Facing Intuition: A functional characterization of intuitive judgment in the context of face perception.

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Declaration:

I hereby declare that I have produced the work entitled *„Facing Intuition: A functional characterization of intuitive judgment in the context of face perception."* submitted for the award of a doctorate, on my own (without external help), have used only the sources and aids indicated and have marked passages included from other works, whether verbatim or in content, as such. I swear upon oath that these statements are true and that I have not concealed anything. I am aware that making a false declaration under oath is punishable by a term of imprisonment of up to three years or by a fine.

Tübingen, den

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Abstract

Intuition is by some conceived of as biased and by others as an important tool to make decisions in a fast paced and uncertain world. Yet, within social interactions, intuitively judging is often the only feasible option to interpret the content of our most important social signals, thus facilitating attunement to social affordances. In fact, humans expertly extract and use face information in an automatic and non-conscious fashion. Is intuition therefore a fundamental building block of the toolbox we need to adapt to the various challenges of life as social beings? How does this fit the notion of intuition as irrational and error-prone?

Among the most widely cited models of intuition that are engaging with these types of questions within contemporary psychology, are dual process theories. However, as the first part of this thesis will show, they do not suffice as general explanatory framework for intuition.

With the surfacing of more issues regarding general dual process models, the explanatory value of this dualistic distinction diminishes. Rather than trying to ascertain in which way the supposed antagonists of intuition and analysis interact with each other, a shift in focus has been proposed. I therefore join the recent endeavour by a different stream of judgment and decision-making researchers, to focus on investigating functional characteristics of intuitive processes along different domains and dimensions.

The aim of this work is to investigate the cognitive processing characteristics and conditions which enable the intuitive perception of and reaction to our most important objects of social judgments. To achieve this, I draw on several empirical investigations, as well as theoretical considerations. In contrast to current trends in face perception research, this puts the focus on the cognitive processes that facilitate the integration of these percepts into social judgments.

The theoretical foundations of this thesis are two-fold. Firstly, the characterization of intuition as a judgment and decision-making process, which operates rapidly, automatically, without conscious awareness of the decision maker and with the inclusion of some type of feeling as judgment signal. Secondly, the context of face perception. Face perception is intuitive and essential for successful social interactions. The processes enabling face perception are performed without conscious awareness or interference and with a surprising swiftness, considering the amount of multi-attribute information that needs to be integrated. The face perception context therefore provides a naturalistic context for the study of every-day type intuitive judgments. It further provides the opportunity to learn more about the cognitive processes that shape our social interactions.

This dissertation utilizes a multi-part research design. It is based on the conceptual analyses of two popular notions of intuition in contemporary psychological research, namely the default-interventionist model and the notion of intuition as feeling based process, respectively. The key results of these theoretical considerations are, firstly, that in several instances deliberation can actually lead to more errors than intuitive processing, thus calling the generality of default-interventionist models into question. Secondly, the close analysis of two investigations into visceral signals evoked during intuitive judgments provides evidence that rather than a single ‘gut feeling’ playing a role in intuition, the type of feelings elicited in intuitive judgments may depend on the task or the type of intuitive process being engaged. It remains to be investigated, what types of feelings are constitutively linked to intuition and when they are expected to enter the process.

The second part of the present thesis relies on empirical investigations of functional characteristics of intuitive social judgments, utilizing the tracking of eye movements as process trace. Intuition is -- by most definitions -- an implicit, internal, not consciously accessible process. More specifically, intuitively gathered information is integrated into mental representations that are thought to be constructed by a gradual, automatic, non-conscious process. Only the result of this process enters awareness. This necessarily poses a great challenge for the study of the processing characteristics of intuitive judgment behavior. One answer to this challenge is to focus on different dimensions of operation which, can either be directly manipulated or investigated without needing to rely on the subjective awareness of the decision maker. As Gustav Fechner famously proposed, subjective experience is a physical process. Thus, measuring the physical properties of internal processes allows for some measure of access to the otherwise inaccessible subjective experience. In this respect, eye movement measures provide a physical basis for the study of internal processes.

If I focus on the forehead region of your face to determine whether you furrow your eyebrows or crinkle your forehead, I am attending to a cue which allows me to gauge if you have understood my argument or I lost you in confusion. Noting where a person looks thus allows for insight into the locus of attention and thus the strategy used to extract meaning from the attended cue. Tracing eye movement in task involving intuitive processes makes it possible to gain insight into the information integration strategies supporting these strategies.

