Diplomarbeit

Titel der Arbeit

Der Einfluss der Blickrichtung auf unbewusste Verarbeitung

verfasst von

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„Many an object is not seen, though it falls within the range of our visual ray, because it does not come within the range of our intellectual ray, i.e. we are not looking for it. So, in the largest sense, we find only the world we look for."

Henry D. Thoreau, 1857

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Abstract

Faces and the perception and processing of such have always been of great interest within the field of research, because they influence us in our daily lives and play an important role in the interaction with other people. Although there are many studies on face processing and many theories on the different structures and areas of the brain that are responsible for face processing, this diploma study investigated a specific theory following the study of Finkbeiner and Palermo (2009):

The processing of unconscious perceived faces uses different structures of the brain than the processing of conscious perceived faces. Low spatial frequency information, that is carried through subcortical brain structures, is said to play a big part in unconscious face processing. High spatial frequency information is associated with conscious face processing and is carried out by cortical structures. A masked priming-paradigm as well as high-pass filtered and low-pass filtered stimuli were used in this study to differentiate conscious processes. The results were conform to our expectation: There was no congruency effect in the masked (unconscious) high-pass filtered prime-stimuli condition when discriminating unfiltered target-stimuli, but a congruence effect was found within the unmasked (conscious) condition.

The fact that there was no congruency effect within the masked condition even though a cue was used to direct attention towards the primes, was an unexpected result. Possible explanations are the time of the presentation of the forward- and backward masks, the time frame between prime and target, the presentation time duration of the prime and the low luminance of the high-pass filtered stimuli.

The results are conform with theoretical assumptions that low spatial frequency information is required in order to discriminate faces unconsciously by the subcortical structures.

Zusammenfassung

In dieser Arbeit wird ein Fokus auf die verschiedenen Gehirnareale, die für das Verarbeiten von Gesichtern verantwortlich gemacht werden, gelegt.

Gesichter und vor allem deren Wahrnehmung und Verarbeitung sind nicht nur in der Forschung von großem Interesse. Jeden Tag spielt das Erkennen, Wahrnehmen und Verarbeiten von Gesichtern in der Interaktion mit anderen Menschen eine große Rolle. Es gibt zwar viele Studien die sich mit dem Verarbeiten von Gesichtern auseinandergesetzt haben, jedoch wird in dieser Diplomstudie, die im Rahmen eines Forschungsprojekts an der Universität Wien geschrieben wurde, eine Theorie untersucht die Finkbeiner und Palermo (2009) in ihrer Arbeit beschrieben haben:

Das Verarbeiten von Gesichtern welches unbewusst, also ohne Aufmerksamkeit, erfolgt wird von anderen Gehirnstrukturen ermöglicht als das bewusste Verarbeiten von Gesichtern. Eine bedeutende Rolle in der unbewussten Verarbeitung spielen niedrige Ortsfrequenzen, die über die subkortikalen Gehirnstrukturen verarbeitet werden. Im Gegensatz dazu spielen hohe Ortsfrequenzen eine große Rolle bei der bewussten Verarbeitung von Gesichtern, die über die kortikalen Strukturen verläuft. Um die Vorgänge der Verarbeitung genauer zu unterscheiden wurde in dieser Diplomstudie ein unmaskiertes und maskiertes Bahnungsparadigma verwendet.

Die Ergebnisse der Studie entsprachen nur teils den Erwartungen: es gab keinen Kongruenzeffekt in der maskierten, also unbewussten, Bedingung in der hochpass-gefilterte Bahnungsreize verwendet wurden. Eine Mögliche Erklärung dafür wurde in der kurzen Darbietungszeit und der niedrigen Helligkeit der hochpass-gefilterten Stimuli gesucht. Das Ergebnis das den Erwartungen entsprach, war der gefundene Kongruenzeffekt der unmaskierten, also bewussten, Bedingung.

Theoretische Annahmen von Studien, die über das Vorhandensein von niedrigen Ortsfrequenzen bei der unbewussten Verarbeitung von Gesichtern bestehen, können also unterstützt werden.

1. Theoretical background

1.1. Introduction

The study that is presented here, builds upon a study that has been done in 2009 by Matthew Finkbeiner and Romana Palermo with the title „The role of spatial attention in non-conscious processing“. The purpose was to explore the many connections of conscious and unconscious forms of face processing within spatial attention and neurological paths of processing. This study was conducted within a research project at the University of Vienna.

In order to fully appreciate the merits of this paper I will first define the key terms necessary for the exploration of this research: „visual system“, „consciousness“, „face processing“, „masked priming paradigm“, the „subcortical route“, and „cue“.
I will then describe the theoretical background, with a closer look at the relationship between spatial attention, non-conscious processing and visual stimuli, and give a brief summary of Finkbeiner and Palermo. At the end I will introduce the goal of my study.

1.2. Definition of terms

Visual System

The visual system consists of the eyes, pathways through the visual cortex and also of other parts of the brain.

Consciousness

In our daily lives the word or state „consciousness“ is being understood as a the experience of an individual regarding their inner and outer world. There are different states of consciousness: awake, sleep and unconscious (Zimbardo & Gerrig, 2004).

Face processing

There are certain areas that are said to be selective for face processing that may also play a role in prosopagnosia. One of them is the fusiform face area (FFA) for example, which is located in the fusiform gyrus located between the inferior/median temporal lobe (Moscovitsch & Winocur, 1995). The processing of faces does rely on holistic information (Biederman & Kalocsai, 1997). Low spatial frequency or LSF, which is associated with the broader information of the face, such as the identification of the sex or the outlines of a face, is considered to be the most important information for identity recognition. Details of the face and emotional expressions rely on HSF or high spatial frequency (Awasthi et al. 2011).

Masked priming paradigm

The presentation of a consciously or unconsciously perceived stimuli can slow down or speed up the reaction to a target stimuli (Jacoby, 1983).

Cue

A cue is used to direct attention towards a specific location. Posner (1980) found that participants performances of perceiving a target-stimuli is better when a cue has been presented at the target location beforehand.

Subcortical route

The subcortical route involves the superior colliculi (SC), pulvinar and amygdala. In contrast to the main pathway the subcortical pathway is limited to automatic processing (Bayle et al., 2009).

2. Details and relationships

2.1. Visual System

For decades now, one of the main focus in the field of perception lies within the examination of the processing of visual stimuli in the brain. Especially the perception of faces plays an important role.

The largest visual area in the human brain is the primary visual cortex or V1. When a visual signal enters the retina it travels through the optic nerve to the thalamus where it is forwarded by the lateral geniculate nucleus (LGN), an important subdivision of the thalamus, to the primary visual cortex. The retina is the earliest stage of visual processing and it has different classes of neurons with different processing properties that create two separate streams of information for motion and form (Ng et al. 2007; Laron & Lokschy, 2009). The visual cortex then feeds into the higher visual areas. The thalamus consists of gray matter nuclei and is located on top of the brain stem. The incoming visual information from the retina relays in the LGN and provides the primary visual cortex V1 with visual information. The LGN consists of six layers with two subdivisions. One subdivision consists of four dorsal parvocellular layers and the other of two ventral magnocellular layers. (Fujita, 2001) The P-cells, or parvocellular cells, have a small sized cell body, and project into the layers 3, 4, 5 and 6 of the LGN. They are responsible for colour and the details of vision and receive their input from the ganglion cells. M - cells, or magnocellular cells, have a larger cell body, project into layers 1 and 2 of the LGN, they are sensitive for movement. Each layer receives signals from one eye. The M-cell from the magnocellular layers (1 and 2) and the P-cells from the parvocellular layers (3-6) then project into layer 4 within the primary visual cortex V1, and from there, they split into the dorsal pathway and the ventral pathway. The dorsal pathway projects to the parietal lobe, and is also known as the „where“ pathway. It is responsible for location and action. The ventral pathway, which projects into the temporal lobe, the „what“ pathway, is responsible for object discrimination (Briggs & Usrey, 2007).

During visual stimulation using MR imaging Fujita et al. (2001) were able to show an activation of the pulvinar (which is also said to play a role within the subcortical route-theory) with the LGN simultaneously. „Functional MR imaging based on BOLD contrast is considered to be the best approach for detecting and distinguishing activation in small nuclei deep in the brain“ (Fujita, *p. 1275*, 2001).

There are a lot of theories concerning the unconscious processing of visual stimuli and the way it comes about. One of them is, that the dorsal pathway makes a significant contribution to unconscious visual processing on a cortical level. But in what way exactly do the ventral and the dorsal stream relate to these different types of processing?

