed, had normal or corrected-to-normal vision and were naive to the purpose of the testing.

7.3 Materials

7.3.1 Apparatus

The presentation of Study 1 and recording of participants' responses and reaction times were conducted on a PC with a screen resolution of 1280x1024 pixels, 60 Hz and 32 bit colour depth. The width between the start and end positions of the moving objects, measured by the object-centre, was 21 cm on the computer monitor, which was viewed at a distance of approximately

57 cm with a 20.9° visual angle. The study was programmed with Experiment Builder® (SR Research 1.6.121). Stimulus presentation and randomisation were also controlled with Experiment Builder.

7.3.2 Stimulus material

7.3.2.1 Condition Kanjis

The stimulus material for the Kanji condition consisted of 88 black and white Japanese characters sized to 80x80 pixels (Fig. 6). Those Kanjis were selected from the Pilot Study, evenly distributed around the total liking mean (M=3.65).

7.3.2.2 Condition Mondrians

The stimulus material for the Mondrian condition consisted of 88 coloured Mondrians sized to 80x80 pixels (Fig. 7). Those Mondrians were selected from the Pilot Study, evenly distributed around the total liking mean (M=3.42).

7.3.3 Movement Patterns

For both stimuli conditions 16 movement patterns were used. These were divided in two Levels of Fluency, which were tested in the Pilot Study. For Study 1 the Levels 2 and 4 of fluency were compared (Fig. 8). Level 2 was selected as the most fluent movement pattern with eight different directions and Level 4 as the least fluent movement pattern. Although Level 1 was judged more fluent than Level 2, it had been rejected, because it contained only four different directions. In addition, eight catch trials were added, to reduce predictability. Catch trials 1-4 appeared at one of the possible four starting positions without moving. Catch trials 5-8 started at one of the possible starting positions and moved only to the middle position, but not to the end position. It was expected, that Level 2 of Fluency would represent the more fluent condition than Level 4.

7.4 Design

7.4.1 Dependent Variables

DV1: Liking Judgments: The measure of liking judgement was represented by participant responses on a 7-point Likert scale ranging from “1=I don’t like it at all” to “7=I like it very much”.

DV2: Reaction time: Reaction time was measured by the time difference of the button being pressed and the time the question appeared. Reaction time was measured in milliseconds (ms).

7.4.2 Independent Variables

IV1: Fluency: Two different fluency conditions (fluent versus non-fluent) based on the Levels of Fluency (Fig. 8) represent the independent variable 1 Fluency.

IV2: Direction HV: The two different fluency conditions can be divided in horizontal (H) versus vertical (V) movements (Fig. 8), which represent the two values of independent variable 2 Direction HV.

IV3: Direction LRTB: Horizontal movements can additionally be divided in left (L) versus right (R) movements, vertical movements in top (T) versus bottom (B) movements (Fig. 8). Accordingly independent variable 2 Direction HV can be divided into four different movement directions: left, right, top, bottom, which represent the four values of independent variable 3 Direction LRTB.

7.5 Procedure

Participants were told that they were taking part in an Eyetracking experiment called “EyeMove”. Participants were also told that the study included a practice trial, where possible movements and stimuli of the main experiment were presented. The purpose of the practice trials was to calibrate the eyetracker and to familiarise participants with the subsequent experiment. Participants were told to follow the instructions presented on the computer screen (see appendix 15.4). These instructions were prepared in advance so that participants were able to carry out the whole experiment without any further verbal instructions or input from the experimenter, as to eliminate interferences by the experimenter. After successfully completing the practice trials, the main experiment started.

The sequence of the events for both conditions is shown in Fig. 12. The instructions were presented together with the practice trials. Participants were told to follow the moving objects on the screen only with their eyes. To ensure that participants only followed the movements with their eyes and not with their head and body, their head was fixed on a chinrest. Additionally, the Eyetracker EyeLink® 1000 Version 4.52 controlled the accuracy of eye-tracking (range of tolerance: 40 pixels around the moving object). If the accuracy failed, participants had to redo the trial. For each trial the fixation cross was presented for 500 ms and could appear at one of four defined screen-positions (starting positions: TM, BM, RM LM; Fig. 10). The fixation cross was replaced by the stimulus which was stationary for 500 ms. Afterwards the object moved at a constant speed for 2,000 ms to one of seven allowed end positions (Fig. 8). After the object had stopped, it was stationary for 500 ms. Subsequently, the instruction to rate how much participants liked the target, appeared where the target had previously disappeared.

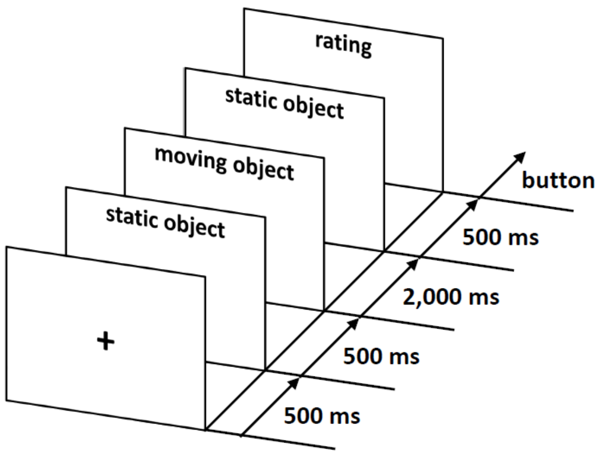


Fig. 12: Sequence of events for Study 1 Conditions Kanjis and Mondrians.

Each movement pattern of Level 2 and Level 4 of fluency was shown in a random order design for five times and three blocks. Additionally, eight catch trials were presented in each block. Hence, each participant completed 88 trials three times– summing up to 264 trials of movements. Each target appeared singularly in the random order design. Hence, each participant rated 88 targets three times.

7.6 Other considerations

Motivation, tiredness and participants' familiarity with the stimuli or the design might have had a significant influence on the preference and fluency judgements. In order to minimise the possibility of confounding variables, all participants were tested during the daytime (09:00-19:00) and were naive to the purpose of the experiment, but they were informed that they were participating in an important scientific study. To reduce familiarity effects, only participants who never participated in any other fluency study and who could not read nor understand Japanese characters, were tested The participants purposefully experienced the stimuli as nonsense-material. At the end of the experiment participants were interviewed and none of them were able to report the purpose of the study.

8. Results and Discussion - Study 1

8.1 Main Analysis

The research question of Study 1 asked if a change in visuomotor fluency has a significant influence on liking ratings and reaction times. Both questions were tested for two conditions of stimulus material (Kanjis and Mondrians) and for both stimulus material in combination (Cumulative Condition). Additionally, it was tested, if a change in visuomotor fluency may have a significant influence on liking ratings for different combinations of directions.

It was expected, that stimuli presented in fluent conditions were rated higher and faster, than stimuli presented in non-fluent conditions. To validate these hypotheses repeated measurement ANOVA were carried out with three within-subjects repeated measure variables: Fluency, Direction HV and Direction LRTB (see chapter 7.4.2). The variable Fluency represent one fluent (Level 2) and one non-fluent (Level 4) condition; the variable Direction HV represent the comparison of horizontal versus vertical movements and the variable Direction LRTB the comparison of left versus right and top versus bottom movements (Fig. 8).

8.1.1 Liking

8.1.1.1 Condition Kanjis

The results did not show a significant main effect for Fluency ($F(1, 9)=1.91$, $p=.20$, $\eta_p^2=.18$) nor for Direction HV ($F(1, 9)=.19$, $p=.67$, $\eta_p^2=.02$) or Direction LRTB ($F(3, 27)=.54$, $p=.66$, $\eta_p^2=.06$).

For the analysis of the interaction effect between Direction HV x Direction LRTB Mauchly's test indicated that the assumption of sphericity had been violated ($x^2(5)=16.72$, $p<.05$). Therefore degrees of freedom were corrected using Greenhouse-Geisser's estimates of sphericity ($\varepsilon=.50$).

The analysis for the interaction effect between Fluency and Direction HV did not reveal a significant effect ($F(1, 9)=.27$, $p=.61$, $\eta_p^2=.03$), neither between Fluency and Direction LRTB ($F(3, 27)=.11$, $p=.96$, $\eta_p^2=.01$) or between Direction HV and Direction LRTB ($F(1.49, 13.42)=.48$, $p=.58$, $\eta_p^2=.05$). The results did not show a significant interaction effect between all three variables Fluency, Direction HV and Direction LRTB (F(3, 27)=.49, p=.69, η_p^2=.05).

8.1.1.2 <u>Condition Mondrians</u>

The results did not show a significant main effect for Fluency (F(1, 19)=1.78, p=.20, η_p^2=.09) nor for Direction HV (F(1, 19)=1.27, p=.28, η_p^2=.06) or Direction LRTB (F(3, 57)=1.65, p=.19, η_p^2=.08).

The analysis for the interaction effect between Fluency and Direction HV did not reveal a significant effect (F(1, 19)=1.19, p=.29, η_p^2=.06), neither between Fluency and Direction LRTB (F(3, 57)=.73, p=.54, η_p^2=.04) or between Direction HV and Direction LRTB (F(3, 57)=.58, p=.63, η_p^2=.03). The results did not show a significant interaction effect between all three variables Fluency, Direction HV and Direction LRTB (F(3, 57)=.55, p=.65, η_p^2=.03).

8.1.1.3 <u>Cumulative Condition</u>

The Cumulative Condition combines the Condition Kanjis (10 participants) and the Condition Mondrians (20 participants).

The results did not show a significant main effect for Fluency (F(1, 29)=3.24, p=.08, η_p^2=.10) nor for Direction HV (F(1, 29)=1.48, p=.23, η_p^2=.05) or Direction LRTB (F(3, 87)=.18, p=.91, η_p^2=.01).

For the analysis of the interaction effect between Direction HV x Direction LRTB Mauchly's test indicated that the assumption of sphericity had been violated (x^2(5)=14.91, p<.05). Therefore degrees of freedom were corrected using Huynh-Feldt's estimates of sphericity (ε=.82).