The key results of these investigations are that individuals employing an intuitive strategy to judge faces rely on holistic information integration processes revealed by an attention map centralized in the stimulus space. Furthermore, the reliance on an intuitive processing strategy to judge another person depends on individual, internal factors, as well as external factors, such as the task domain. Specifically, we find that individuals use similar cognitive processes to judge the gender identity of a person, irrespective of their own sexual orientation. When it comes to judging the sexual orientation of another person, however, the reliance on an intuitive processing strategy is moderated by the sexual orientation of the perceiver.

While the general efficacy of intuition will most likely remain a topic of ongoing debate, the social judgment domain offers a great opportunity for the characterization of intuitive processes in an ecologically valid and motivationally relevant context. This dissertation provides further evidence for the usefulness of intuitive processes in social judgments. Low-level visual perception of social cues impacts impression formation and social evaluations. At the same time, the relationship between visual perception and the social/cultural practices these visual processes are trained on is dynamic and bi-directional. Elucidating the functional characteristics and contributions of intuitive processes to the formation of these percepts is thus of fundamental importance. Not only for the furthering of the theoretical debate on intuition, but also to understand the processes which determine social evaluations. In the future, the thereby gained insights may become the building blocks for the development of techniques to overcome the effects of negative social evaluations.

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As many who have completed the process of graduate school would surely agree, working on a PhD and writing the corresponding thesis is a community effort. My work is certainly no exception to this rule.

This dissertation would not have been possible without the generous support from friends and family, who have contributed to this effort with great patience, countless liters of coffee, open ears to listen to my struggles and kind offers of advice. A heartfelt thank you goes out to each and every one of you and I will make sure to express my gratitude to you personally.

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I. SYNOPSIS

One of the most famous quotes from J.W. Goethe's seminal tragedy "Faust I" stems from a dialogue between the studious academic Dr. Faust and his subordinate Wagner. Therein, Dr. Faust bemoans the impossibility of knowledge. In an effort to describe the inner turmoil he feels, having studied various disciplines (Philosophy, Law, Medicine *„and even Theology"*; I, 356), only to realize „dass wir nichts wissen können (*that we cannot know anything;* I, 364) ", Faust says to Wagner: "Zwei Seelen wohnen, ach!, in meiner Brust (*Oh! Two souls are living in my chest*)"[1]. Feeling utterly distraught at this failure of knowledge or rationality (the one "soul"), Faust eventually turns to the dark arts to achieve the corporeal and emotional experience of life (the other "soul").

[1] Translations are my own.

Some two thousand years earlier, Plato described a comparable dualistic dilemma in his speech on Phaidros. Therein, the soul is symbolized as a chariot steered by a coachman and two steeds “of opposite kind and heritage”. Hindu mythology evokes similar imagery. In this view, consciousness is thought to be the nature of the soul and the driver of the chariot[2]. The notion of duality is evoked here in the form of Parāśakti (the soul’s superconscious mind) and Paraśiva (the soul’s inmost core), who together make up the essence of the immortal soul, ātman. The study of intuition can be traced back to this idea of a division of the mind into fundamentally distinct parts. In the Eastern tradition, an example of this is the above mentioned school of thought known as Vedanta. Sri Aurobindo, a yogic scholar, poet, musician and founder of the tradition known as “Integral Yoga”, draws on Vedic texts to divide mental

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[2] Kṛishṇa Yajur Veda, Maitrī Upanishad 2.5. UPM, 99

faculties. In keeping with Eastern philosophical tradition, Aurobindo conceives of a basal “thinking mind”, where reason and analysis are located, and an “intuitive mind” as a form of (self) knowledge on a “higher plane of consciousness”, which can only be achieved through (spiritual) practice. He defines intuition (smriti) as “the faculty by which true knowledge hidden in the mind reveals itself to the judgment and is recognized at once as the truth. It is as when one has forgotten something one knew to be the fact, but remembers it the moment it is mentioned again” (Aurobindo, 1990).[3]

Western philosophical tradition, on the other hand, traces the study of intuition to Plato’s idea of a mind divided between emotionality and rationality as described in the

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[3] For a deeper look at the similarities between Eastern and Western philosophy see Thompson (2015) and the specific relation between greek *philosophia* and Buddhist philosophy as pertaining to Reason, see McClintock (2010).