Some studies differentiate between vision for perception and vision for action. As already mentioned, the visual projection from V1 to the temporal and parietal lobes divides into two streams. The ventral stream, which plays a critical role in the recognition of objects, and the dorsal stream that enables us to localize these same objects. The ventral stream is thought to be used for conscious processing. It is also known as vision-for-perception. Because the ventral stream is largely dominated by parvocellular (small cells) input, it is very slow at processing information. While the ventral stream is projecting to the inferior temporal cortex, the dorsal stream projects to the posterior parietal cortex. The dorsal stream is much faster, automatic and it is not necessary to consciously registrate a visual stimuli to elicit processing. Magnocellular input is dominant within this pathway. If you were to cross a street, for example, and a car would speed up around the corner, the ventral pathway would be to slow to process the information, and thus you would get hit by the car. Processing in the faster, automatic, and non-conscious dorsal pathway is required to produce a rapid reaction. Therefore the dorsal pathway is also known for vision-for-action (Tapia & Breitmeyer, 2011; Milner & Goodale, 1998). Evidence for the assumption that unconscious processing occurs by the dorsal stream, can be found in the work that Milner and Goodale have done on monkeys. The monkeys had to discriminate between objects on the basis of their visual features, which they could not do due to a lesion to the inferior temporal cortex. Nonetheless they were able to localize those same objects (Milner & Goodale, 1998).

2.2. Consciousness

What is „consciousness“? Over a 100 years ago, Sigmund Freud already concentrated on the personality of human beings. He compared the human consciousness with the structure of an iceberg, where only the tip of the iceberg is visible and the rest is hidden.

In our daily lives the word or state „consciousness“ is being understood as a the experience of an individual regarding their inner and outer world. There are different states of consciousness: awake, sleep and unconscious (Zimbardo & Gerrig, 2004). Unconscious processes are characterised by an automatic processes that proceed conscious processing, and therefore are needing less attention. The connection between consciousness / unconsciousness and the visual processing of stimuli is presented by Kiefer (2008): the visual perception of stimuli does not always need conscious processing, it can be influenced by factors, that are not actively attended to. So these processes can take place unconsciously and can have a great influence on the behaviour and experience of the person, without them being aware that these processes are taking place. This unconscious and subliminal perception of stimuli is being used within the research of the masked priming paradigm.

2.3. Masked priming paradigm

Priming can be described as the influence of the processing of a stimuli by a subsequent activation of implicit memory contents. The presentation of a consciously or unconsciously perceived stimuli can slow down or speed up the reaction to a target stimuli (Jacoby, 1983).

The mechanism of priming is best explained by demonstrating an example. A person that is reading a list of words or a story that includes the word *nature* for example, and later has to complete a word that starts with *nat* is more likely to write down *nature* as opposed to a person who hasn‘t been primed. In a typical priming experiment the participant is given a variety of stimuli in the first trial and reaction times as well as correct answers are recorded. In the next trial the participants are either shown the same stimuli or stimuli that are in some way similar to the prime stimuli and any effect that is specific to the stimulus is a measure of priming. (Breitmeyer, 2008) Another example is the experiment conducted by Forster and Davis (1984), in which participants were asked to classify words or non-words. In this so called „sandwich-technique“, a prime is placed between two masks, a forward mask and a backward mask before a target stimuli is presented. The words that were presented more frequently during the experiment, increased the speed and the accuracy of classification. The first representation of a word (the prime) influences the later stimuli that is similar to the prime (the target). The goal of Forster and Davis was, to determine whether or not priming effects in a lexical decision task were stronger for low frequency words than for high frequency words, and their results showed that a priming effect could be found even when they used a masked prime. The prime was shown for a maximum of 60ms (Forster and Davis, 1984).

Because of the masking, the prime could not be processed consciously. Masking a prime means, that the prime is simply made invisible by using symbols, for example ****** or a string of letters, checkerboards or scrambled pictures that is shown before the prime (forward mask) or after the prime (backward mask). To further ensure the invisibility of the prime, it is not only masked but the time of presentation is only between 10 to 50ms. So if there should be a measurable prime effect, it is not due to conscious perception. The so called visibility test is a statistical procedure which ensures that the masked primes cannot be perceived consciously. If the participants could only recognise the primes with a probability of 50% it could be assumed that the primes were invisible (Breitmeyer & Ögmen, 2006; Kiesel, 2009).

Dehaene et al. used behavioural and brain-imaging techniques to determine how well masked words are being processed. Participants had to categorize a visible target stimuli by pressing a button with their left hand for „smaller than five“ or a button with their right hand for “bigger than five“. The prime stimuli could not be conceived consciously, and was shown prior to the target stimuli. The prime stimuli was either on the same side of the target stimuli (prime stimuli: 2/ target stimuli: 4) which is also called the congruent condition, or on a different side of the target stimuli (prime stimuli: 3/ target stimuli: 7) which is called the incongruent condition. Their results showed that masked stimuli had a significant influence on the brain activity, demonstrating again that processing can occur without awareness. Response times in the congruent condition (prime is the same as the target) were significantly faster than in incongruent conditions (prime is different than target) which is called the masked congruence effect or MCE and is therefore a measure for the priming effect (Dehaene et al., 1998).

The knowledge that was gained from the studies about priming shows that unconscious perceived prime stimuli influence the processing of the subsequent target stimuli. But it is yet unknown in which way or even if attention is a prerequisite. Posner and Snyder (1975), and also Schneider and Shiffrin (1977) argued that unconscious processing of information can occur without attention, and therefore automatically. Naccache, Blandin and Dehaene (2002) argued that attention is a prerequisite for unconscious processing of information.

2.4. Face processing

Studies on Prosopagnosia have suggested that there is a difference between the processing of faces, and the processing of non-face objects. Prosopagnosia is a disorder resulting from lesions to the right hemisphere. The patients are unable to recognize the face of a familiar person, and sometimes they are even unable to recognize themselves when they look into a mirror. Because they are still able to read for example, or identify a familiar person by the way they dress, researchers suggested that there is a difference in processing faces, and non-face objects. Another theory of face processing which involves a subcortical route stems from Weiskrantz and his experiments with blind sight patients (Weiskrantz, 1996). Blindsight is „the ability of a person with a lesion in the primary visual cortex, to reach towards or guess at the orientation of objects projected on the part of the visual field that corresponds to this lesion, even though they report that they can see nothing in that part of their visual field“ (Johnson, *p.766*, 2005). So despite patients claiming to be blind and not being aware of a stimuli they are still able to give the right answer above chance when asked to guess the identity of this stimuli.

There are certain areas that are said to be selective for face processing that may also play a role in prosopagnosia. One of them is the fusiform face area (FFA) for example which is located in the fusiform gyrus located between the inferior/median temporal lobe (Moscovitsch & Winocur, 1995). Non-face objects are processed based on their parts and edges, whereas the processing of faces does not rely on single features but on holistic information (Biederman & Kalocsai, 1997). To better understand the processing of faces we first have to take a closer look at the range of spatial frequencies that enable our visual system to recognize faces. Low spatial frequency or LSF which is associated with the broader information of the face, such as the identification of the sex or the outlines of a face, is considered to be the most important information for identity recognition. Details of the face and emotional expressions rely on HSF or high spatial frequency (Awasthi et al. 2011). Low spatial frequency is carried to the superior colliculus and pulvinar via the magnocellular channels, providing a quick route of visual processing. Even though it is a fast pathway, that is able to process faces at a latency less than 100ms, it is insensitive to HSF. High spatial frequency is carried by parvocellular channels to the cortical ventral visual stream offering fine resolution but at a very slow pace (Johnson, 2005). While high spatial frequency information correlates with the conscious processing of faces, low spatial frequency correlates with unconscious processing of faces.

To study the perceptional processing of faces Awasthi et al. (2011) measured the time it took the participants to reach out and touch the screen. The stimuli used were male and female faces, and they both contained low and high spatial frequency information. The images were presented peripherally and centrally. Results showed that there was less effect of LSF faces at the fovea compared to periphery demonstrating that peripherally presented LSF information enables processing of faces via a subcortical route. In experiment 1 the participants were shown two images in the periphery. One image was shown in the center in experiment 2, and in experiment 3 two images were shown in the periphery and in the center in alternate blocks. The participants of this study had to reach out and touch the black target box on the screen. Reaching trajectories were used as a measure of behavior, because they allow to witness the time it takes to make a perceptual decision (Awasthi, 2011).

2.5. A subcortical route

Contrary to the main visual pathway that includes the lateral geniculate nucleus (LGN), the striate cortex and parietal and temporal extrastriate cortices, Weiskrantz argues for the existence of a subcortical route which involves the superior colliculi (SC), pulvinar and amygdala. In contrast to the main pathway the subcortical pathway is limited to automatic processing. Weiskrantz introduced his theory in his work with blind sight patients. Evidence for a subcortical route can not only be found in patients with blind sight but also in healthy patients. Forster and Davis (1984) conducted experiments on healthy patients using masked primes to minimize the influence of possible traces of the primes. Their experiment shows that the first presentation of a word, the prime, leaves behind a kind of trace in the epsiodic memory that is contacted when the same word, the target, is presented again. Forster and Davis used a neutral word as the first stimulus with the purpose of acting as a forward mask for the prime, which was the second stimulus. The prime consisted of lower case letters and was either congruent (identical) to the target or incongruent (different to the target word) and the third stimulus, the target, had to be identified as a word or as a non-word. The mask and the target were shown for 500 ms, the primes was only shown for 60ms. Results showed that the decision times for words were faster in the congruent condition.