The analysis for the interaction effect between Fluency and Direction HV did not reveal a significant effect (F(1, 29)=.41, p=.53, η_p^2=.01), neither between Fluency and Direction LRTB (F(3, 87)=.34, p=.80, η_p^2=.01) or between Direction HV and Direction LRTB (F(2.46, 71.32)=.76, p=.52, η_p^2=.03). The results did not show a significant interaction effect between the three variables Fluency, Direction HV and Direction LRTB ($F(3, 87)=.82$, $p=.49$, $\eta_p^2=.03$).

8.1.2 Reaction time

8.1.2.1 Condition Kanjis

The results did not show a significant main effect for Fluency ($F(1, 9)=1.76$, $p=.22$, $\eta_p^2=.16$) nor for Direction HV ($F(1, 9)=.03$, $p=.87$, $\eta_p^2=.003$) or Direction LRTB ($F(3, 27)=.59$, $p=.63$, $\eta_p^2=.06$).

The analysis for the interaction effect between Fluency and Direction HV did not reveal a significant effect ($F(1, 9)=.30$, $p=.60$, $\eta_p^2=.03$), neither between Fluency and Direction LRTB ($F(3, 27)=1.85$, $p=.16$, $\eta_p^2=.17$) or between Direction HV and Direction LRTB ($F(3, 27)=1.83$, $p=.17$, $\eta_p^2=.17$). The results did not show a significant interaction effect between all three variables Fluency, Direction HV and Direction LRTB ($F(3, 27)=.40$, $p=.76$, $\eta_p^2=.04$).

8.1.2.2 Condition Mondrians

The results did not show a significant main effect for Fluency ($F(1, 19)=.63$, $p=.44$, $\eta_p^2=.03$) nor for Direction HV ($F(1, 19)=.28$, $p=.61$, $\eta_p^2=.01$) or Direction LRTB ($F(3, 57)=.87$, $p=.46$, $\eta_p^2=.04$).

The analysis for the interaction effect between Fluency and Direction HV did not reveal a significant effect ($F(1, 19)=.51$, $p=.49$, $\eta_p^2=.03$), neither between Fluency and Direction LRTB ($F(3, 57)=1.08$, $p=.36$, $\eta_p^2=.05$) or between Direction HV and Direction LRTB ($F(3, 57)=.19$, $p=.90$, $\eta_p^2=.01$). The results did not show a significant interaction effect between all three variables Fluency, Direction HV and Direction LRTB ($F(3, 57)=.59$, $p=.63$, $\eta_p^2=.03$).

8.1.2.3 Cumulative Condition

The results did not show a significant main effect for Fluency ($F(1, 29)=2.38$, $p=.13$, $\eta_p^2=.08$) nor for Direction HV ($F(1, 29)=.28$, $p=.60$, $\eta_p^2=.01$) or Direction LRTB ($F(3, 87)=.54$, $p=.66$, $\eta_p^2=.02$).

For the analysis of the interaction effect between Fluency x Direction LRTB Mauchly's test indicated that the assumption of sphericity had been violated

($x^2(5)=13.09$, $p<.05$). Therefore degrees of freedom were corrected using Huynh-Feldt's estimates of sphericity ($\varepsilon=.91$).

The analysis for the interaction effect between Fluency and Direction HV did not reveal a significant effect ($F(1, 29)=.82$, $p=.37$, $\eta_p^2=.03$), neither between Fluency and Direction LRTB ($F(2.73, 79.13)=1.54$, $p=.21$, $\eta_p^2=.05$) or between Direction HV and Direction LRTB ($F(3, 87)=.45$, $p=.72$, $\eta_p^2=.02$). The results did not show a significant interaction effect between all three variables Fluency, Direction HV and Direction LRTB ($F(3, 87)=.68$, $p=.56$, $\eta_p^2=.02$).

8.1.3 Overview

Table 3 shows the means and standard deviations for liking ratings separated by fluency and the different compared directions of Study 1.

Table 3: Means and standard deviations for liking ratings of Study 1.

	Kanjis		Mondrians		Cumulative	
	M	SD	M	SD	M	SD
Fluent	3.93	.18	4.01	.12	3.98	.10
Non-fluent	3.86	.19	3.94	.12	3.91	.10
Horizontal	3.90	.19	4.00	.11	3.97	.10
Vertical	3.88	.18	3.94	.12	3.92	.10
Right	3.98	.19	3.91	.11	3.93	.09
Left	3.85	.21	4.04	.13	3.98	.11
Bottom	3.92	.17	3.94	.12	3.94	.10
Top	3.82	.23	4.01	.12	3.94	.11
Total	3.89	.18	3.97	.11	3.95	.10

Table 4 shows the means and standard deviations for reaction times separated by fluency and the different compared directions of Study 1.

Table 4: Means and standard deviations for reaction times of Study 1.

	Kanjis		Mondrians		Cumulative	
	M	SD	M	SD	M	SD
Fluent	1,041	89.97	1,180	97.61	1,133	71.74
Non-fluent	1,106	112.66	1,193	100.47	1,164	76.02
Horizontal	1,077	107.26	1,193	95.02	1,154	72.37
Vertical	1,070	94.49	1,179	104.00	1,143	75.76
Right	1,099	107.78	1,201	96.06	1,167	72.88
Left	1,049	105.06	1,197	98.39	1,148	74.43
Bottom	1,053	95.62	1,191	103.57	1,145	76.00
Top	1,091	103.73	1,155	104.42	1,134	76.85
Total	1,073	98.96	1,186	98.71	1,148	73.26

Table 5 and shows an overview of main analysis significance values.

Table 5: Significance values of Study 1, main analysis of liking ratings and reaction times.

	Liking ratings			Reaction times		
	Kanjis	Mondrians	Cumulative	Kanjis	Mondrians	Cumulative
Fluency	.20	.20	.08	.22	.44	.13
Direction HV	.67	.28	.23	.87	.61	.60
Direction LRTB	.66	.19	.91	.63	.46	.66
F x HV	.61	.29	.53	.60	.49	.37
F x LRTB	.96	.54	.80	.16	.36	.21
HV x LRTB	.58	.63	.50	.17	.90	.72
F x HV x LRTB	.69	.65	.49	.76	.63	.56

8.2 Additional Analysis

8.2.1 Analysis of Errors

As mentioned before, participants had to follow the onscreen moving object with a range of tolerance of 40 pixels. If participants failed to track the target with the defined accuracy, they had to repeat the trial until the check for accuracy did not fail. Participants were informed with an additional information screen, to repeat the trial more precisely.

It was expected, that fluent movement conditions were easier to follow and result therefore in less failures than non-fluent condition. To validate this hypothesis repeated measurement ANOVA were carried out with three within-subjects repeated measure variables: Fluency, Direction HV and Direction LRTB (see also chapter 7.4.2). The variable Fluency represent one fluent (Level 2) and one non-fluent (Level 4) condition; the variable Direction HV represent the comparison of horizontal versus vertical movements and the variable Direction LRTB the comparison of left versus right and top versus bottom movements (Fig. 8).

8.2.1.1 <u>Cumulative Condition</u>

To explore main effects for fluency and direction Mauchly's test indicated that the assumption of sphericity for Direction LRTB had been violated ($x^2(5)=15.72$, $p<.05$). Therefore degrees of freedom were corrected using Huynh-Feldt's estimates of sphericity ($\varepsilon=.82$).

The results show a significant main effect for Fluency ($F(1, 29)=26.94$, $p<.01$, $\eta_p^2=.48$) but neither for Direction HV ($F(1, 29)=.14$, $p=.71$, $\eta_p^2=.01$) nor Direction LRTB ($F(2.4, 71)=.91$, $p=.43$, $\eta_p^2=.03$).

Fluent movement conditions were, as expected, easier to follow and resulted therefore in less failures (M=1.67) than the non-fluent conditions (M=3.55).

For the analysis of the interaction effect between (1) Fluency x Direction LRTB, (2) Direction HV x Direction LRTB (3) and Fluency x Direction HV x Direction LRTB Mauchly's test indicated that the assumption of sphericity had been violated (FxLRTB: $x^2(5)=22.50$, $p<.05$, HVxLRTB: $x^2(5)=29.37$, $p<.05$, FxHVxLRTB: $x^2(5)=12.40$, $p<.05$). Therefore degrees of freedom were corrected using Greenhouse-Geisser estimates of sphericity (FxLRTB: $\varepsilon=.67$, HVxLRTB: $\varepsilon=.63$) and Huynh-Feldt's estimates of sphericity (FxHVxLRTB: $\varepsilon=.88$).

The analysis for the interaction effect between Fluency and Direction HV did not reveal a significant effect ($F(1, 29)=.81$, $p=.38$, $\eta_p^2=.03$) or between Direction HV and Direction LRTB ($F(1.9, 54.9)=.11$, $p=.88$, $\eta_p^2=.004$). The results did not show a significant interaction effect between all three variables (Fluency, Direction HV and Direction LRTB) neither ($F(2.6, 583.6)=.23$, $p=.83$, $\eta_p^2=.01$). The results showed a significant interaction effect between Fluency and Direction LRTB ($F(2, 58.7)=3.56$, $p=.03$, $\eta_p^2=.11$). The contrast between fluent vs. non-fluent compared to left vs. top movements revealed a significant interaction term ($F(1, 29)=5.82$, $p=.02$, $\eta_p^2=.17$). Fig. 13 shows the interaction diagram between the variables Time and Direction LRTB.

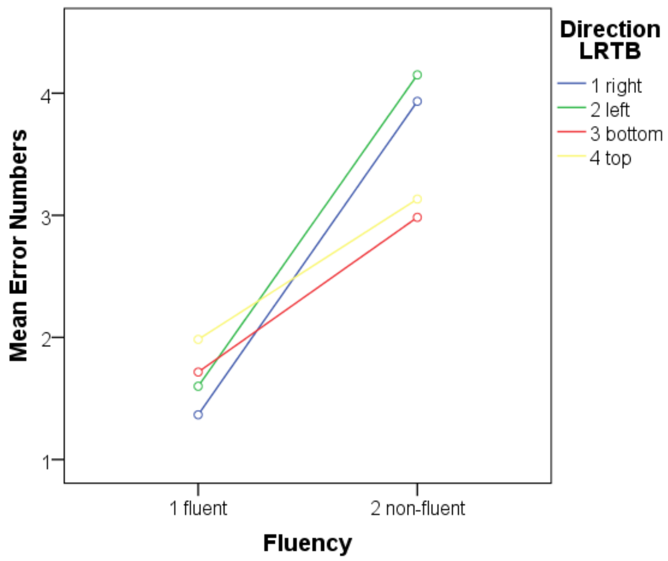


Fig. 13: Interaction diagram for Fluency x Direction LRTB, Study 1, error analysis.