Phaidros speech. Drawing on both eastern and western philosophical traditions, Swami Sivananda[4] concludes:

> *"Both intellect and intuition are faculties of the same mind. There is no break of continuity between them. Intuition does not contradict reason. It fulfills it. They are not exclusive of each other. Intuition gives the cognition of the whole. Intellect can only have a conceptional knowledge of the whole. Intuition has direct knowledge of the whole and intellect gives us analysis of parts."*

This dualistic understanding of intuition is still reflected in contemporary psychological research and is one of the most

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4 http://sivanandaonline.org/public_html/?cmd=displaysection&section_id=770

prolific domains for the study of intuition -- most notably by a class of theories subsumed under the name ‘Dual Process Theories’ (hereafter: DPT), which I will discuss in detail below.

A clear definition of intuition remains elusive, despite the fact that different schools of thought have pondered over its defining features, underlying mechanisms and rules of application for centuries. Some examples of definitions that have been put forth (and are being tested empirically) include:

- “Intuition is manifested in the fluent, holistic and situation sensitive way of dealing with the world” (Dreyfus, Drey-fus, & Zadeh, 1987).
- “Intuition is a perception of coherence at first not consciously represented but which comes to guide our thoughts toward a ‘hunch’ or hypothesis” (Bowers, Regehr, Balthazard, & Parker, 1990).

- “I use the terms gut feeling, intuition, or hunch interchangeably, to refer to a judgment 1. that appears quickly in consciousness, 2. whose underlying reasons we are not fully aware of, and 3. is strong enough to act upon” (Gigerenzer, 2007).
- “Intuition is a process of thinking. The input to this process is mostly provided by knowledge stored in long-term memory that has been primarily acquired via associative learning. The input is processed automatically and without conscious awareness. The output of the process is a feeling that can serve as a basis for judgments and decisions” (Betsch, 2008, p.4).

Common to these definitions are the notions of speed, the holistic formation of associations, and the automatic or non-conscious formation of these holistic associations, which consequently inform the judgment output. These characteristics thus form my definition of intuition, which underlies the research presented in this dissertation.

Importantly, similarly to other colleagues (Betsch, 2008; Andreas Glöckner & Witteman, 2010a, 2010b), I understand intuition to be a container-term used to describe specific types of cognitive processes (namely, fast, holistic and automatic/non-consciously formed ones), rather than conceiving of intuition as a single, differentiable mental system or knowledge source.

While the social domain provides rich evidence for everyday situations in which people rely on intuitive processes for the formation of judgments, impressions and perceptions, social intuitions are as of yet underrepresented in the literature on intuition. The present work therefore seeks to fill this gap by directly investigating intuitive judgment processes in the context of face perception. Since faces are among the most important social signals for humans (Adolphs, 2003; Hari & Kujala, 2009) and the perception of faces has repeatedly been shown to rely on intuitive processing (Ambady, 2010; Ambady & Weisbuch, 2010; Gore & Sadler-Smith, 2011; Willis & Todorov, 2006), faces represent “ecologically valid objects” (Hammond & Stewart, 1975) for the study of intuition. Face perception thus provides a highly relevant and motivationally salient framework in which to study the cognitive characteristics of intuitive judgment processes; fulfilling an important criterion for the study of social judgments (Sherif & Hovland, 1961) and addressing one of the biggest criticisms of intuition research to date (Eiser, 2012; Ferguson, Mann, & Wojnowicz, 2014; Gigerenzer, 2000; Hertwig & Volz, 2013)[5].

In the following sections, I will first outline the theoretical foundation for the research questions that drive the present work, starting with a brief overview of dual process theories. I will then outline the framework of social judgment research, within which the present work is

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[5] Namely, that a large part of intuition research thus far relies on computationally heavy tasks restricted to the laboratory environment and lacking ecological validity.

situated, and finally discuss the most important features of face processing as pertaining to the research questions I have posed. The second section will detail the motivation underlying the choice of eye-tracking as a research methodology and introduce the most important features of using eye-tracking in tracing cognitive processes. The third section will summarize the main findings of this dissertation. In the fourth section, an overall conclusion of the dissertation is drawn. Lastly, in the outlook I make a first attempt at disentangling notions of embodied feelings in intuitive processes.