Another prove of the existence of a subcortical route is being presented by the studies with ERP or event related potential-records from patients with epilepsy by Johnson (2005) that have shown that a face selective response occurs even before the primary visual cortex (V1) is activated. ERPs or event-relates potentials are „electrical potentials that are generated in the brain as a consequence of the synchronized activation of neuronal networks by external stimuli. These evoked potentials are recorded at the scalp and consist of precisely timed sequences of waves or components“ (Johnson,*p. 767*, 2005).

2.6. Relationships and the „classic view“ versus the „modern view“

Results from research about consciousness / unconsciousness suggest how objects and faces are perceived and processed unconsciously. Attention plays an important role in conscious processing as well as in unconscious processing which will be looked at in the following paragraph.

Posner, Snyder and Davidson conducted several studies in which they examined the influence of attention on the processing of visual information. Participants were asked to fixate a dot on the computer screen, and at the same time identify a target stimuli that would be presented either left or right as fast as they could. Previously to the target prime they chose to show a spatial cue which could be in the same place as the target prime or a different place. The authors concluded from their results, that the processing of the target stimuli relied on the position of the spatial cue. If the spatial cue was in the same position as the target stimuli responses were quicker.

The role of attention within in the context of the unconscious perception of visual stimuli is widely discussed. Since 1970 it was the assumption that unconscious processing occurs without attention. Perception and processing of stimuli was characterised as automatic (Posner & Snyder, 1975; Schneider & Schiffrin, 1977). This is what is meant by the „classic view".

In 2002 Naccache, Blandin and Dehaene conducted a new study with the title „Unconscious masked priming depends on temporal attention". The authors demonstrated to the surprise of many that attention indeed is a prerequisite to trigger unconscious processing (Lemaire & Grainger, 2007). These results contradicted the „classic view" and it is what is called the „modern view".

2.7 Summary of Finkbeiner and Palermo and the „middle position"

Trying to combine both views, and to compare the differences in processing faces versus non-face objects Finkbeiner and Palermo conducted a study in 2009 without representing either one view or the other. The authors hypothesised that the „classic view", unconscious processing occurs without attention, is dependent on the kind of stimuli that is being presented. Therefor there could not be made a general statement about attention never or always influencing unconscious processing. The authors used photographs of animals and tools (Experiment 1a), pictures of male and female faces (Experiment 1b and 2b) and pictures of animals and vegetables (Experiment 2a) as target stimuli. Prime stimuli were shown in between a forward mask and a backward mask and were followed by the target stimuli. Target stimuli were always shown on the lower position of the screen, prime stimuli always on the upper position of the screen. Stimuli were either congruent or incongruent, prime and target from the same category (congruent) prime and target from a different category (incongruent). Spatial attention was directed either to prime stimuli or target stimuli with a cue that was shown right before the presentation of the prime.

Participants were asked to concentrate on the target stimuli at the lower position. To ensure that participants did not perceive the face primes consciously they were also asked to discriminate the sex of the prime stimuli in a control condition. The participants had to determine the target stimuli using two keys on a computer keyboard. If the prime and the target stimuli originated from the same category (congruent trial) a priming effect occurred. Finkbeiner and Palermo were able to confirm their hypothesis in which masked priming effects of faces are independent of spatial attention but masked priming effects of objects rely on spatial attention. Finkbeiner and Palermo were able to show prove for a „middle position“. Unconsciously perceived faces are independent of attention, unconsciously perceived non-face objects can only be processed if attention is present. They referred to neurological findings and suggested that the processing of faces and objects occurs via two different paths within the brain and they argued for the subcortical route that is responsible for the unconscious processing of faces. This new view is being called the „ middle position“.

Mascha Wisseler's diploma thesis (2011) could show in a subsequent study that faces with low spatial frequency produce a priming-congruence effect. These results support Finkbeiner and Palermo. Wisseler (2011) further explored the role of low spatial frequencies by using high spatial frequency prime stimuli in which low spatial frequencies had been removed. Since there was no prime-congruence-effect within high spatial frequency stimuli the hypothesis that low spatial frequencies play an important role within the unconscious determination of faces could be supported.

3. Research of Diploma thesis

3.1 The research question

The present study strives to examine cues that point to a subcortical route in the processing of faces in more detail, by using masked and unmasked high-pass face prime stimuli. According to this theory it should be possible to find that images of faces that include all spatial frequency information and are shown in the periphery can be processed without a cue that directs attention towards them. This should also be possible for the images of faces with LSF information but it should not be possible for images that only include HSF information. The images only holding HSF information should produce a congruence effect only when attention was directed to the primes.

In this study the images of faces were filtered and images with only LSF information as well as images with only HSF information was obtained. A cue was used to direct attention to either the periphery or the fovea. If the primes can indeed be processed it should lead to faster reaction times in congruent conditions.

Additionally the participants eye movements were being recorded with an eye tracker so it could be proven that the participants were fixating the targets.

3.2 Hypothesis

HSF primes that are shown peripherally without a cue to direct attention towards them do not lead to shorter reaction times in congruent conditions.
HSF primes that are shown peripherally with a cue that directs attention towards them lead to shorter reaction times in congruent conditions.

A missing congruence effect of the prime stimuli within the masked trial would support the neurological findings that unconscious perceived unfiltered faces are being processed via the subcortical route. Faces with low spatial frequency are being processed through the magnocellular channels. Faces that contain only high spatial frequency should be excluded from the subcortical theory, because they are being processed through the slower parvocellular channels.

3.3 Evidence for the hypothesis

3.3.1. Methods and instruments

The hypothesis was tested with a computer based experiment.

The experiment was conducted in a basement room (TRK-7) of the Psychologicum in Liebbiggasse 5, 1010 Vienna. The room was darkened with a black foil on the window and the lights were turned off except of a small table lamp that was located right next to the computer monitor. The computer used in this experiment was a wDell OptiPlex GX960 Intel Core 2 Duo E7400. Visual stimuli were presented on a 15-inch colour CRT monitor with a display refresh rate of 59.1 Hz. The participants had to sit in front of the monitor with a distance of 57 cm and their head was resting in a chin rest to control the constant viewing distance, and to make sure they were looking straight ahead. Additionally an eye tracker was used in this experiment to ensure that participants had their eyes on the screen during the entire experiment. The eye tracker used was a SR Research Ltd. Eye-Link 1000, and monocular tracking was used. The eye which calibrated best was recorded and the gaze position was at a rate of 1000 Hz. Participants were asked to only use three keys on the keyboard. The keys for „L“, and „A“ as well as the spacebar. The keys „L“, and „A“ were labeled with a neutral white sticker to ensure an easy recognition.

Reaction times that were measured by pressing the keys were saved with the Software MATLAB (more information at: http://www.mathworks.de/products/matlab) and Psychotoolbox-3 (more information at: http://psychotoolbox.org/HomePage). These programs enabled the statistical analysis of the data as well as a graphical presentation, and the presentation of the stimuli. Psychotoolbox is an add-on of MATLAB, and it presents the stimuli right on the second so the reaction times could be measured exactly.

3.3.2. Participants

All of the 40 participants of this experiment were recruited by a participant management system of the University of Vienna (RSAP, for further information regarding the RSAP see: http://www.univie.ac.at/experimentalwiki/rsap/public/), and some of them were recruited from a circle of acquaintances. For their participation all of them were given course credits which could be used as bonus points for exams. 33 of the 40 participants were female, and the mean age of males and females was 24.6 years. 14 participants had to use a visual aid, like glasses. It was also made sure that all of the participants had sufficient knowledge of the German language to understand the instructions.

3.3.3. Stimuli

The stimuli that were being used consisted of HSF as well as LSF primes, unfiltered targets, cues and masks. The HSF and LSF primes were created by an image editing program (ImLab 2.3.3, MIT License, 2009). A Laplacian of Gaussian filter with the standard deviation of 1 was used to modulate spatial frequency. The resulting images were identical in terms of their size, shape, and resolution compared to the unfiltered face-stimuli. Primes were also adjusted in terms of their background, and foreground contrast as well as the contrast within the faces to match the original images. Gray scales of the primes were also adjusted to match the original images.

As in the experiment of Finkbeiner and Palermo (2009) the stimuli that were used consisted of masks, cues and ten neutral images of five male, and five female faces, see figure 1. The face-stimuli were taken from the Karolinska Directed Emotional Faces database (KDEF) (Lundqvist, Flykt & Öhman, 1998).

To focus only on relevant facial features the images were cut into an oval shape. Using ImLab, a graphical application for scientific image processing (ImLab 2.3.3, MIT License, 2009) the HSF primes that were used within the experiment were created from the unfiltered face-primes.

Figure 1 : Target stimuli that were being used in block A and B. The first row shows female faces, and the second row shows male faces.