Table 6 shows the interaction matrix between Fluency and Direction LRTB of error analysis. Fluent movement conditions to the right, the left, top or bottom were, as expected, easier to follow and result therefore in less failures than non-fluent right, left, top or bottom condition.

Table 6: Means and standard deviations of errors in the interaction matrix between Fluency and Direction LRTB of Study 1.

		M	SD
Fluent	Right	1.37	.29
	Left	1.60	.35
	Bottom	1.72	.25
	Top	1.98	.48
Non-fluent	Right	3.93	.72
	Left	4.15	.62
	Bottom	2.98	.54
	Top	3.13	.61

Table 7 shows the number of errors (N), their means and standard deviations separated by fluency and the different compared directions of Study 1.

Table 7: Number of errors, means and standard deviations of errors of Study 1, Cumulative.

		Cumulative		
		N (%)	M	SD
Fluency	Fluent	400 (31,9%)	1.67	.29
	Non-fluent	852 (68,1%)	3.55	.54
Direction HV	Horizontal	615 (49,1%)	2.56	.44
	Vertical	637 (50,9%)	2.65	.39
Direction LRTB	Right	325 (26,0%)	2.65	.48
	Left	290 (23,2%)	2.88	.45
	Bottom	338 (27,0%)	2.35	.34
	Top	299 (23,9%)	2.56	.48
Total Errors		1252 (100%)	2.61	.40

8.2.2 Liking without repetition trials

To assure, that repetition of trials and the knowledge of repeating the same movement and stimuli again had no effect on main analysis, repeated trials were rejected from analysis in the Cumulative Condition.

Table 8 shows the means and standard deviations of Cumulative Condition for liking ratings and reaction times separated by data with and without repetition trials.

Table 8: Number, means and standard deviations of liking ratings and reaction times with and without repetition trials of Study 1.

		N (%)	M	SD
Liking	All	7,920 (100%)	3.92	1.74
	Repetition Trials	985 (12.44%)	-	-
	Without repetitions	6,935 (87.56%)	3.92	1.74
Reaction time	All	7,920 (100%)	1,170	881.09
	Repetition Trials	985 (12.44%)	-	-
	Without repetitions	6,935 (87.56%)	1,163	874.46

8.2.3 Time effects

As described, each participant was tested in three iterations (Block 1, 2 and 3). To validate that participant’s ratings were steady over time repeated measurement ANOVA were carried out with four within-subjects repeated measure variables: Time, Fluency, Direction HV and Direction LRTB (see also chapter 7.4.2).

Results for fluency and Direction HV and LRTB have been already reported in the main analysis (see also chapter 8.1).

8.2.3.1 Cumulative Condition - Liking ratings

The results for liking ratings did not show a significant main effect for Time ($F(2, 58)=.07$, $p=.93$, $\eta_p^2=.002$).

All, except one, analyses for the interaction effects between Time, Fluency, Direction HV and LRTB did not reveal significant effects. The interactions between Time and Direction LRTB for liking ratings revealed a significant interaction ($F(6, 174)=2.83$, $p=.01$, $\eta_p^2=.09$). The contrast between Block 1 vs. Block 3 compared to right vs. top movements revealed a significant interaction term ($F(1, 29)=11.82$, $p<.01$, $\eta_p^2=.29$). Fig. 14 shows the interaction diagram between the variables Time and Direction LRTB for liking ratings.

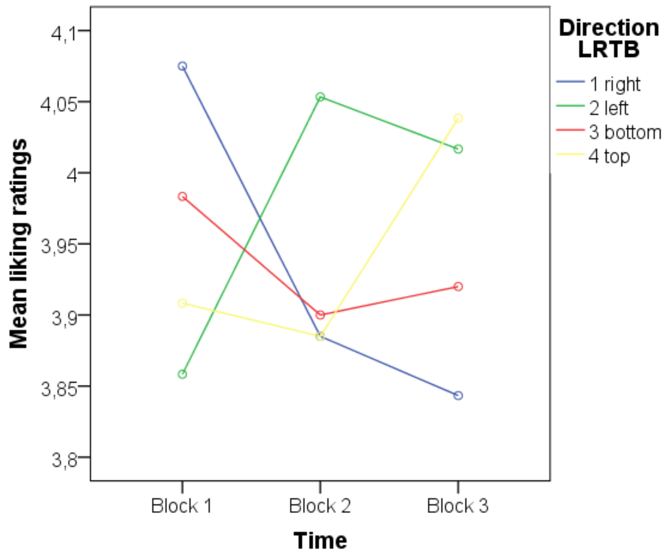


Fig. 14: Interaction diagram for liking ratings between Time x Direction LRTB of Study 1.

Table 9 shows the interaction matrix between Time and Direction LRTB of liking ratings.

Table 9: Means and standard deviations of liking ratings in the interaction matrix between Time and Direction LRTB of Study 1.

		M	SD
Block 1	Right	4.08	.08
	Left	3.86	.10
	Bottom	3.98	.12
	Top	3.91	.10
Block 2	Right	3.89	.10
	Left	4.05	.13
	Bottom	3.90	.11
	Top	3.89	.14
Block 3	Right	3.84	.13
	Left	4.02	.16
	Bottom	3.92	.11
	Top	4.04	.14

All, except one, analyses of the different blocks did not reveal significant effects. Only the analysis of block 3 revealed a significant main effect for Direction HV ($F(1, 29)=5.65$, $p<.02$, $\eta_p^2=.16$). Horizontal movements were liked more (M=4.02) than vertical movements (M=3.89).

8.2.3.2 <u>Cumulative Condition – Reaction times</u>

To explore main effects of Time Mauchly's test indicated that the assumption of sphericity for Time had been violated ($x^2(2)=22.68$, $p<.05$). Therefore degrees of freedom were corrected using Greenhouse-Geisser's estimates of sphericity ($\varepsilon=.64$).

The results for reaction time showed a significant main effect for Time ($F(1.29, 37.30)=5.63$, $p<.02$, $\eta_p^2=.16$). On the basis of reaction time means it can be resumed, that participants increased their answering time during testing and were fastest in Block 3 (M=1,061) and slowest in Block 1 (M=1,254).

All, except one, analyses for the interaction effects between Time, Fluency, Direction HV and LRTB did not reveal significant effects. The interactions between Time and Fluency for reaction times revealed a significant interaction ($F(2, 58)=4.48$, $p=.02$, $\eta_p^2=.13$). The contrast between Block 1 vs.

Block 3 compared to fluent vs. non-fluent movements revealed a significant interaction term ($F(1, 29)=8.86$, $p<.01$, $\eta_p^2=.23$). Fig. 15 shows the interaction diagram between the variables Time and Fluency for reaction times.

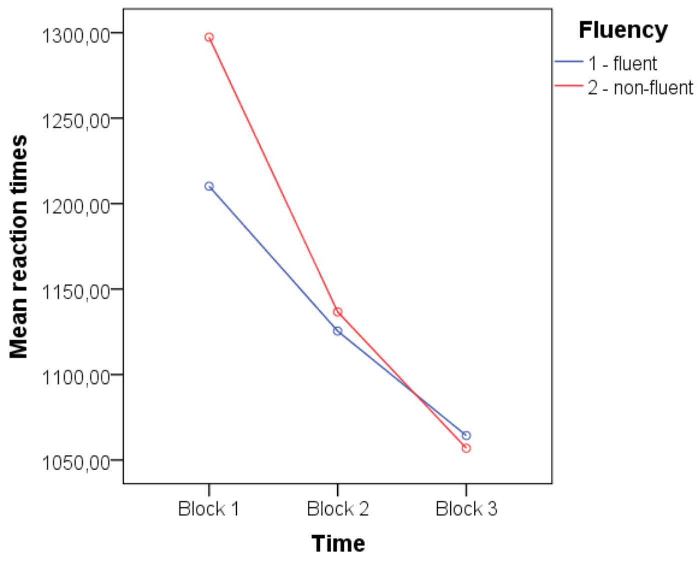


Fig. 15: Interaction diagram for reaction times between Time x Fluency of Study 1.

Table 10 shows the interaction matrix between Time and Direction LRTB of liking ratings.

Table 10: Means and standard deviations of reaction times, interaction matrix between Time and Fluency of Study 1.

		M	SD
Block 1	Fluent	1,210	81.93
	Non-Fluent	1,297	93.65
Block 2	Fluent	1,125	73.38
	Non-Fluent	1,137	73.44
Block 3	Fluent	1,064	82.48
	Non-Fluent	1,057	84.03

The analysis of the three blocks revealed a significant main effect for fluency in Block 1 $F(1, 29)=8.09$, $p<.01$, $\eta_p^2=.22$). Fluent conditions were significant rated faster (M=1,210) then non-fluent ones (M=1,297).

8.2.3.3 Cumulative Condition –Overview

Table 11 shows an overview of interaction significance values between Time, Fluency and Directions HV and LRTB for liking ratings and reaction time.

Table 11: Significance values of Study 1, main analysis, *p<.05, **p<.01.

	Liking	Reaction time
T	.93	**.02***
T x F	.82	**.02***
T x HV	.15	.48
T x LRTB	**.01***	.28
T x F x HV	.40	.85
T x F x LRTB	.40	.21
T x HV x LRTB	.40	.26
T x F x HV x LRTB	.998	.20

8.3 Discussion

The results of the main analysis, with regard to changes in visuomotor fluency, did not show the expected changes neither in liking ratings nor in reaction times. Neither condition revealed a significant main or interaction effect for liking ratings or reaction times.

Even though all of the results of the main analysis did not reveal significances, in all analysis of Study 1 (1) fluent conditions were rated slightly higher, accompanied by (2) faster reaction times, than non-fluent ones, as well as (3) horizontal movements were rated higher than vertical movements, but accompanied by (4) slower reaction times. The results of the additional analysis support these suggestions. For liking ratings block three revealed significant better ratings for horizontal movements and for reaction times block 1 revealed significant faster ratings of fluent than non-fluent presented targets.