1. Theoretical Foundation

Dual Process Theories (DPT) are among the most often evoked models for the study of intuition, as they expound upon the interplay between and properties of intuitive and analytic processes in judgment and decision making (Glöckner & Witteman, 2010). Whether it be the general concept of dual systems or the more specific concept of dual-processes, the notion of duality has certainly been a great catalyst for the production of a plethora of scientific evidence, especially in decision science (De Neys, Cromheeke, & Osman, 2011; A. Glöckner & Betsch, 2008), social cognition (Chaiken & Trope, 1999; Lieberman, 2000, 2007) and (neuro-) economics (Kahneman, 2011; Slovic, Finucane, Peters, & MacGregor, 2002). While DPTs differ along many dimensions and predictions, depending largely on the arena of investigation (e.g. neuro-economics versus social psychology), the basic premise is largely the same. DPT assume the existence of two differing types of cognitive processes that govern human reasoning, judgment and decision-making. These two types fall along a divide of:

T1: intuitive, automatic, holistic, fast

T2: deliberate, reflective, analytic, slow

DPT developed out of (and owe a great deal of their popularity to) the Heuristics and Biases program put forth by Kahneman and Tversky (Kahnemann, Slovic, & Tversky, 1982). Therein, intuition is viewed as cognitive short cut or heuristic which is frequently biased and thus leads to erroneous choices or decisions. In contrast, most DPT assume that in some situations, intuitive/T1 processes can actually lead to the more appropriate or valid answer. These are mostly instances where the decision maker can make use of "overpracticed cues" (Evans & Stanovich, 2013a).[6]

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[6] Though note that a number of researchers who do not specifically ascribe to the DPT approach also argue for the effectiveness of intuitive decision-making, especially in contexts where the task is decomposable or information is incomplete (Betsch, 2008; Dane & Pratt, 2007; Gaissmaier & Gigerenzer, 2006; Gigerenzer, 2007; Gore & Sadler-Smith, 2011; Hodgkinson et al., 2008; Hogarth, 2001; Mega & Volz, 2014).

The dual process approach has led to a large proliferation of models, which I will not detail here (for an excellent and timely review, see Strack and Deutsch, 2015). However, I do want to briefly introduce two of the most prominent classes of DPT, since they build part of the theoretical backbone of the present work. The first of these is dual systems theory and is considered to be among the more general of DPT. It makes predictions not only about cognitive processes in specific domains[7], but rather assumes a general divide of mental capacities into two different and differentiable systems (Sloman, 2002; Stanovich & West, 2000). Sloman (1996, 2014) argues that the mind contains two independent reasoning systems, which use separate and different processes to operate, learn and change. System 1 is assumed to be "evolutionarily old"

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[7] such as the MODE model with attitudes (Fazio, 1990) or the Cognitive Experiential Self Theory as theory of personality (S Epstein, 1994; Seymour Epstein & Pacini, 1999).

and "shared with other animals", operating associatively and producing "quick and dirty" answers based on heuristics (such as representativeness or availability). System 2, on the other hand, is proposed to be a historically more recent neural development, operating in a rule-based fashion and able to provide explanations of the environment[8].

Neural correlates of intuition according to dual systems theory

The 'Social Cognitive Neuroscience' approach (Lieberman, 2002; 2007) builds on dual systems theory to propose two distinct neural systems, thought to bring forth the different mental operations. These are the 'reflexive' system, comprised of the amygdala, basal ganglia, lateral

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[8] See Gigerenzer & Regier (1996) for an early critique on the problem of imprecision and testability of the characteristics proposed for the two systems by Sloman.

temporal cortex, and assumed to be responsible for non-conscious, implicit, intuitive cognitive processes. The second system, called ‘reflective’, is proposed to rely on activation of the anterior cingulate cortex, prefrontal cortex and medial temporal lobe (including hippocampus), and assumed to bring forth conscious, explicit and rational thought.

Neural correlates of intuition beyond the dual systems approach

Independently of the Social Cognitive Neuroscience approach, Volz and her colleagues’ investigations of the neural architecture underlying intuitive processes paint a different picture (Bar et al., 2006; Horr, Braun, Zander, & Volz, 2015; Volz, Rubsamen, & von Cramon, 2008; Volz & von Cramon, 2006). For visual and auditory as well as semantic task domains, the authors find specific activity in the medial orbitofrontal cortex (mOFC) when individuals engage in intuitive processing. The OFC is thus proposed to be a candidate region for intuitive processing carrying out a preliminary gist-extraction of the incomplete stimulus input.