The basis of the high-pass filttered prime-faces were also images taken from the KDEF database. Figure 2 shows that two images were chosen to be the primes. The prime-stimuli were not part of the the already shown target images shown above.

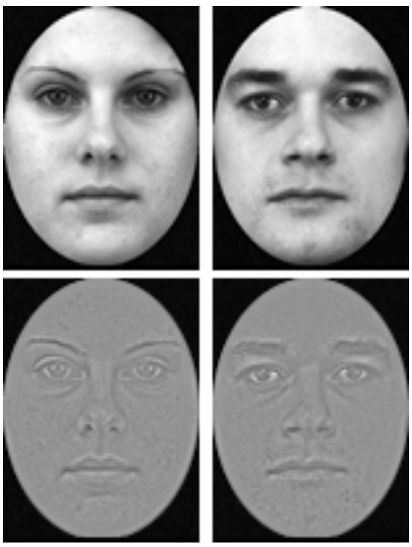

Figure 2: Prime stimuli of female and male images. First row shows KDEF-faces before filtering. Second row shows high-pass KDEF-faces.

Aside from prime-, and target-stimuli a forward-mask, a backward-mask, and a cue were being used. Figure 3 shows a checkerboard that was used as a forward-mask, and a scrambled picture of the two unfiltered prime-stimuli images used as a backward-mask. The spatial cue consisted of a black dot on a white background.

Forward- and backward-mask were being used in the masked trial to make the prime-stimuli invisible. The masks were black in the unmasked trial, because the prime stimuli had to be visible for the participants. The spatial cue was used to direct attention towards the desired location.

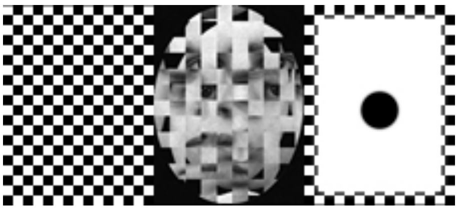

Figure 3: Forward-mask/ backward-mask/ cue

The stimuli were standardized regarding size, colour, and resolution. As seen in figure 3 a checkerboard pattern was used as a forward mask and a scrambled picture of two combined faces was used as a backward mask.

The primes were always shown for 50ms in the upper half of the computer monitor while the targets were shown in the lower half for 300ms. To direct attention the cue was shown at either prime or target position. Each trial included congruent conditions in which the prime was from the same category as the target stimuli (male/male or female/female) or incongruent conditions in which the prime and the target were from a different category (male/female or female/male).

Figure 4 shows an example trial of a congruent condition with a female prime and a female target. The images were shown simultaneously and the time of presentation is shown in milliseconds. As a forward mask a checkerboard pattern was used and a scrambled combination of two unfiltered face primes was used as a backward mask.

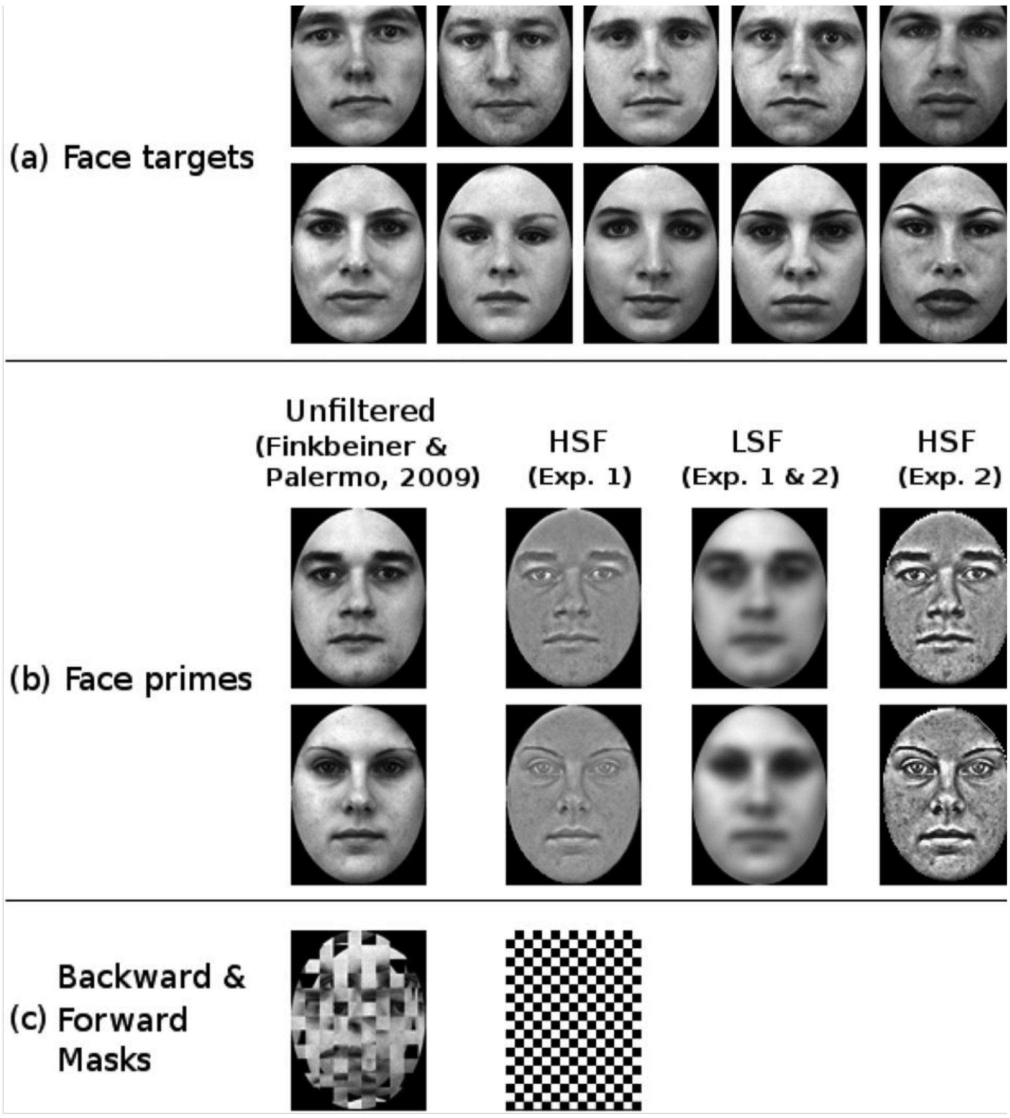
(a) Face targets
Unfiltered
(Finkbeiner & Palermo, 2009)
HSF
(Exp. 1)
LSF
(Exp. 1 & 2)
HSF
(Exp. 2)
(b) Face primes
(c) Backward & Forward Masks

Figure 4: Row (a): male and female face targets. Row (b): face primes Finkbeiner and Palermo (2009) also used in their experiment. Row (c): the backward mask, and the forward mask (a checkerboard pattern).

3.3.4. Design

The experiment was divided into three parts. Part one and two were used for sex discrimination in which the participants had to discriminate the target face stimuli. To give an example, figure 5 shows a trial within a congruent condition. Part three was used to test whether or not the masked primes were visible.

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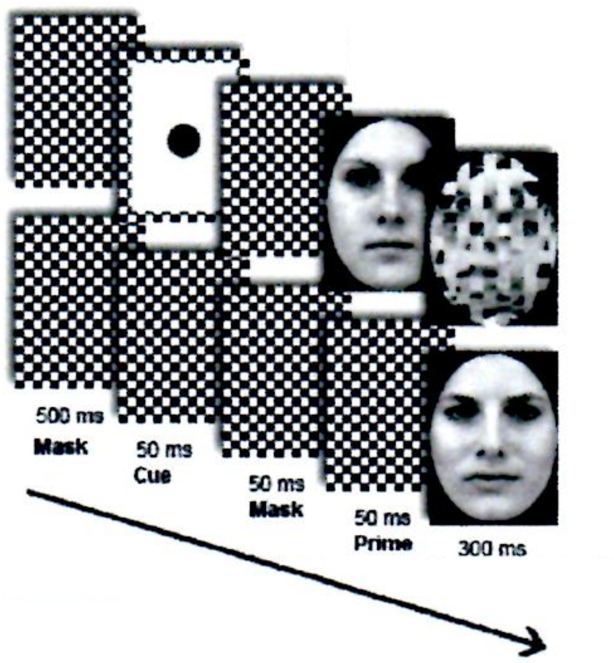

Figure 5: Unfiltered prime-stimuli cued trial within a congruent condition.

In the first part of the experiment HSF, LSF and unfiltered primes were shown, and they were assigned pseudo-randomly. It was also made sure that there were never the same targets consecutively. Participants had to discriminate the sex of the target stimuli.

Part two of the experiment, similar to part one, also asked participants to discriminate the sex of the target stimuli but after each correct answer they were also asked to discriminate the sex of the prime stimuli.

Part three was used to test if the participants could see and discriminate the prime stimuli that were shown unmasked and without a target stimuli.