From time-to-time during the experiment participants reacted verbally and non-verbally with displeasure to repetitive trials. It was possible that participants reacted on repetition trials with less positive liking ratings, additional analysis should reconnoitre if repetition trials distorted the results of the main analysis. The means in descriptive analysis did not show a noteworthy difference, neither for liking ratings, nor for reaction time. Hence, repetition of trials had no negative effect on the main analysis.

Additional analysis affirmed two speculations: first, fluent conditions resulted in fewer errors than non-fluent conditions. This can be considered as further validation, that there is a difference between the visuomotor facility of fluent and non-fluent trials.

Second, analysis of time aspects showed results which are in conflict with observed reactions of participants. By increasing the duration of the experiment almost all participants mentioned tiredness and lack of motivation and asked how long the testing would take. Besides, participants increased the breaks during trials and their motor agitation. Therefore it had been expected that participants reaction times would slow down and it had also been suspected, that liking ratings, because of more negative attitude to the testing, would result in more negative answers. However, it is also possible that participants increased their reaction times but have been less accurate with their liking ratings because they wanted the experiment to be over as quickly as possible. Indeed, analysis revealed no significant effect of time on liking ratings, but a significant effect on reaction time, however in the opposite direction. By increasing the experiment duration, participants increased their answering speed. Against the background of mere exposure effect (Zajonc, 2001), these results seem to be consequential. Repetitive presentation causes a feeling of familiarity and reduces cognitive processing resources. Regarding pure reaction time, liking ratings revealed no significant time effects, only the movement patterns, but stimuli were not affected by mere exposure effect.

In regard to the examined hypotheses, no explicit answers can be given. There are weak indicators that changes in visuomotor fluency may have the expected influence on liking ratings rather than on reaction time, but Study 1 could not show a definite result to this. Furthermore, Study 1 showed no indication that different movement directions, such as those anticipated in Hypotheses 2-4, systematically distinguish from each other.

Therefore, the design of Study 1 was modified. To create bigger difference between fluent versus non fluent conditions, the effect of representational friction was added via an obstacle.

9. Method – Study 2

9.1 Aim of Study 2

As well as Study 1, the aim of Study 2 was to investigate, if a change in visuomotor fluency has an influence on liking ratings and reaction times. Because Study 1 did not reveal the expected results, the design of Study 2 was modified in advance so, that a bigger visuomotor difference between fluent and non-fluent conditions may be generated. An obstacle (black cross) separated the display in four parts. The target could, after passing the obstacle, move on in the expected direction (fluent condition) or appear in a different, not expected part of the display (non-fluent condition) and need to be visually re-caught. Hence, representational friction might have an influence on the perception and visuomotor experience of the targets.

9.2 Participants

The participants were 19 female undergraduate students for each condition (mean age 21.6, SD=2.51) of the University of Vienna. They volunteered to attend the Study in exchange for course credit. Participants were tested individually in a quiet room at the Faculty of Psychology. All participants, except one, were right-handed, all had normal or corrected-to-normal vision and were naive to the purpose of the testing.

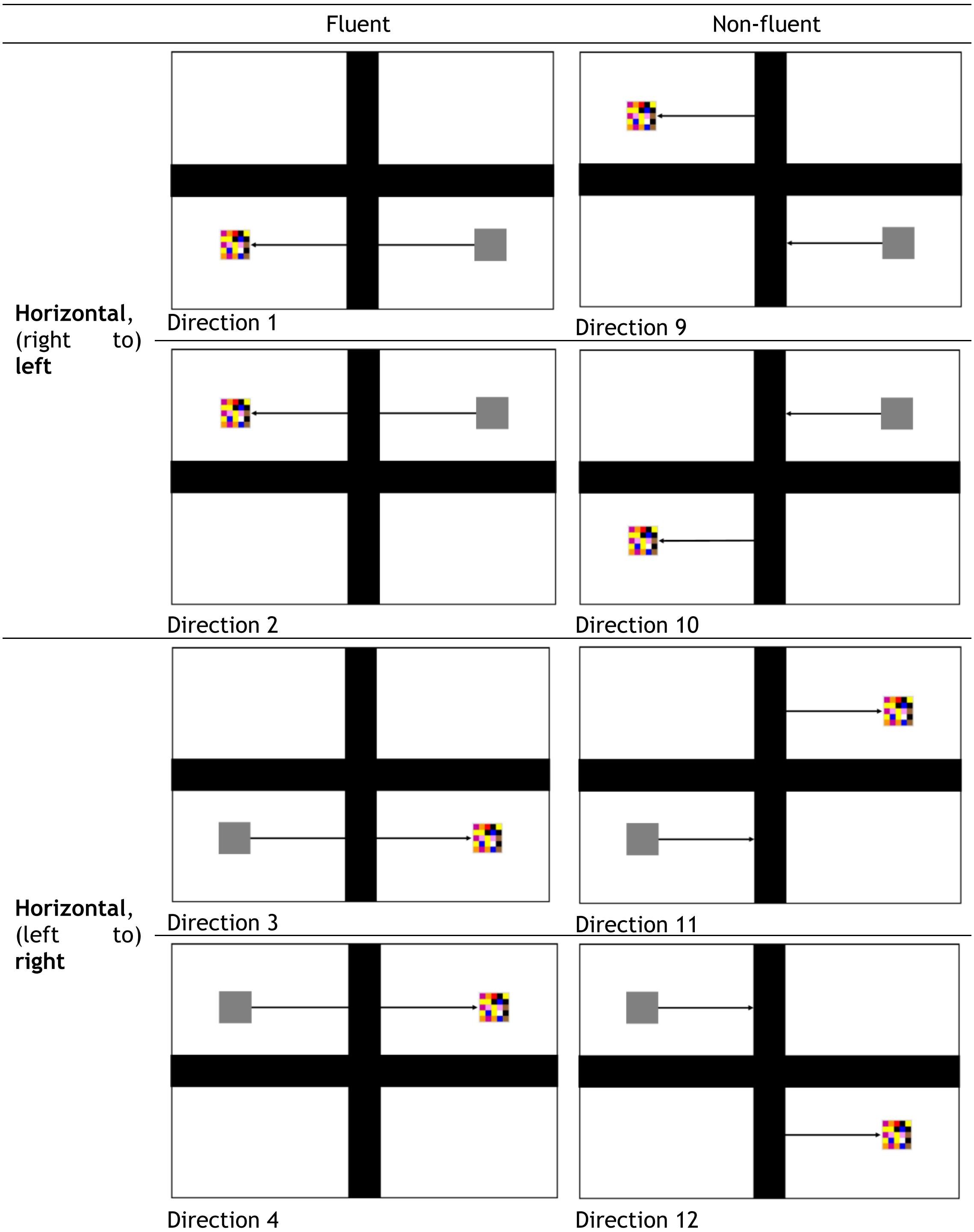
9.3 Materials

9.3.1 Apparatus

The presentation of Study 2 and recording of participants' responses and reaction times were executed on a PC with a screen resolution of 1280x1024 pixels, 85 Hz and 32 bit colour depth. The width between the start and end positions of the moving objects, measured by the object-centre, was 23 cm on the computer monitor, which was viewed at a distance of approximately 57 cm with a 22.8° visual angle. The study was programmed with Experiment Builder® (SR Research 1.6.121). Stimulus presentation and randomisation were also controlled with Experiment Builder.

9.3.2 Movement Patterns

In Study 2 16 movement patterns were used (Fig. 16). Besides, eight catch trials were added, to reduce predictability. Catch trials 1-4 appeared at one of the possible four starting positions without moving. Catch trials 5-8 started at one of the possible starting positions and moved only to the middle position, but not to the end position.



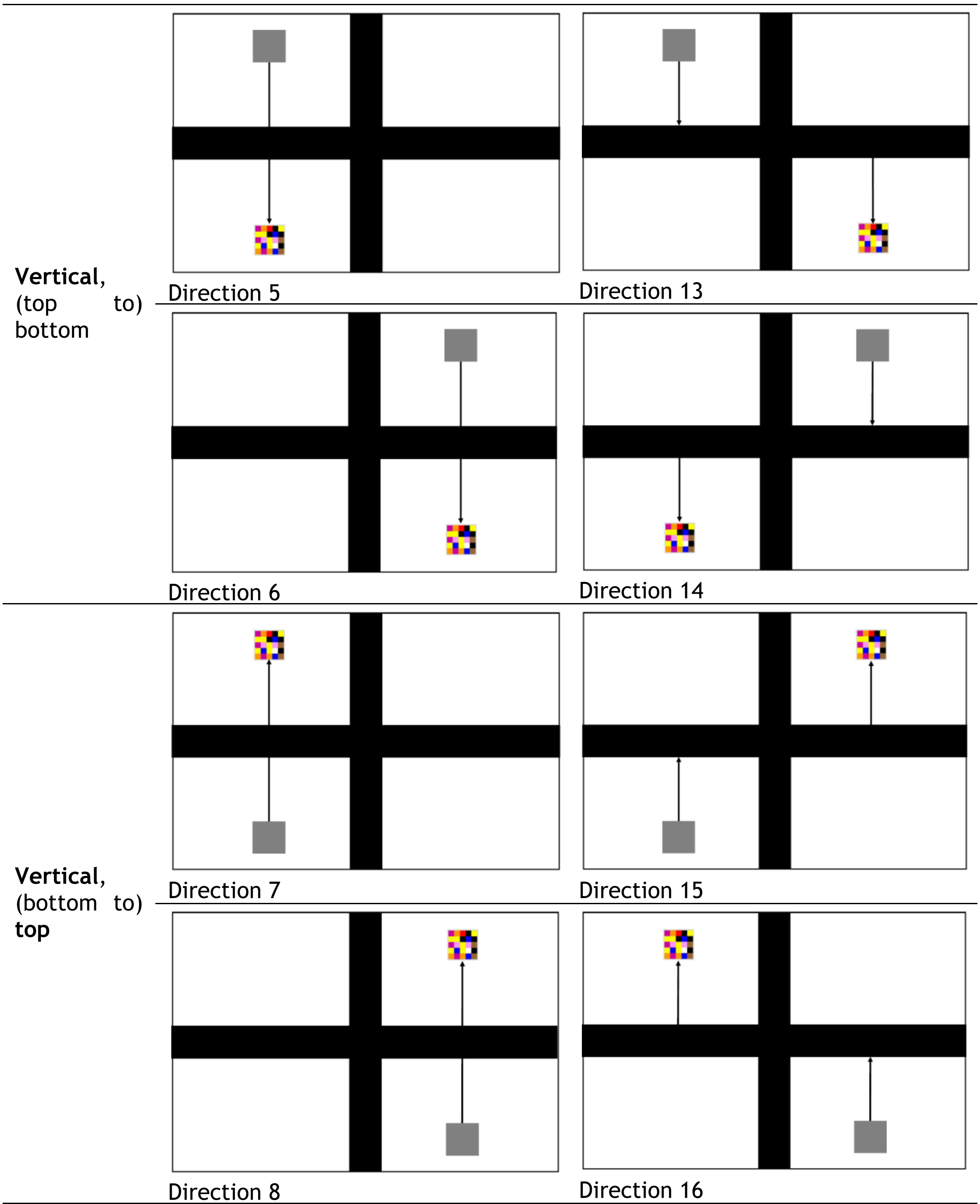


Fig. 16: 16 movement patterns of Study 2, divided into fluent and non-fluent movements.