Building on these findings of the mOFC as a possible region of holistic and associative stimulus integration in intuition, we set out to directly test neural predictions derived from dual systems theory via functional magnetic resonance imaging (fMRI) in a face perception task (Mega, Gigerenzer, & Volz, 2015). We chose face perception as the task domain, since perceiving and judging facial expressions can be accomplished both intuitively (i.e. fast and without conscious awareness of the underlying processes) and analytically. That is, parameters of analysis can be trained through the use of tools such as the micro-expressions training tool (Ekman, 2006), wherein individuals are trained to detect miniscule changes in facial expressions during nearly sub-liminal presentation times. We measured functional brain activity while participants were specifically instructed to either intuitively (group 1) or deliberately (group 2) judge the authenticity of happy and fearful facial expressions. Results from three different analyses revealed both common brain networks of activation across decision mode and differential activations as a function of strategy adherence. As outlined above, dual systems theories would predict differentiated activity within either the ‘reflexive’ or the ‘reflective’ system specifically for an intuitive (former) or deliberative (latter) condition. Contrary to the dual systems predictions, the results of a covariate analysis show largely overlapping networks for both fast and slowly responding individuals, namely regions of primary visual perception (cuneus, lingual gyrus) as well as the right OFC, fusiform gyrus and temporoparietal junction. We thus interpret our results as contradicting popular dual-systems accounts that propose a clear-cut dichotomy of the processing systems.

Dual process theories are not a general explanatory framework for all types of intuitive judgment processes

As stated before, the general assumption of DPT is the existence of two qualitatively distinct process types (automatic ‘intuition’ and controlled ‘deliberation’ or ‘reflection’), which are thought to underlie observable behavior. Contemporary uses of DPT focus on the default-interventionist model (hereafter: D-I-model), which assumes that automatic, intuitive processes (Type 1) yield default responses unless intervention by higher order, reflective reasoning processes (Type 2) is needed (Evans & Stanovich, 2013a, 2013b). Therein, the authors split the attributes of both process types into defining and correlated features, as outlined below:

Type 1 Processes (intuitive)		Type 2 Processes (reflective)
➢ Working memory not required ➢ Autonomous	Defining Feature	➢ Working memory required ➢ Cognitive decoupling ➢ Mental simulation
- Fast - Non-conscious - Biased responses - Experience-based decision-making	Correlated Features (Examples)	- Slow - Conscious -Normative responses -Consequential decision-making

Figure 1: Attributes of intuitive and reflective proceses, split by defining and correlated features, as outlined in

Evans & Stanovich, 2013a.

Despite the prevalence of dual-process models as explanatory frameworks for judgment and decision making, the “paradox of introspection” (Jonathan W Schooler & Schreiber, 2004) raises important concerns for the general applicability of DPT to the understanding of intuition (see Ch. IV.1 of the present work, or Mega & Volz, 2014).

According to D-I-type models, T2 reflective processes are called upon to intervene on default answers in situations beyond those relying on innate or conditioned response capacities. Here, the engagement of T2 processing is assumed to be more likely to find the normatively correct answer. Importantly (as shown in figure 1), T2 processes have mental simulation and cognitive decoupling as defining features. The introspection literature, however, provides ample evidence for situations in which cognitive decoupling (i.e. the engagement of type 2 processes) does not lead to correct answers, but disrupts the judgment process and leads to alterations in judgment/preference/memory. Introspection refers to the ability to explicitly characterize one's experience, i.e. to become meta-aware. When asked to introspect, especially in experimental settings, we are asked to put our internal experience into words. This necessarily involves a re-representation of the contents of experience, termed cognitive decoupling. In one early study on the effect of introspective error, participants were shown a short video of a robbery and later tasked with recognizing the robber among a set of new faces. Participants who had been asked to describe the face prior to picking it out in a subsequent line-up of faces showed substantially reduced recognition rates compared to participants who tried to recognize the previously seen face without describing it first (J W Schooler & Engstler-Schooler, 1990; Jonathan W. Schooler, Ohlsson, & Brooks, 1993). Similarly, reflecting on the reasons for their preference of one type of jam over another disrupted the actual preference, whereas individuals who did not reflect on the reasons for their preference remained with their choice (Wilson & Schooler, 1991). Based on these and similar results in other studies (Jonathan W Schooler, 2002; Winkielman & Schooler, 2011), the authors conclude that verbal overshadowing causes translational dissociations. Put differently, when one tries to verbally represent inherently non-verbalizable processes, disruption or distortion of the preference/decision can occur. “In sum, we suggest that reflecting about reasons will change people’s attitudes when their initial attitude is relatively inaccessible and the reasons that are salient and plausible happen to have a different valence than people's initial attitude” (Wilson & Schooler, 1991, p.4). In this way, contrary to the proposition of D-I-Models, the introspective error is an example of how re-representing subjective experience, by cognitively decoupling can lead to biases and incorrect decisions. Notably, this counterintuitive finding is not limited to T1-specific situations, where over-learned cues elicit the right answer, but also occurs in situations where the problem is hard to solve directly from previous experience or from previously stored cue validities. In tasks requiring the individual to introspect, the recruitment of T2 processes seems to elicit a dissociation between experiential consciousness and meta-consciousness, leading to (a) distortions of underlying experience (as demonstrated in the 'verbal overshadowing' phenomenon), (b) a decline in performance (e.g. speed), or (c) a decline in accuracy (e.g. recognition). The characterization of intuition and its interaction with other cognitive processes as outlined in the D-I-model may therefore represent one way in which intuition functions, although it certainly does not hold up as a general model for every type of judgment or decision.