Each trial consisted of a sequence of parallelly shown stimuli. Primes were always shown in the upper position, and targets were always shown in the lower position. At the beginning of the experiment the participants had to first go through a practice phase with 20 trials. Part one and two of the experiment consisted of 320 trials in total, 40 trials in each of the conditions. Prime-cued congruent condition, target-cued congruent condition, prime-cued incongruent condition, target-cued congruent condition. Participants were primarily informed about the upcoming trial by the conductor of the experiment, and were additionally shown an instruction on the computer monitor. During the whole experiment the conductor was present and available for any questions.

In each trial the stimuli were presented on a black screen. A trial started with a checkerboard mask for 500ms. Next a cue was shown pseudo-randomly at either the prime or the target location together with the checkerboard mask at the non-cued location for 50ms. Because of the cue attention was directed either towards the prime (in the prime-cued condition) or towards the target (in the target-cued condition). Following the cue a checkerboard mask was presented for 50ms once more at both positions. After this a prime-face stimulus was shown at the upper position and a checkerboard mask was presented for 50ms at the target‘s position. In the unfiltered priming blocks the face primes were similar to the face targets in all respects except for the face identities. In the HSF priming blocks high-pass filtered face primes were used for one half (group 1) of the participants. High-pass filtered face-primes that were luminance-equated as well as foreground-background contrast equated with the unfiltered face-primes were used for the other half (group 2) of the participants. A scrambled-face mask followed the prime. At the same time a face-target was presented at the lower position for 300ms. Across trials prime and target gender varied to create congruent and incongruent conditions. In the congruent conditions the prime face gender was the same as the target face gender. Prior to a male face-target a male face-prime was presented or a female face-target was presented prior to a female face-prime, see in figure 1. In the incongruent conditions the prime face gender was different from the target face gender. Prior to a female photograph face-target a male face prime was shown, or prior to a male face-target a female face-prime was shown.

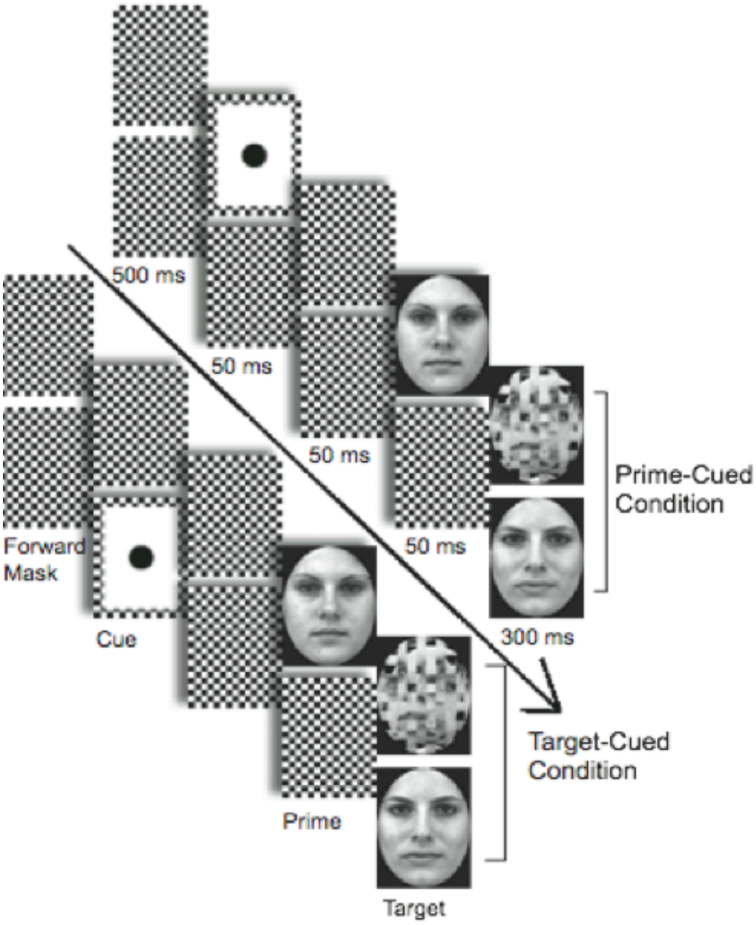

Figure 6 : An example of a congruent trial. The forward-masks consisted of a checkerboard pattern, and the backward-mask of a scrambled picture of two unfiltered prime-stimuli images in the masked condition.

The participants had to discriminate the gender of the target face photographs by pressing one of the labeled keys on the computer keyboard in the „target discrimination task". They had to press one key for a male face-target and the other key for the female face-target. The keys that had to be pressed to discriminate the gender were balanced out and randomized across the participants. There were two blocks of primes in the „target discrimination task". One with HSF primes, and one with unfiltered primes. Which of the block was shown first was also balanced out and randomized. In the two target discrimination blocks 20 repetitions of each combination of cueing (prime-cued or target-

cued), target type (male, female), and prime-target congruence level (congruent, incongruent) were presented, 160 trials in total. Additionally 16 filler trials with HSF face targets were used within each of the „target-discrimination“ blocks. At the end of the experiment another block was added after the correct target discrimination in which participants had to discriminate the masked prime's gender. Again participants had to press one key for the female face-prime, and another key for the male face-prime. Another 200 trials were shown in the prime-discrimination task 100 of which were unfiltered face primes, and the other 100 trials consisted of HSF face-primes.
The conditions in each block were assigned pseudo-randomly, and no same face-target succeeded the previous one.
In total the experiment took about 45 to 55 minutes. To ensure a fast and accurate response participants were given a feedback after each answer.

3.3.5. Procedure

The experiment took place in the spring term of 2012. Because an eye tracker was being used only one participant at a time could be tested.

At the beginning the participant was greeted and informed about the upcomming study, and about the calibration of the eye tracker. To agree to the publication of results, participants were given a consent form. What followed was a pratical instruction and demonstration of how to rest their head in the chin rest and how to use the eye tracker. The participants were also shown how they should respond to the targets by pressing the keys „A“, and „L“ on a standard serial computer keyboard with their left (for „A“) and right (for „L“) index fingers on the keys. Additionally the keys were labelled with a sticker.

The conductor of the study was present the entire time in case any questions had to be answered, and also to make sure, that the eye tracker was recording the signal properly.

The eye tracker was calibrated before the experiment began. The participants had to follow a dot on the monitor. Once the signal was stable and the right or left eye was recognized by the eye tracker the instructions to the experiment appeared on the screen. To start the experiment the participants had to press the spacebar after reading the instructions. After each trial the participants were able to take a break and continue the next trial with pressing the spacebar again.

If the reaction time of a participant was to slow, they were made aware of it through a clue that appeared on the monitor saying „ react faster“. This clue appeared after 1250 milliseconds.

The whole experiment took a maximum of 60 minutes including small breaks, although most of the participants finished after about 45-55 minutes. The procedure is shown in figure 6.

4. Statistical analysis and results of empirical investigation

4.1 Target-stimuli discrimination trial

For the first part of the analysis, the correct target responses were considered, because the filler trials, as well as the erroneous trials were analyzed separately.

The mean RTs were calculated for each participant and condition, see figure 7. Some trials (3.8%) were thrown out, because they were faster or slower than 2.5 standard deviations of the mean, and only trials where the target was fixated during the procedure were included (71.7%). Trials, in which the prime was fixated (3.2%), as well as trials with a gaze-position error exceeding 0.5° after the calibration, or trials with too much eye-blinking (25.1%) were excluded. As seen in Khalid (2013) an omnibus repeated-measures ANOVA with the variables cue type (target-cued vs. prime-cued), prime type (LSF prime vs. HSF prime) and prime-target congruence (congruent vs. incongruent) was run. For all statistics throughout the study Bonferroni adjustments for multiple comparisons and an alpha level of .05 were applied.

There were significant two-way interactions with the variables prime type and congruence, $F (1,29) = 10.05$, $p < .01$, partial $\eta 2 = .26$. This showed overall net congruence effects of 6ms and 5ms with the LSF primes in the target-cued and prime-cued conditions and dropped in to -1ms and -3ms with the HSF primes.