9.3.3 Stimulus material

The stimulus material for Study 2 consisted of 88 coloured Mondrians sized to 80x80 pixels. Those Mondrians were selected from the Pilot Study, evenly distributed around the total liking mean (M=3.42). Each Mondrian consisted of 5x5 squares in different colours. There were two different types of Mondrians: 44 with sharp lines and edges and 44 with wavy lines and edges (Fig. 7).

9.4 Design

9.4.1 Dependent Variables

DV1: Liking Judgments: The measure of liking judgement was represented by participant responses on a 7-point Likert scale ranging from “1=I don’t like it at all” to “7=I like it very much”.

DV2: Reaction time: Reaction time was measured by the time difference of the button being pressed and the time the question appeared. Reaction time was measured in milliseconds (ms).

9.4.2 Independent Variables

IV1: Fluency: Two different fluency conditions (fluent versus non-fluent) based on the Levels of Fluency (Fig. 16) represent the independent variable 1 Fluency.

IV2: Direction HV: The two different fluency conditions can also been divided in horizontal (H) versus vertical (V) movements (Fig. 16), which represent the two values of independent variable 2 Direction HV.

IV3: Direction LRTB: Horizontal movements can additionally be divided in left (L) versus right (R) movements, vertical movements in top (T) versus bottom (B) movements (Fig. 16). Accordingly independent variable 2 Direction HV can be divided into four different movement directions: left, right, top, bottom, which represent the four values of independent variable 3 Direction LRTB.

9.5 Procedure

Participants were told that they were taking part in an Eyetracking experiment called “EyeMove II”. Participants were told to follow the instructions presented on the computer screen (see appendix 15.5). These instructions were prepared in advance so that participants were able to carry out the whole experiment without any further verbal instructions or input from the experimenter, as to eliminate interferences by the experimenter. After successfully completing the practice trials the main experiment started.

The sequence of the events for both conditions is shown in Fig. 17. Participants were told to follow the moving objects on the screen only with their eyes. To ensure that participants only followed the movements with their eyes and not with their head and body, their head was fixed on a chinrest. Additionally, the same Eyetracker as in Study 1 controlled the accuracy of eye-tracking (range of tolerance: 40 pixels around the moving object). If the accuracy failed, participants did not repeat the trial, but the eyetracking system reported the error to the result file. For each trial the fixation cross was presented for 500 ms and could appear at one of four defined screen-positions. The fixation cross was replaced by a grey square, which was stationary for 500 ms. Afterwards the grey square moved at a constant speed for 3,000 ms to the end position. After the grey square stopped it was replaced by the target stimulus. The target was stationary and participants had to fixate the Mondrian for at least 500 ms. If participants failed this visual fixation check, the stimuli disappeared after a maximum of 5,000 ms. Subsequently, the instruction to rate how much participants liked the target, appeared where the stimulus had previously disappeared.

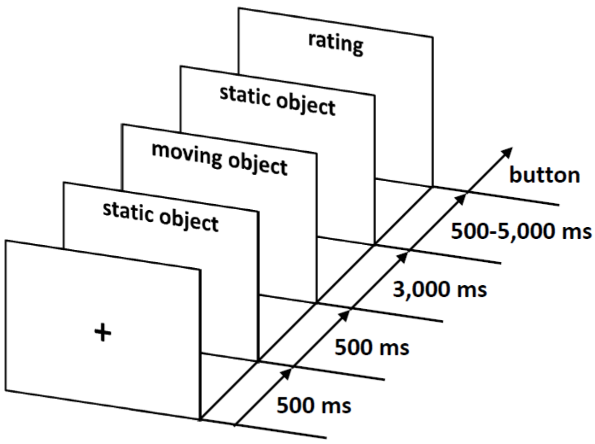


Fig. 17: Sequence of events for Study 2.

Each movement pattern of Level 2 and Level 4 of fluency was shown in a random order design for five times and three blocks. Additionally, eight catch trials were presented in each block. Hence, each participant completed 88 trials three times- summing up to 264 trials of movements. Each target appeared singularly in the random order design. Hence, each participant rated 88 targets three times.

9.6 Other considerations

Motivation, tiredness and participants' familiarity with the stimuli or the design might have had a significant influence on the preference and fluency judgements. In order to minimise the possibility of confounding variables all participants were naive to the purpose of the experiment, but they were informed that they were participating in an important scientific study. To reduce familiarity effects, only participants who had never participated in any other fluency study, were tested. The participants purposefully experienced the stimuli as nonsense-material. At the end of the experiment participants were interviewed and none of them were able to report the purpose of the study.

10. Results and Discussion – Study 2

10.1 Main Analysis

The research question of Study 2 asked, as well as Study 1, if a change in visuomotor fluency has a significant influence on liking ratings and reaction times. Because Study 1 did not reveal the expected results, the design of Study 2 was modified. The aim was to create a bigger visuomotor difference between fluent and non-fluent conditions.

It was expected, that stimuli presented in fluent conditions were rated higher and faster, than stimuli presented in non-fluent conditions. To validate these hypotheses repeated measurement ANOVA were carried out with three within-subjects repeated measure variables: Fluency, Direction HV and Direction LRTB (see also chapter 9.4.2). The variable Fluency represented one fluent and one non-fluent condition; the variable Direction HV represented the comparison of horizontal versus vertical movements and the variable Direction LRTB the comparison of left versus right and top versus bottom movements (Fig. 16).

10.1.1 Liking

The results did not show a significant main effect for Fluency ($F(1, 19)=.15$, $p=.71$, $\eta_p^2=.01$) nor for Direction HV ($F(1, 19)=.21$, $p=.65$, $\eta_p^2=.01$) or Direction LRTB ($F(3, 57)=.37$, $p=.78$, $\eta_p^2=.02$).

For the analysis of the interaction effect between Direction HV x Direction LRTB Mauchly's test indicated that the assumption of sphericity had been violated ($x^2(5)=12.80$, $p<.05$). Therefore degrees of freedom were corrected using Greenhouse-Geisser's estimates of sphericity ($\varepsilon=.69$).

The analysis for the interaction effect between Fluency and Direction HV did not reveal a significant effect ($F(1, 19)=.26$, $p=.62$, $\eta_p^2=.01$), neither between Fluency and Direction LRTB ($F(3, 57)=.41$, $p=.75$, $\eta_p^2=.02$) or between Direction HV and Direction LRTB ($F(2.05, 39.04)=1.39$, $p=.26$, $\eta_p^2=.07$). The results did not show a significant interaction effect between all three variables Fluency, Direction HV and Direction LRTB (*F*(3, 57)=1.50, *p*=.22, η_p^2=.07).

10.1.2 Reaction time

The results did not show a significant main effect for Fluency (*F*(1, 19)=2.94, *p*=.10, η_p^2=.13) nor for Direction HV (*F*(1, 19)=1.70, *p*=.21, η_p^2=.08) or Direction LRTB (*F*(3, 57)=.20, *p*=.90, η_p^2=.01).

For the analysis of the interaction effect between Fluency x Direction HV x Direction LRTB Mauchly's test indicated that the assumption of sphericity had been violated ($x^2(5)=11.98$, $p<.05$). Therefore degrees of freedom were corrected using Greenhouse-Geisser's estimates of sphericity (ε=.68).

The analysis for the interaction effect between Fluency and Direction HV did not reveal a significant effect (*F*(1, 19)=.00, *p*=.995, η_p^2=.00), neither between Fluency and Direction LRTB (*F*(3, 57)=.62, *p*=.60, η_p^2=.03) or between Direction HV and Direction LRTB (*F*(3, 57)=.21, *p*=.89, η_p^2=.01). The results did not show a significant interaction effect between all three variables Fluency, Direction HV and Direction LRTB (*F*(2.04, 38.71)=2.05, *p*=.09, η_p^2=.12).

10.1.3 Overview

Table 12 shows the means and standard deviations for liking ratings and reaction times separated by fluency and the different compared directions of Study 2.

Table 12: Means and standard deviations for liking ratings and reaction times of Study 2.

	Liking		Reaction time	
	M	SD	M	SD
Fluent	3.57	.13	1,388	94.18
Non-fluent	3.59	.12	1,341	98.08
Horizontal	3.57	.13	1,374	99.42
Vertical	3.59	.12	1,355	91.25
Right	3.56	.14	1,357	98.26
Left	3.61	.13	1,372	94.71
Bottom	3.54	.12	1,370	97.27
Top	3.60	.14	1,359	94.89
Total	3.58	.12	1,365	95.14

Table 13 shows the significance values for liking ratings and reaction times separated by fluency and the different compared directions of Study 2.

Table 13: Significance values of Study 2, main analysis, *p<.05, **p<.01.

	Liking	Reaction time
	p	*p*
Fluency	.71	.10
Direction HV	.65	.21
Direction LRTB	.78	.90
F x HV	.62	.995
F x LRTB	.75	.60
HV x LRTB	.26	.89
F x HV x LRTB	.22	.09

10.2 Additional Analysis

10.2.1 Time effects

As described, each participant was tested in three iterations. To validate that participant’s ratings were steady over time a repeated measurement ANOVA was carried out with four within-subjects repeated measure variables: Time, Fluency, Direction HV and Direction LRTB (see also chapter 9.4.2). Results for fluency and Direction HV and LRTB have been already reported in main analysis.