The study of intuition has recently experienced a divergence of research streams. It has fanned out into specialized research endeavors concerned with specific aspects of intuition and contexts of its use, such as managerial decisions (Dane & Pratt, 2007), syllogistic reasoning (De Neys, Vartanian, & Goel, 2008) and judgments of semantic coherence (Ilg et al., 2007; Topolinski & Strack, 2009; Zander, Fernandez Cruz, Winkelmann, & Volz, 2016), to name just a few. It seems as though a general unifying theory of intuition applicable to all aspects of human cognition/rationality may not be within reach – if, indeed, it will ever be reached. Some researchers have even gone so far as to postulate that intuition is in fact a blanket term used to describe different types of automatic processes (Andreas Glöckner & Witteman, 2010a). Put differently, “presumably, the ideal case of pure intuition or pure deliberation does not exist in reality” (Betsch, 2008, p.7). Rather than searching for the truth-value of ‘what intuition is’, I therefore concentrate on functionally characterizing the intuitive judgment process in the context of face perception.

1.1 Focus on Processing Characteristics

Intuition is a type of process which many conceive of as relying in large part on stored experience. Thus, an agent's cultural, social, environmental and situational contexts necessarily make up the 'training base' for intuitive processes. Coupled with the individual's cognitive capacities (which, in turn, are also at least partially shaped by the individual's life experience), this context-dependency seems to further support the hypothesis that there cannot be one single type of intuition. Instead, one might conceive of different types of processing, more or less intuitively, in order to deal with rapidly changing environments. These processes may share certain characteristic features, but they may also diverge to suit the specific needs of different task domains, contexts, and situations. This concept of intuitive processing shares similarities with Hammond and colleagues' cognitive continuum theory (Hammond, Hamm, Grassia, and

Pearson (1987), wherein intuition and deliberation are seen not as completely distinct categories of cognitive processes, but rather as poles of a cognitive continuum. It also shares similarities with the unimodel, which proposes intuition and deliberation to rely on similar or the same kind of rules (Kruglanski, 2013; Kruglanski & Gigerenzer, 2011).

Therefore, in this dissertation I will not argue for a generalized theory of intuition. Instead, I follow the suggestion of focusing on processing characteristics of intuition which may be shared across task domains and contexts (Glöckner and Witteman, 2010). The aim of the present work is thus the functional characterization of the processes by which we intuitively judge our most important social signals.

1.2 Research Questions

As discussed above, many authors generally agree that intuitive processing produces judgments that are based on a rapid and holistic perception of information and stored experience, involving the retrieval of this experiential information from memory and its integration with perceived stimulus information. Intuitive judgment processes are thought to adapt to context and to be accompanied by or result in some feeling(s), which may or may not have a bodily component.

I chose to focus my investigation on three of these aspects, which I will discuss in more detail in the next sections. The main research questions are:

1) Is the default-interventionist model a general explanatory framework for intuitive judgment processes?
2) What characterizes the intuitive processing of social stimuli?
3) When is an intuitive processing strategy enlisted to judge social stimuli?
4) What types of feelings are part of intuitive judgment processes?