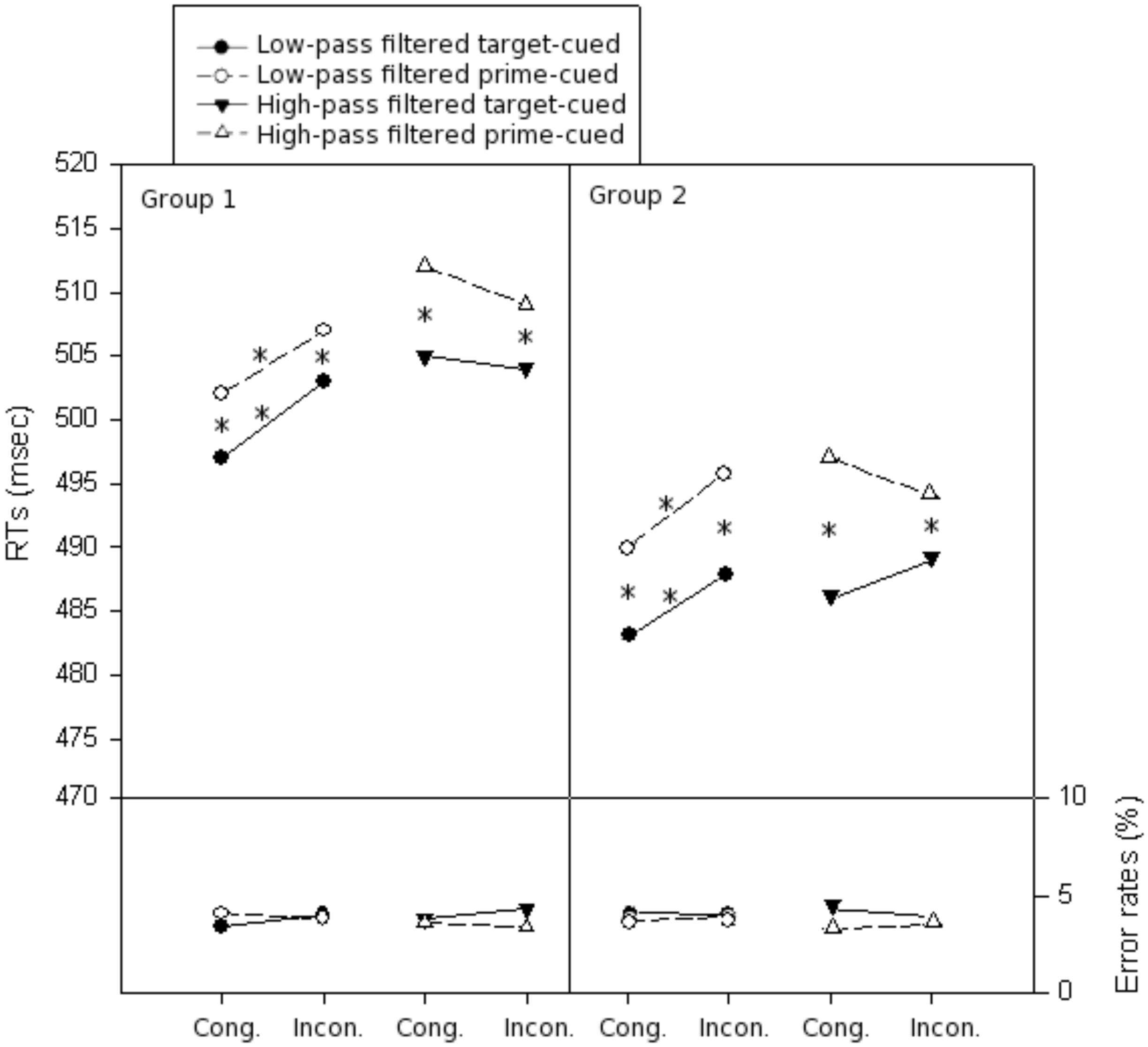

Figure 7: This figure taken from Khalid et al. (2013) shows the congruence effects of the low-pass filtered target-cued and prime-cued conditions of both Groups 1 (Exp. 6) and 2 (Exp. 5). There was no congruence effect in the high-pass filtered conditions. „A star (*) shows the significant effects of congruence (when it appears in the middle of a line) or cue type (when two stars appear each between the starting and the ending oints of lines“ (Khalid et al., 2013, p.5).

An overall effect of cue type, $F(1,29) = 9.54$, $p < .01$, partial $\eta 2 = .25$ was also found. Performance was better in the target-cued condition (M = 502ms) than in the prime-cued condition (M = 508ms). No other significant effect or interaction was found, all Fs < 1.00.

A significant main effect of the within-participant variable cue type and congruence was revealed by a follow-up ANOVA of the HSF condition, $F(1,29) = 5.73$, $p < .03$, partial $\eta 2 = .17$. The performance of the participants was faster in the target-cued condition (M = 504ms) than in the prime-cued (M = 511ms) condition. A significant main effect of congruence was found by a follow-up ANOVA of the LSF condition, $F(1,29) = 14.98$, $p < .01$, partial $\eta 2 = .34$, where the performance of the participants was faster in the congruent condition (M = 499ms) compared to the incongruent condition (M = 505ms). The LSF condition produced a significant main effect of cue type, $F(1,29) = 4.77$, $p < .04$, partial $\eta 2 = .14$, where performance was faster in the target-cued condition (M = 500ms) than in the prime-cued condition (M = 505ms). No other interaction of effect could be found, all $Fs < 1.00$.

4.2. Error rates

Again an omnibus ANOVA was conducted with the error rates. Also no significant interaction of significant effect could be found, all $Fs < 1.00$, and all $ps > .05$.

4.3. Filler trials

The participants were able to discriminate the gender of the face primes that were used as targets in the filler trials of the HSF condition (M = 79.4%, SE = 2.7), $t(29) = 10.82$, $p < .001$, and the LSF condition (M = 80.0%, SE = 2.1), $t(29) = 14.10$, $p < .001$.

4.4. Distribution analysis

The correct RTs of each condition were sorted from fast to slow responses to investigate if a mean congruence effect of the masked HSF primes could possibly be found in the fastest responses. The resulting RT distribution was then split into 4 bins (Kahlid, 2013). The ANOVA was conducted with the mean RT from each quartile and an additional variable bin. Again there was no other significant interaction or significant effect found, all $Fs < 1.00$.

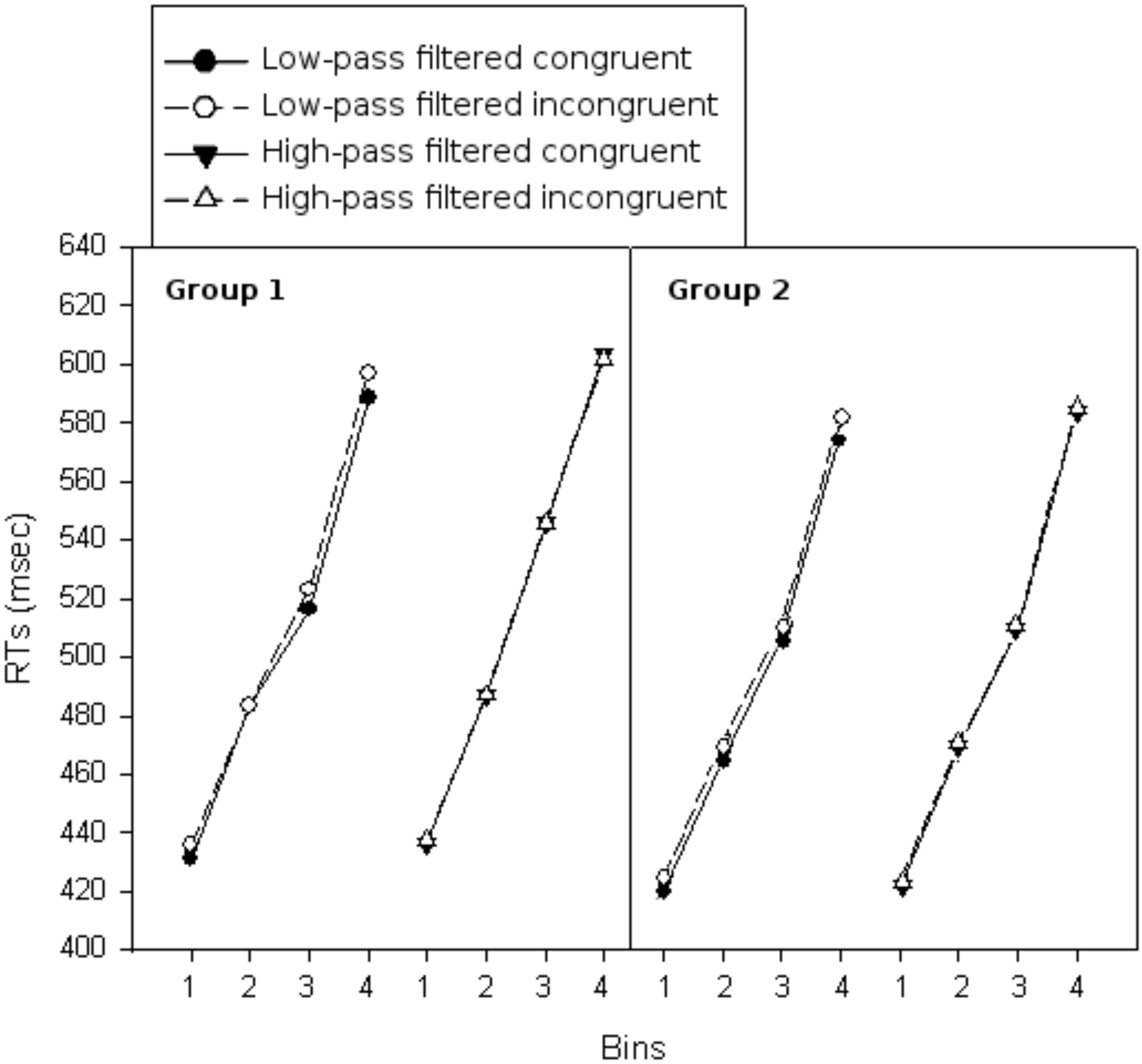

Figure 8: This figure by Khalid et al. (2013) shows the mean Reaction Times (RTs) in milliseconds on the y axis. Prime type, and congruence are shwon on the x axis, in Group 1 (on the left side) and Group 2 (on the right side). The solid lines and filled symbols represent the congruence, the dashed lines and unfilled symbols the incongruence, and the circles represent the unfiltered condition, the triangles represent the high-pass filtered condition (Khalild et al., 2013,p.7) .