10.2.1.1 Liking ratings

To explore main effects of Time Mauchly's test indicated that the assumption of sphericity had been violated (x^2(2)=9.92, p<.05). Therefore degrees of freedom were corrected using Greenhouse-Geisser's estimates of sphericity (ε=.70).

The results for liking ratings showed a significant main effect for Time (F(1.41, 26.69)=6.03, p<.01, η_p^2=.24). Pairwise comparisons showed the expected significant comparison between Block 1 and Block 2 (p<.01) but not Block 1 and Block 3 (p=.05), nor between Block 2 and Block 3 (p=.14).

The analysis for interaction effects between Time, Fluency, Direction HV and LRTB did not reveal any significant effects.

An additional analysis of the different blocks did not reveal any significant main or interaction effect.

10.2.1.2 Reaction Time

To explore main effects of Time Mauchly's test indicated that the assumption of sphericity had been violated (x^2(2)=8.45, p<.05). Therefore degrees of freedom were corrected using Greenhouse-Geisser's estimates of sphericity (ε=.73).

The results for reaction time showed a significant main effect for Time (F(1.46, 27.65)=28.66, p<.01, η_p^2=.60). On the basis of reaction time means and all significant pairwise comparisons it can be assumed, that participants increased their answering time during testing and were fastest in Block 3 (M=1,206) and slowest in Block 1 (M=1,559).

The analysis for interaction effects between Time, Fluency, Direction HV and LRTB did not reveal any significant effects.

An additional analysis of the different blocks did not reveal any significant main or interaction effect.

10.2.1.3 Overview

Table 14 shows the means and standard deviations for liking ratings and reaction times separated by fluency and the different compared directions of Study 2.

Table 14: Means and standard deviations for liking ratings and reaction times, separated by time of Study 2.

	Liking		Reaction time	
	M	SD	M	SD
Block 1	3.74	.13	1,559	100.40
Block 2	3.46	.13	1,329	98.69
Block 3	3.54	.12	1,206	97.84
Total	3.58	.12	1,365	95.14

Table 15 shows an overview of interaction significance values between Time, Fluency and Directions HV and LRTB for liking ratings and reaction time.

Table 15: Significance values of Study 2, main analysis, *p<.05, **p<.01.

	Liking	Reaction time
T	**<.01****	**<.01****
T x F	.90	.38
T x HV	.53	.77
T x LRTB	.33	.14
T x F x HV	.43	.15
T x F x LRTB	.16	.24
T x HV x LRTB	.09	.31
T x F x HV x LRTB	.60	.65

10.3 Discussion

The results of the main analysis, with regard to changes in visuomotor fluency, did not show definite comparison to changes neither in liking ratings nor in reaction times.

Analysis of liking ratings did not reveal the expected significant differences in fluency changes, neither for fluency, nor for different directions. Furthermore, analysis of interaction effects of liking ratings did not show significant results either.

Participants spontaneously mentioned after the experiment, that so called fluent conditions were very boring and more tiring, than so called non-fluent movements, which were described as more interesting and likeable, because they were considered as surprise and a change to the routine.

With accretive duration of the experiment participants reacted verbally and non-verbally with displeasure on the testing length. Almost all participants mentioned tiredness and lack of motivation and asked how long the testing would take. Besides, breaks during trials and motor agitation increased. Therefore it had been expected that participants reaction times would slow down and it had also been suspected that liking ratings, because of more negative attitude to the testing, would result in more negative answers.

Analysis of time aspects showed results which were in conflict with the observed reactions of participants. Indeed, analysis revealed significant effect of time on liking ratings and on reaction time. As expected, liking ratings decreased with the length of testing duration, which means there were significant higher ratings in at the beginning of the testing, than at the end. With regard to reaction time results seemed to significantly tend towards the opposite than expected direction. By increasing the experiment duration participants increased their answering speed. Against the background of mere exposure effect (Zajonc, 2001), results of reaction time seem to be consequential. Repetitive presentation causes a feeling of familiarity and reduces cognitive processing resources. However, the mere exposure effect should lead to facilitated processing and, therefore, to higher liking ratings as well as faster reaction times, which it did not.

With regard to the examined hypotheses, no explicit answers can be given. There are indicators that changes in visuomotor fluency have an influence on liking ratings rather than on reaction time, but Study 2 could not show a definite result to this. Furthermore Study 2 showed no indication that different movement directions, such as those anticipated in Hypotheses 2-4, systematically distinguish from each other.

11. General Discussion & Conclusion

The present thesis has examined the effect of visuomotor fluency on liking in two studies.

In the Pilot Study, the designed Levels of Fluency were evaluated regarding their perceived level of fluency and two different speed conditions. The slow condition was designed in a way that following the target was almost effortless and easy whereas the faster condition was designed in a way that it was only possible to follow the target with effort and concentration. Results of the Pilot Study clearly showed a difference between the four Levels of Fluency, as expected, towards the slower condition. Movements, predicted as most fluent, with no direction change, were rated as most fluent, whereas movements, predicted as least fluent, because of the greatest direction change, were rated as the least fluent movements. The underlying assumption refers to findings of representational momentum and gravity and Kerzel's (2000; Kerzel et al., 2001) findings of visuomotor overshoot. As described before, the overshoot and the great direction change in the least fluent condition induce the greatest catch saccade for participants. This was, as expected, experienced as the highest effort movement to follow. In the faster condition results were ambiguous. This was attributed to (1) the faster movement, which per se may have been too hard to follow, (2) the lack of motivation and tiredness at the end of the testing, (3) that participants were already familiar with the experimental design and (4) some participants changed their answering behaviour for no certain reason. Lack of motivation, tiredness or a task that was considered too easy or boring, instead of a challenging task may lead to ambiguous or less fluent results (e.g. Hayes et al., 2008; Winkielman et al., 2003).

For Study 1 two Levels of Fluency from the Pilot Study in the slower condition were selected (the most fluent direction with direction change and the least fluent). It was evaluated if a change in visuomotor fluency has an influence on liking judgments for nonsense stimulus material. The Mondrian and Kanji stimulus material rated in the Pilot Study, were used. In this experiment the target moved along a fluent or non-fluent trajectory. Afterwards, participants had to rate as quickly as they could how much they liked the target. It was expected that, independent of which stimulus occurs targets which moved along a fluent trajectory should be liked more than targets in a non-fluent condition. As described before, the underlying assumption was again that targets which were presented in a non-fluent condition were more difficult to follow, because of the larger catch-saccade, than fluently presented targets. In fact, results of Study 1 did not show significant differences in liking ratings or for reaction time analysis. Lack of motivation and tiredness of participants could be noticed during the testing, as well as displeasure on repetitive trials. These confounding variables may have influenced the answering behaviour, both on liking ratings and on reaction times, and may be responsible for the ambiguous results. Therefore, variables like motivation and tiredness should be considered when designing a visuomotor experiment, as described subsequently. Interestingly, analysis of error trials affirmed that fluent trials led to fewer failures and can be considered easier to follow. This result fosters the underlying assumption of the influence and effectiveness of representational momentum and gravity on visuomotor fluency tasks.

In Study 2 the effect of representational friction was added. The target had to pass behind an obstacle and appeared either in a fluent condition (no direction changes) or in a non-fluent condition (catch saccades were needed to re-catch the target). The described manipulation of visuomotor fluency revealed no significant effects for liking ratings. However, the influence of the obstacle and therefore representational friction may have biased the tracking more than expected, which would lead to less fluent experiences for fluent conditions as well as for non-fluent conditions. Contra expectations were results that reaction times increased with testing length, but at last expected, that liking ratings decrease because of the long testing. Against the background of mere exposure effect results can be explicable. Furthermore, as described earlier more challenging or diversified tasks can lead to higher attention and willingness of participants and may also be interpreted as a possible explanation for contra expected reaction time results as well as for the not univocal results of liking ratings.

In regard to the examined Hypothesis 1, that visuomotor fluency enlarges perceptual fluency and in so doing processing fluency, no explicit affirmation can be reported. Study 1 as well as Study 2 gave indication that changes in visuomotor fluency have an impact on the affect towards the target, but neither study can give univocal evidence.

Furthermore, no systematic difference for different movement directions could be found in Study 1 nor in Study 2. Again, indications were found, that horizontal movements were liked more than vertical movements, but no statistical significance can be reported. Hence, for Hypotheses 2-4 no proof can be given.

Hypothesis 5, that the influence of visuomotor fluency on liking is independent of used stimuli, can be accepted. No systematic differences for stimulus material were found, neither in the Pilot Study, in which the stimuli were initially rated, nor in Study 1.

Even though the present thesis could not prove the impact of visuomotor fluency on liking this should not be comprehended as a falsification. Several limitations and confounding variables were reported and should be considered in further research.

Further work will be necessary to understand if visuomotor fluency manipulations can or cannot influence the affective state of a person. The present thesis opens up several research directions.

As reported previously, motivation and tiredness of the participating persons were noticeable and often mentioned by themselves. In account of this when designing a visuomotor experiment these aspects should be considered. Each reported experiment took about one hour (instruction and final review inclusive). Although participants were told that they could take breaks during the testing, whenever they need, the testing was designed in advance so that no breaks were intended. Given that participants were placed in a dark room and in a rather uncomfortable seating position (because of head fixation for the eyetracker) tiredness and motor agitation was comprehensible. Furthermore, participants had no reference how long the testing would take during the tasks, because no watch or trial counter could serve as reference. This aspect was well observable by participants who asked several times during the experiment how much time was left and if they would be finished soon. Interestingly, every participant was told at the beginning that the experiment would take one hour, but some participants asked if they had finished about 15-20 minutes after the testing started. The lack of motivation to participate in this not really challenging experiment as well as no sense of time in the dark room without any references may serve as a comprehensible explanation. Further experiments should be designed in advance so that participants may take intended breaks during the testing, after different blocks or after a given time, which should be considered in respect to the length of the experiment.