1.3 Social Judgments

Before attempting to answer the questions posed above, a brief look at the process of judgment formation is merited. The psychological domain of judgment and decision making asks questions about the type of information used in judgments, the ways in which this information is gathered and how it is integrated to form a judgment (Betsch, Funke, & Plessner, 2011). Although social judgments share many similarities with other types of judgments (Eiser, 2012), some important distinctions do exist. Most relevant for the context of this dissertation are the following features:

- Many components of social judgments are not (or only indirectly) measurable.
- Social judgments need to be formed using a wealth of different cues.
- The perceiver and object of perception can interact with each other, dynamically

influencing both the judgment process as well as the object of judgment.

Having set the stage for the types of judgments under investigation in this dissertation, as well as having provided ample evidence for why intuitive processes are uniquely suited to perform social judgment tasks efficiently, I will now outline the specific task context.

1.4 Face Perception

Face perception – the study of how and what people perceive in another person's face – makes up another large area of research within social cognition. As early as in the 1870s, Charles Darwin already recognized the importance of facial expressions as crucial regulators of behavior, especially in nonverbal communication (Darwin, 1872). More than one hundred years later, researchers are assembling a vastly growing body of evidence to support this claim in both humans and non-human primates

(Sherwood 2003, Tsao 2008*).* The importance of faces emerges not only in the knowledge that specialized neural areas have developed which activate almost exclusively upon encountering a face stimulus (Atkinson & Adolphs, 2011; Bruce & Young, 1986; Jv Haxby, Hoffman, & Gobbini, 2000; J V Haxby, Hoffman, & Gobbini, 2002; Kanwisher, McDermott, & Chun, 1997; Saxe & Kanwisher, 2003). A wider lens onto the issue shows us that throughout human culture and communication, faces have an exclusive and special function (Mega, 2015). They are seen as direct displays of emotion and communicative intent, as well as opportunities for empathy. In fact, cultural history studies on faces conceive of them as semantic fields on which such topics as beauty, mortality or social hierarchy are portrayed and debated (Weigel & Belting, 2013).

While the term intuition does surface now and again within face perception research, the context of face perception remains understudied thus far in the endeavor of functionally characterizing intuitive processing in the social domain, as well as in everyday use. For this reason, the present work uses the context of face perception paradigms as a means of investigating intuitive judgment processes. I outline further details of face perception mechanisms below to address the specificities of face perception and categorization as they pertain to the individual studies discussed.

2. Methodology

Eye-tracking technology is increasingly being used to determine where, when and for how long perceptual, attentional and cognitive processes are applied to a visual stimulus (Henderson, Williams, & Falk, 2005; Russo, 2011; Vo, Smith, Mital, & Henderson, 2012). It therefore provides an opportunity for judgment and decision-making researchers to use fixation-based methods as a means of tracing cognitive and perceptual processes. The three pairs of muscles surrounding the eye uniquely decide its movement and orientation. This directing of the gaze to relevant locations in space is controlled by large parts of the brain (Holmqvist et al., 2011), a fact that is exploited in many research areas studying, for example, preference, judgments or (consumer) decisions.

The most reported type of eye-tracking data are fixations[9], which are generally considered a proxy to measure attention (Holmqvist et al., 2011). It is important to note that while strong relationships exist between eye movements and cognitive processes, eye tracking remains an indirect measure, similar – in this manner – to fMRI. To curb the dangers of reverse inference[10], it is necessary to design eye-tracking studies grounded in testable theories. From these, corollary predictions can be drawn and implemented into experimental manipulations, which –

[9] Fixation refers to a period of time in which the eye stays still (anywhere from around 100ms up to several seconds).

[10] For a discussion of reverse inference see (Poldrack, 2006).

when resulting in changes in (eye movement) behavior – can indicate differences in cognitive processes. The eye-tracking compendium by Holmqvist et al. (2011) includes several excellent chapters on the design of eye-tracking studies and recommendations to avoid the most common pitfalls.