4.5. Prime visibility

The visibility of the primes was investigated in the „prime-discrimination task“. d’ from the signal detection theory (SDT) by Green and Swets (1966) was used. d’ scores were obtained through the calculation of hit rates and false alarm rates. In this study male face photographs that were used as primes were taken as ‘signals’ and female face photographs that were used as primes were taken as ‘noise’. d’ is the z-transformation of false alarm rates that are subtracted from the z-transformed hit rate. If the participants only guess in their performance, the index becomes zero and it can increase infinitely with each discrimination performance. The participants could not discriminate the sex of the masked prime-stimuli, as indicated with one-sample t-tests. In the masked HSF target-cued condition the results showed no significant difference of the mean d‘s from zero ($M = 0.12$), $t(29) = 1.54$, $p > .13$, neither did the results in the masked HSF prime-cued condition ($M = 0.05$), $t(29) = 0.48$, $p > .63$. In the masked LSF target-cued condition the mean d‘s also showed no significant difference from zero ($M = -0.04$), $t(29) = -0.55$, $p > .58$, neither did the mean d‘s in the masked LSF prime-cued condition ($M = 0.11$), $t(29) = 1.72$, $p > .09$ (Khalid et al., 2013).

4.6. Unmasked prime discrimination

Results showed that the participants were able to successfully discriminate the gender of the prime-stimuli in the unmasked HSF ($M = 92.1\%$, $SE = 1.1$), $t(29) = 37.84$, $p < .001$, and unmasked LSF ($M = 78.5\%$, $SE = 2.7$), $t(29) = 10.73$, $p < .001$, conditions. The participants were able to discriminate the HSF primes significanlty faster than the LSF primes, $t(29) = 5.97$, $p < .001$.

5. Discussion

This study was conducted with the goal of closing the gap between the connection of conscious and unconscious processing of faces and spatial awareness. The results should additionally allow to draw more conclusions about the subcortical magnocellular channels and the cortical parvocellular channels. The study was conducted within a research project at the University of Vienna.

Before I will go into the discussion of this study, I will briefly summarize the theoretical background on which this study was built.
Some researchers postulated that the unconscious processing of stimuli occurs without attention (also known as the „classic view“) (Posner & Snyder, 1975; Schneider & Schiffrin, 1977) and through subcortical structures. Conscious processing is being associated with cortical structures (Morris, Ölman and Dolan, 1999). Others contradicted these findings and showed that unconsciouss processing can only occur with attention (also known as the „modern view“) (Nacchache, Blandin & Dehaene, 2002) and are being processed through cortical structures. Conscious processing in this theory occurs through subcortical paths (see Kouider, Eger, Dolan and Henson, 2009).
Against this background a study conducted by Finkbeiner and Palermo (2009) contributed considerable insight to this issue in showing that whether or not attention is a prerequisite in processing depends on the kind of stimuli that is being presented. Unconscious received stimuli can only be processed when attention is focused on them, whereas the processing of faces can occur without attention. The unconscious processing of faces seems to occur through faster subcortical structures, because of their low spatial frequency information (Johnson, 2005).
In this present study a masked and unmasked priming-paradigm with high-spatial frequency prime stimuli photographs was used to investigate the connection between different spatial frequencies, conscious or unconscious processing and neurological brain structures.
The results of the study confirm the hypothesis:
HSF primes that are being shown peripherally without a cue to direct attention towards them do not lead to shorter reaction times in congruent conditions.
HSF primes that are shown peripherally with a cue that directs attention towards them lead to shorter reaction times in congruent conditions.

Before I will go into discussing the results in more detail I will outline the statistical conditions of the study to underline the results:
The visibility test ensured that the prime-photographs were visible for the participants in the unmasked condition, and invisible in the masked condition. The results of the visibility test showed an above chance classification of visible primes within the unmasked condition.
The invisible masked primes could only be determined by chance. This way conscious perception of the filtered stimuli within the unmasked condition, and unconscious perception within the masked condition could be confirmed.

The results of the filler trials showed that the participants were able to use a search pattern for LSF as well as for HSF. Based on this it was ensured that a congruence effect was produced between high-pass filtered primes and unfiltered target stimuli. The fact that a congruence effect did not occur can be traced back to the fact that the visual differences between prime- and target stimuli were too big (Wisseler, 2011).

The error rate ensured a fast and precise reaction within the trials. No significant effect or interaction was found using the ANOVA.

The distribution analysis of reaction times enabled a more detailed inspection of the obtained data in regard to the reaction times. Significant results could be confirmed, but no other significant effect or interaction was found.

The analysis of variance could show a significant interaction between the variables „masked" (unmasked vs. masked) and „prime-target-congruence" (congruent vs. incongruent). This result is very interesting in regards to the two different paths of processing, because of the assumption that the conscious or unconscious perception of filtered primes is relevant to the fact if a congruence effect can occur.

In a follow-up-analysis the masked and unmasked condition was viewed in more detail:

The follow-up-ANOVA could register a significant congruence effect within the unmasked condition. Participants showed quicker response times in congruent conditions versus incongruent conditions.

Within the masked condition the follow-up-ANOVA could not register a congruence effect.

These results confirm the assumption that the occurrence of a congruence effect is due to a conscious (unmasked) or unconscious (masked) processing of prime stimuli.

The classification of male and female face stimuli with high spatial frequency can only be made if these are shown „consciously" (unmasked). „Unconscious" (masked) perception and classification of face stimuli with high spatial frequency is not possible. The „unconscious" classification or perception requires low spatial frequency information.

These results are consistent with Finkbeiner and Palermo (2009) Kahlid (2013): Faces that do not include low spatial frequency information can not be processed unconsciously.

Low spatial frequencies are being processed in subcortical brain structures by cells within the magnocellular layers of the LGN (lateral geniculate nucleus).

The processing of face-stimuli that not only contain low spatial frequency, but also high spatial frequency information occurs in the cortical structures of the brain. This occurs through the parvocellular layers in which the processing of information is slower compared to the magnocellular layers, but also more detailed.

Up until now the results seem to fulfill the expectations that were made on the basis of Finkbeiner and Palermor (2009) and their „middle position“.

This study however reveals contradicting results in regards to the influence of spatial attention on the processing of faces:

The spatial cue directed spatial attention towards either the prime stimuli or the target stimuli.

In general the main effect showed that participants were able to discriminate target-stimuli significantly more quicker if spatial attention was directed to the target-stimuli instead of the prime-stimuli.

Within the unmasked, and therefor visible, condition the high-pass filtered primes successfully influenced the reaction to the target-stimuli regardless of spatial attention. This result was very much expected, because the missing of the forward and backward masks, which made the primes visible.

In the masked (unconscious) condition there was no effect of the spatial attention in regards to the prime-target-congruence. Spatial attention was directed to either prime-stimuli or target-stimuli, but the high-pass filtered prime could not solicit a unconscious congruence effect, contradicting Finkbeiner and Palermo (2009) who stated that spatial attention that was directed towards the high-pass filtered masked prime-stimuli should be able to balance out the missing low spatial frequency information.

The missing influence of the spatial attention regarding the masked prime-stimuli can not be fully explained, but there are some aspects which can be considered:

a congruence effect could not occur due to the forward masks and backward masks.

the time frame in which spatial attention was directed towards the filtered prime-stimuli was too short to activate the visual system.

the presentation time of the prime-stimuli was to short (50ms) to solicit a congruence effect. The influence of a prime-stimulus rises with the duration of its presentation.

Due to the filtering of the high-pass prime-stimuli the illumination and contrast could have been to weak to solicit a congruence-effect even though spatial attention was directed towards the prime-stimuli.

Likewise there was no congruence effect found through the presentation of masked high-pass filtered prime-stimuli in Mascha Wisseler‘s study (2011) assumingly due to the difference of the prime-stimuli after the filtering process compared to the unfiltered target-stimuli.
This assumption was falsified by the results from the filler trials mentioned above, because participants were able to classify target-stimuli with high spatial frequency information as well as target-stimuli with low spatial frequency information.