To enhance the attractiveness and therefore the motivation to participate in the experiment several options can be considered. On the one hand, the movements which display the different fluency occurrences can be designed in more complex trajectories than linear ones with a more or less predictable direction change. It would be one possibility to add more than one direction change in the trajectory, as well as to add nonlinear movements such as spirals or combinations of linear and curved trajectories. When using curved movements the impact of representational centripetal force should be kept in mind. Moreover, experiments can include either more catch or control trials, or more than one type of movements (linear or curved) as well as more different trajectories during an experiment. Each described manipulation would enhance the attractiveness of the experiment for participants, because of more diversification and more bounded cognitive resources because of more possible movement patterns that may occur.

Reducing available cognitive resources may also be a practicable way to manipulate visuomotor fluency experiments. Winkielman et al. (2003) reported that limited cognitive resources led to enhanced fluency experiences because the possibility to integrate and process additional information of the target or experiment were reduced. In the present studies, a few participants reported that they had changed their answering behaviour for no certain reason. A few reported that they had tried to interpret the Kanji stimuli or tried to find a system behind the colours in the Mondrian stimuli. This gives evidence that participants had enough time and cognitive resources to try to integrate additional information or intentions of the experiment. Further experiment designs may include deflecting cognitive tasks such keeping a long-digit number (Winkielman et al., 2003) or list of words in mind to reduce free cognitive resources. Another possibility would be to add time pressure components or delimitate the response time. When participants cannot decide by themselves how long they look at the target or how long time they take to decide how they like the target, the impact of additional information or interpretations will be reduced.

Although in the fifth hypothesis the independence of used stimuli is accepted, the possibility of the impact of mere exposure effect on the Mondrian stimuli should be mentioned. In the present thesis no evidence can be found that the mere exposure effect had the impact that all Mondrians were interpreted as already seen and known. On the contrary, participants reported a preference for different colours or colour combinations and it can be assumed that participants could distinguish between different Mondrians.

As in Study 1 error trials may be repeated by the participant but the design should be modified in advance so, that participants did not notice the repetition. As described earlier, to redo trials led to less motivation and kind of displeasure against the experiment.

Finally, further visuomotor fluency experiments might add motor components, as for example in Hayes et al. (2008). Participant possibly track a moving target visually and with a finger, or in different body postures as described by Förster (2004) or Strack et al. (1988) for facial feedback.

In conclusion, although the present thesis cannot report evidence regarding the influence of visuomotor fluency changes on affective states, we attribute this to the experiment's design. It can be assumed that visuomotor fluency – just as other evidences on embodied fluency – will lead to enhanced affective states. The design of visuomotor experiments may contain larger differences in fluency experiences like different trajectories or cognitive distraction. Additionally experiments should be designed in advance so that the per se tiring aspect of a visuomotor manipulation will not cloud the fluency experience. As far as we know by now, the present thesis can be understood as the first *direct* visuomotor fluency manipulation on liking judgments and opens up a wide field of investigations.

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13. Index of Figures

14. Index of Tables

15. Appendix

15.1 Stimuli Mondrians

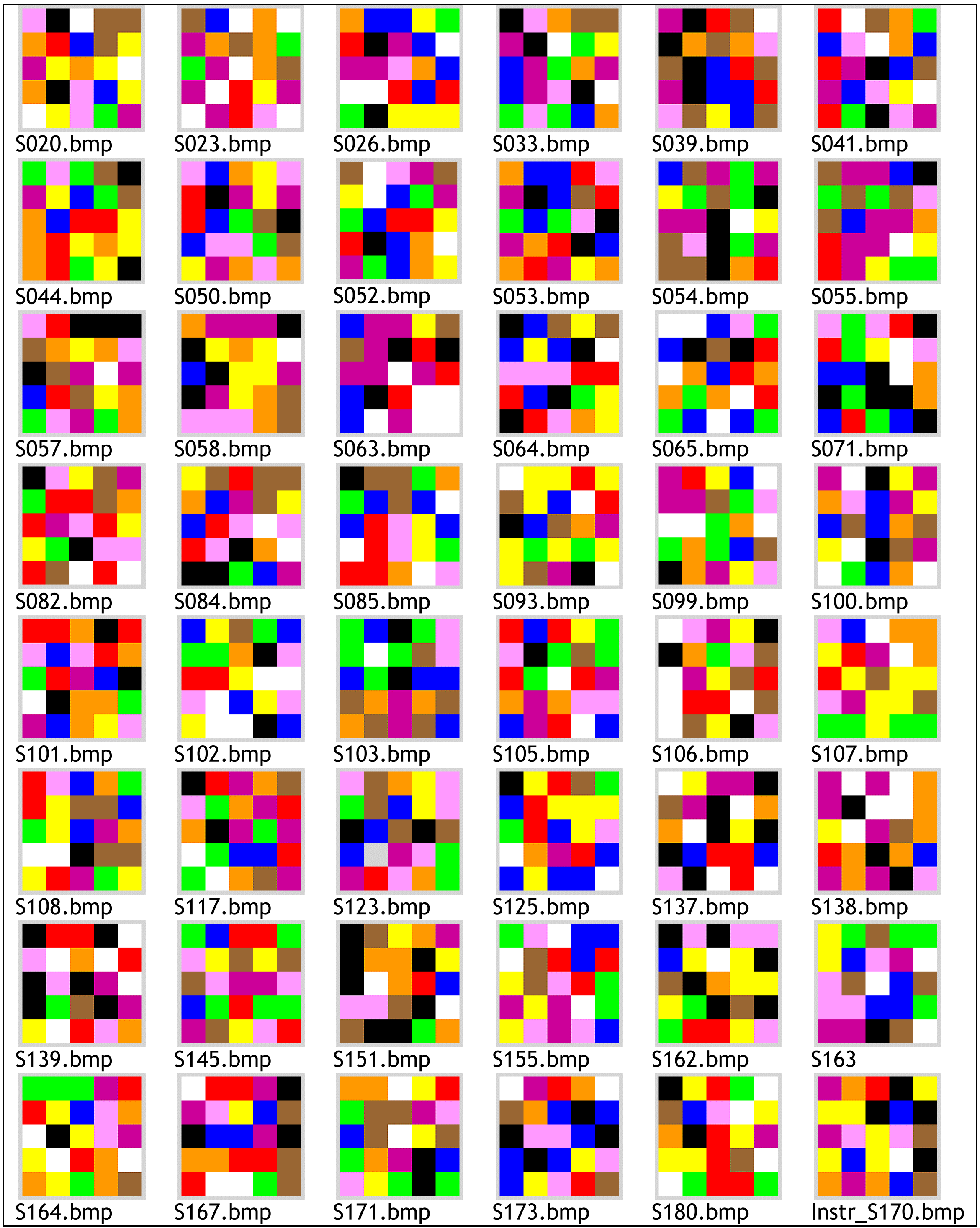


Fig. 18: List of all 48 (47 stimuli set plus one Instruction) sharp Mondrians used.

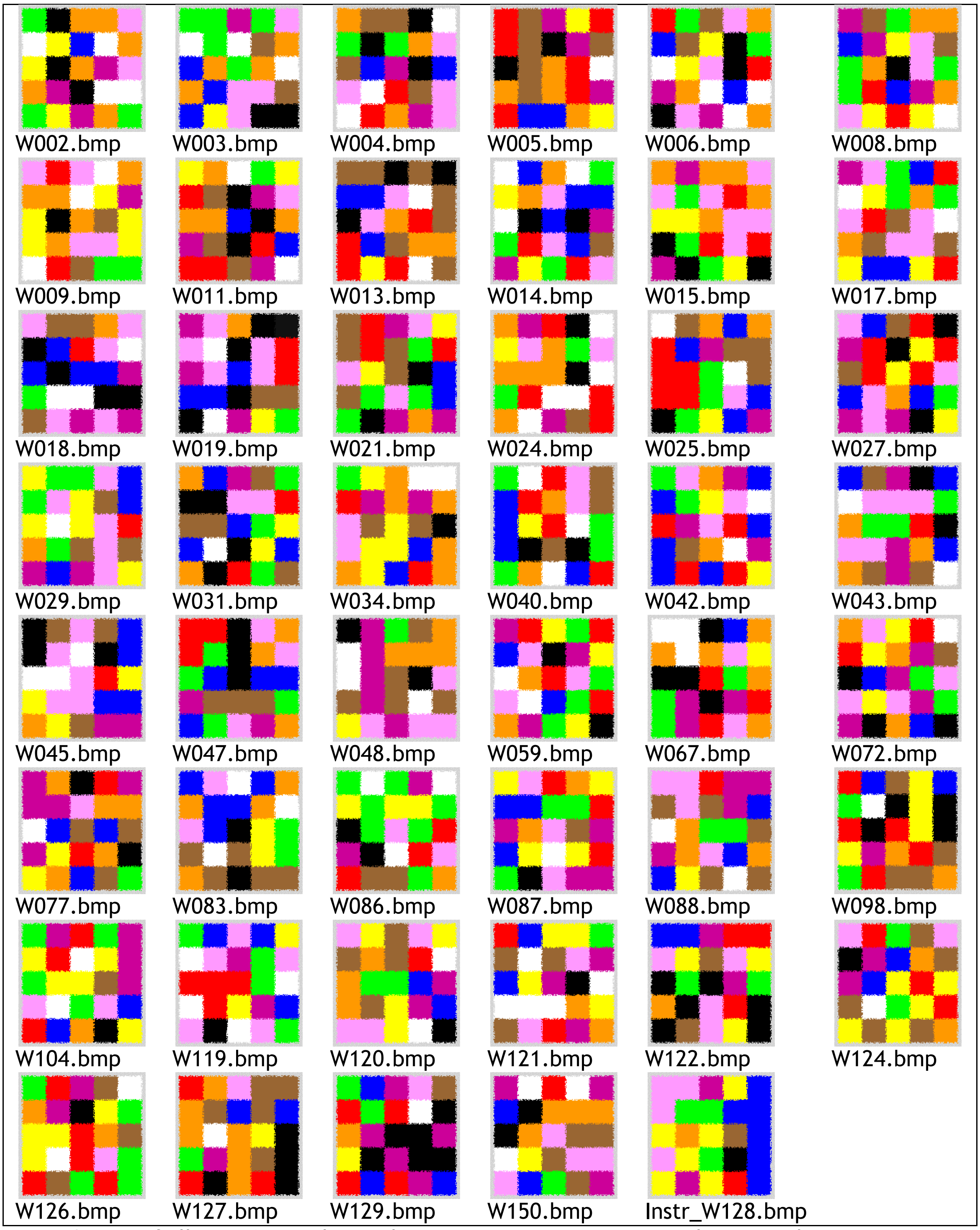


Fig. 19: List of all 47 (46 stimuli set plus one instruction) wavy Mondrians used.

15.2 Stimuli Kanjis

Fig. 20: List of all 100 (99 stimuli set plus one instruction) kanjis used.

15.3 Instructions Pilot Study

15.3.1 Conditions slow and fast

Welcome-Screen

Willkommen zu dem Experiment!

Drücken Sie die Leertaste, um fortzufahren...

Instruction 1

Sie werden in diesem Experiment ein graues Quadrat sehen, dass sich am Bildschirm bewegt.

Ihre Aufgabe ist es, genau den Weg des Quadrats am Bildschirm zu verfolgen.

Folgen Sie dem Objekt bitte nur mit Ihren Augen, aber halten Sie dabei Ihren Kopf so ruhig als möglich.

Drücken Sie die Leertaste, um fortzufahren!

Instruction 2

Sobald das graue Quadrat stehen bleibt, werden Sie gefragt, wie fließend Sie die Bewegung empfunden haben!

gar nicht fließende Bewegung 1 - 2 - 3 - 4 - 5 - 6 - 7 sehr fließende Bewegung

Wenn Sie z.B. finden, dass die Bewegung sehr fließend war, drücken Sie "7".

Wenn Sie z.B. finden, dass die Bewegung gar nicht fließend war, drücken Sie "1".

Sie können und sollen alle Zahlen der Skala nutzen!

Drücken Sie die Leertaste, um fortzufahren!

Instruction 3

Haben Sie noch Fragen?

Drücken Sie die Enter-Taste, um mit dem Experiment zu starten!

Thank you-Screen

Vielen Dank für Ihre Teilnahme!

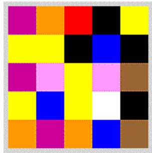
Drücken Sie die Leertaste um das Experiment zu beenden!

15.3.2 Conditions Kanjis and Mondrians

Welcome-Screen
Willkommen zu dem Experiment!
Drücken Sie die Leertaste, um fortzufahren...

Instruction 1

Sie werden in diesem Experiment jeweils für einen kurzen Moment ein Objekt am Bildschirm sehen.



or 恭

Ihre Aufgabe ist es, sich das Objekt so gut als möglich anzusehen.

Drücken Sie die Leertaste um fortzufahren!

Instruction 2

Sobald das Objekt verschwunden ist, werden Sie gefragt, wie gut Ihnen das Objekt gefallen hat!

gar nicht gefallen 1 - 2 - 3 - 4 - 5 - 6 - 7 sehr gut gefallen

Wenn Ihnen z.B. das Objekt sehr gut gefallen hat, drücken Sie "7".

Wenn Ihnen z.B. das Objekt gar nicht gefallen hat, drücken Sie "1".

Sie können und sollen alle Zahlen der Skala nutzen!

Drücken Sie die Leertaste um fortzufahren!

Instruction 3
Haben Sie noch Fragen?
Drücken Sie die Enter-Taste, um mit dem Experiment zu starten!

Thank you-Screen
Vielen Dank für Ihre Teilnahme!
Drücken Sie die Leertaste, um das Experiment zu beenden!

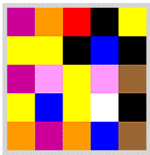
15.4 Instruction Study 1

Welcome-Screen

Willkommen zum Übungsdurchgang *(or Experiment)*!

Instruction 1 (only in practice trial)

Sie werden im folgenden Experiment ein Objekt sehen, dass sich am Bildschirm bewegt.



or 恭

Ihre Aufgabe ist es, genau den Weg des Objekts am Bildschirm zu verfolgen.

Folgen Sie dem Objekt bitte nur mit Ihren Augen, aber halten Sie dabei Ihren Kopf so ruhig als möglich.

Blinzeln Sie während das Objekt zu sehen ist nicht!

Drücken Sie die Leertaste um fortzufahren!

Instruction 2 (only in practice trial)

Sobald das Objekt stehen bleibt werden Sie gefragt, wie gut ihnen das Objekt gefällt!

gefällt mir gar nicht 1 - 2 - 3 - 4 - 5 - 6 - 7 gefällt mir sehr gut

Wenn Sie z.B. finden, dass Ihnen das Objekt sehr gut gefällt, drücken Sie "7".

Wenn Sie z.B. finden, dass Ihnen das Objekt überhaupt nicht gefällt, drücken Sie "1".

Sie können und sollen alle Zahlen der Skala nutzen!

Drücken Sie die Leertaste um fortzufahren!

Instruction 3

Drücken Sie die Enter-Taste um mit dem Übungsdurchgang (*or Experiment*) zu starten!

Thank you-Screen

Vielen Dank für Ihre Teilnahme!

Drücken Sie die Leertaste, um das Experiment zu beenden!

15.5 Instruction Study 2

Welcome-Screen

Willkommen zum Experiment!

Instruction 1

Sie werden im folgenden Experiment ein graues Quadrat sehen, dass sich am Bildschirm bewegt.

Ihre Aufgabe ist es, genau den Weg des Quadrats am Bildschirm zu verfolgen.

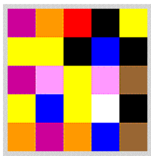
Folgen Sie dem Quadrat bitte nur mit Ihren Augen, aber halten Sie dabei Ihren Kopf so ruhig als möglich.

Blinzeln Sie während das Quadrat zu sehen ist nicht!

Bitte drücken sie die Leertaste um fortzufahren...

Instruction 2

Das graue Quadrat wird schließlich durch ein neues Objekt ersetzt.



Ihr Aufgabe ist es, sich spontan dafür zu entscheiden, wie gut ihnen das jeweils neue Objekt gefällt

gefällt mir gar nicht 1 - 2 - 3 - 4 - 5 - 6 - 7 gefällt mir sehr gut

Wenn Sie z.B. finden, dass Ihnen das Objekt sehr gut gefällt, drücken Sie "7".

Wenn Sie z.B. finden, dass Ihnen das Objekt überhaupt nicht gefällt, drücken Sie "1".

Sie können und sollen alle Zahlen der Skala nutzen!

Bitte drücken sie die Leertaste um fortzufahren...

Instruction 3

Haben Sie noch Fragen?

Bitte drücken sie die Leertaste um fortzufahren...

Thank you-Screen

Vielen Dank für Ihre Teilnahme!

Drücken Sie die Leertaste, um das Experiment zu beenden!

16. Abstracts

16.1 Abstract (English)

The process of decision making has been in the focus of research for a long time. Decisions and evaluations can be influenced by the subjective experience of ease or difficulty associated with the processing of a mental task, which is called fluency. As proven several times before, higher fluency leads to higher liking ratings and more generally to more positive responses. The present thesis investigated for the first time if visuomotor fluency too leads to higher liking ratings. In two experiments the influence of visuomotor fluency was tested without (Study 1) and with a visual obstacle (Study 2). Participants watched a moving object in fluent or non-fluent trajectories. The fluent trajectories were designed so, that they were easy to follow with no or small direction changes, whereas in non-fluent movements the target changed its way to the opposite direction. Even though the studies did not reveal significances, it can be observed that (1) fluent conditions were rated slightly higher, accompanied by (2) faster reaction times, than non-fluent ones, as well as (3) horizontal movements were rated higher than vertical movements, but accompanied by (4) slower reaction times. Although, the present thesis could not prove the impact of visuomotor fluency on liking this should not be comprehended as a falsification but pave the way for further investigations on visuomotor fluency.

16.2 Abstract (German)

Wie wir Entscheidungen treffen, war schon immer für die Wissenschaft und Forschung interessant. Entscheidungen und Meinungen werden stark vom subjektiven Gefühl beeinflusst, wie einfach oder schwierig eine kognitive Aufgabe zu verarbeiten ist. Dieser Effekt ist in der Literatur als *fluency* (dt. Flüssigkeit) bekannt. In der Vergangenheit konnte bereits vielfach gezeigt werden, dass hohe Verarbeitungsflüssigkeit zu positiveren Urteilen und Entscheidungen führt. Die vorliegende Arbeit untersuchte zum ersten Mal, ob auch visuomotorische *fluency* zu den bekannten positiveren Urteilen führt. In zwei Experimenten wurde der Einfluss von visuomotorischer *fluency* untersucht – ohne (Studie 1) und mit visuellem Hindernis (Studie 2). Die Versuchspersonen beobachteten ein sich bewegendes Objekt, das sich entweder eher fließend oder nicht-fließend bewegte. Die fließenden Bewegungsbahnen waren durch keine oder geringe Richtungsänderungen gekennzeichnet, wohingegen die nicht-fließenden Bewegungsbahnen Richtungsänderungen in die entgegengesetzte Richtung vollzogen. Obwohl die vorliegenden Studien keine signifikanten Belege für den Effekt von visuomotorischer *fluency* aufzeigen konnten, wurde beobachtet, dass (1) fließende Bewegungen positiver beurteilt wurden, sowie (2) von schnelleren Antwortzeiten begleitet wurden, als bei nicht fließenden Bewegungsabläufen. Zusätzlich konnte gezeigt werden, dass (3) horizontale Bewegungsabläufe besser beurteilt wurden als vertikale, allerdings begleitetet von (4) langsameren Antwortzeiten. Auch wenn die vorliegende Arbeit den Einfluss von visuomotorischer *fluency* nicht nachweisen konnte, sollte dies nicht als Widerlegung verstanden werden, sondern den Weg für weitere Forschung im Bereich der visuomotorischen *fluency* ebnen.

17. Curriculum Vitae

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Name	Daniela OHRNER
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Ausbildung

ÖAGG	seit 02/2009 Psychotherapeutisches Propädeutikum
Universität Wien	seit 03/2002 Studienrichtung: Psychologie, Diplomstudium
Bundesrealgymnasium Wien IX	09/1993-06/2001 Abschluss: Matura
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Tanzschule Hochstätter	02/2001-06/2002 Tanzassistentin
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