5.1. A critical reflection of the study

Despite the amount of care with which this study was conducted there are a few limitations to its design and statistical analysis.
The main point of criticism is the cue that was presented as a black dot on a white background. Posner (1980) as well as Posner, Snyder and Davidson (1980) show that cues can be effective stimuli to direct spatial attention to either the prime-stimuli or the target-stimuli, but the question is in which way a black dot compared to a face photograph can be a sufficient stimuli to direct attention.
The influence of faces used for stimuli is so profound that it determines living and experiences within our culture (Kanwisher & Yovel, 2006). So the question is whether the faces used in this study were much stronger stimuli to direct attention than a cue signal based on an evolutionary perspective?
Another question that is interesting for this discussion is whether or not the effects and interactions that were found are relevant, because they were mostly only a few milliseconds. The results meet all statistical criteria and are significant, but in future studies it should be considered to use a more strict alpha than 0.05.

The results of this study are conform with the assumptions made by Finkbeiner and Palermo (2009) as already illustrated in the theoretical background, but to be able to retrieve a overall picture of visual processing additional, and especially contrary studies should be taken into consideration. The results found refer only to gender classification processes and are not general statement about the processing of faces.
Johnson (2005) presented in his study that the identification of faces is a slow and detailed process that is therefore associated with a slow cortical pathway. Additionally there are three specific

cortical brain structures that are said to play a part in the processing of faces. Haxby, Hoffman and Gobbini (2000) identified the three specific structures as the occipital face area (OFA), fusiform face area (FFA), the superior temporal sulcus.

5.2. Summary and research prospects

The purpose of this study was to try to investigate the face-classification-process on a deeper level. The results show that high-pass-filtered face-stimuli can only be processed consciously, not unconsciously. These results were confirmed through the assumption by Finkbeiner and Palermo (2009) that subcortical brain structures play a big part in the unconscious processing of face-classification.

Subsequent studies could shed a light on the issue as to why there was no effect of masked high pass-filtered prime-stimuli on target-classification when spatial attention was directed to the prime-stimuli.

In this discussion the low illumination and the low contrast was thought to be a possible explanation for the missing effect.

Additionally it would be interesting to conduct a subsequent study with not only neutral face photographs, but with face photographs that contain emotional expressions for different results, and also alternate the position of the face-stimuli.

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Appendix

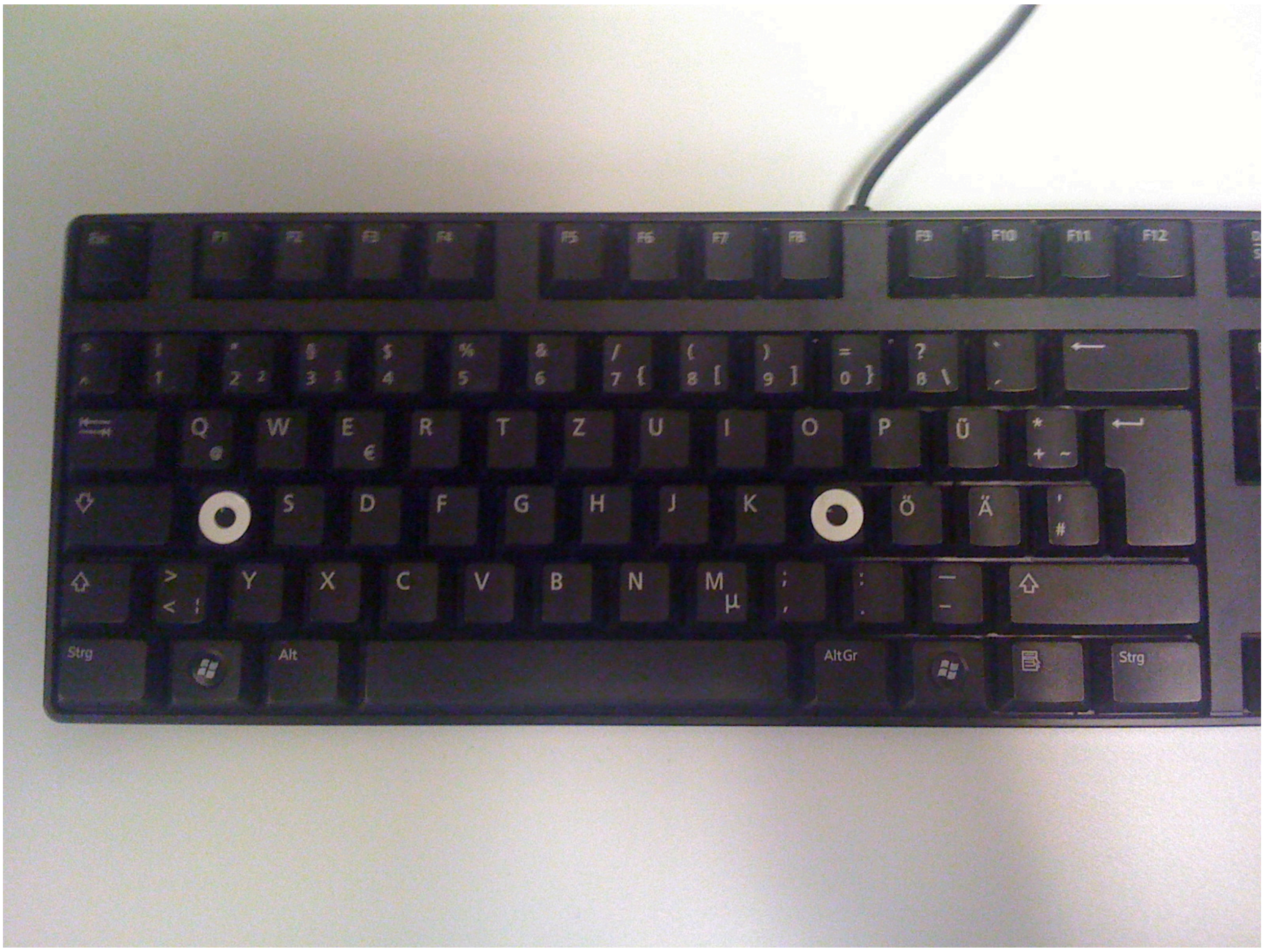
Characteristics of participants

Nr.	Age	Gender	Glasses	Hand
1	28	female	yes	right
2	25	male	no	right
3	29	male	yes	right
4	19	female	yes	right
5	22	male	yes	left
6	20	female	yes	right
7	31	female	yes	right
8	31	female	no	right
9	22	female	no	right
10	37	female	yes	right
11	23	female	yes	right
12	19	female	yes	right
13	23	female	yes	right
14	21	female	no	right
15	51	male	yes	right
16	20	female	yes	right
17	27	male	yes	right
18	22	female	no	right
19	20	female	no	right
20	36	female	no	right
21	34	female	yes	right
22	21	male	yes	right
23	25	female	no	right
24	23	female	yes	right
25	28	female	no	right

Nr.	Age	Gender	Glasses	Hand
26	23	female	no	right
27	19	female	yes	left
28	22	female	yes	right
29	21	female	yes	left
30	18	female	yes	right
31	33	female	yes	right
32	20	female	no	right
33	26	female	yes	right
34	21	female	yes	right
35	21	female	no	right
36	22	male	no	right
37	19	female	yes	right
38	19	female	yes	right
39	20	female	no	right
40	22	female	yes	right

Pictures of Testroom

Testroom at Psychologicum, Liebiggasse 5, 1010 Vienna, Austria:


F1 F2 F3 F4 F5 F6 F7 F8 F9 F10 F11 F12
1 2 3 4 5 6 7 8 9 0
Q W E R T Z U I O P Ü
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S D F G H J K Ö Ä #
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Strg Alt AltGr Strg

Curriculum Vitae

Bernadette Maria Brigitte Zecha

PERSONAL DATA

Name: Bernadette Maria Brigitte Zecha

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EDUCATION

10/2008 - present:	University of Vienna, Austria
01/2014 - present:	Sigmund Freud University of Vienna, Austria
	Training in Emergency Psychology and the treatment of trauma
10/2005 - 01/2008:	University of Vienna, Austria
	Diploma study of Law
09/1997 - 05/2005:	Bundesgymnasium Nonntal, Salzburg, Austria
08/2002 - 05/2003:	La Cueva High School, Albuquerque, New Mexico, USA
09/2003:	Language school, Sevilla, Spain
	Exchange program
09/1993 - 07/1997:	Volksschule Nonntal, Salzburg, Austria

PRACTICAL EXPERIENCE

08/2002 - 01/2003:	Presbeterian Hospital, emergency room and psychiatric unit, Albuquerque, New Mexico, USA Volunteer
09/2006:	Kafka & Palkovic Law firm, Vienna, Austria Internship
08/2010:	Soup kitchen, Portland, Orgegon, USA Volunteer
09/2011 - 01/2012:	Health rehabilitation Center, WIG, hotline for eating disorder, Vienna, Austria Internship including training supervision
09/2012 - 04/2013:	National crisis hotline for children and youth, „Rat auf Draht", Vienna, Austria Internship including training supervision
07/2013 - 10/2013:	Child protection center „Die Möwe", Vienna, Austria Internship including training supervision
02/2014:	BEST - Assesment center for sex offenders, Vienna, Austria Internship