In the case of the present work, the theory-based predictions were three-fold. Firstly, anecdotal evidence in previous face perception research (Armann & Bülthoff, 2009) revealed a sub-group of participants whose fixation pattern was condensed and located around the center of the stimulus face. In a post-session questionnaire, participants of this sub-group reported performing the task ‘intuitively’ and trying to gain an ‘overall impression’. Furthermore, in a study using computational models to cluster eye movement patterns into holistic and analytic face recognition strategies (Chuk, Chan, & Hsiao, 2014), longer fixation times and a condensed fixation pattern was attributed to the holistic strategy. Further support for the prediction of longer and less fixations in intuitive judgment processes comes from the study of expertise. Several investigations of experts in various areas such as chess, art and goal-keeping have found longer and fewer fixations in experts than in novices (Charness, Tuffiash, Krampe, Reingold, & Vasyukova, 2005; Savelsbergh, Williams, Kamp, & Ward, 2002). The authors do not interpret longer fixation times as a higher amount of processing in this case, but rather a function of processing efficiency. More specifically, the idea is that experts extract more information around the point of fixation (thus the longer fixation time) and therefore need less fixations overall. Conversely, novices, who – due to lack of skill – will extract less information per fixation (shorter fixations) and thus need more fixations overall to complete the task (Reingold, Charness, Schultetus, & Stampe, 2001). Expertise has long been associated with intuition (e.g. Dane & Pratt, 2007; Moxley, Anders Ericsson, Charness, & Krampe, 2012). Dane and colleagues confirm the amplified effectiveness of intuitive decision-making processes for instances in which individuals have high levels of domain expertise. Examples of this include the effects of domain expertise on intuitive decision making in tasks such as judging basketball performances or identifying of counterfeit handbags. The authors conclude: “Domain experts are well equipped to capitalize on the potential benefits of intuition because they possess rich bodies of domain knowledge that foster the rapid and sophisticated associative processes that produce accurate intuitions” (Dane & Pratt, 2007). I therefore used eye movement analysis as a tool to trace the cognitive processing characteristics of intuitive judgments in face perception tasks.

3. Summary of Main Findings

3.1 Thinking about thinking

The first main finding of this dissertation is that the interplay of intuitive and deliberative processes as proposed by default-interventionist models does not reflect the way these processes interact in situations involving introspection. I outlined this discussion in detail within the theoretical background of this thesis (p. 8-11). For the full paper, see Ch. IV.1 of this thesis.

3.2 Intuitive face judgments rely on holistic eye movement pattern

Moving towards the goal of functionally characterizing intuitive judgment processes, the aim of the first study summarized below was to characterize the cognitive processes involved in intuitive social judgments, by investigating eye movement patterns in a face judgment task. Eye movement strategies involved in the perception of faces can rely on either global or local information sampling patterns and observers can flexibly adapt these strategies (Miellet et al., 2011, 2013). This speaks for the importance of individual differences in face perception strategies, though culture has repeatedly been shown to modulate these strategies strongly. For example, in the holistic and analytical cultural framework of perceptual processing styles researchers found that individual differences in preferred fixation positions when viewing human faces persisted over time (see Kelly et al., 2010; Miyamoto, Nisbett, & Masuda, 2006; Nisbett & Masuda, 2007, as well as Peterson & Eckstein (2013)[11]. Cognitive

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[11] The holistic and analytical cultural framework is based on extensive evidence that individuals from Western cultures rely on categorical rules and analysis, whereas individuals from Eastern cultures (e.g. China and Japan) pay more attention to context and relationships between objects (Kelly et al., 2010; Yuki, Maddux, & Masuda, 2007).

processing styles or modes such as intuition range among such individual factors, which purportedly influence eye movement patterns during the perception of human faces. Thus, in keeping with the aim of characterizing intuitive judgment processes in the context of face perception, the research question underlying the present study was whether differences in processing style do indeed modulate eye movement strategies underlying the judgment of faces.

This holds true for the viewing of faces (wherein Caucasians seem to look more towards single facial features, such as the eyes, then the mouth, whereas Asian individuals prefer to look at the center of the face) as well as the perception of art and photography (T Masuda, Gonzalez, Kwan, & Nisbett, 2008; Takahiko Masuda, Wang, Ito, & Senzaki, 2012; Nisbett & Masuda, 2007). Interestingly, in an elegantly designed study investigating eye movement patterns of Korean children adopted by Swiss families, Caldara and colleagues (2016) were able to show that these differences in processing are shaped by cultural upbringing rather than genetic factors.

To this end, we studied the eye movements of two differentially instructed groups of participants while these were engaged in the judgment of facial expressions. The first was an ‘intuitive group’, whom we instructed to judge the authenticity of facial expressions relying on their “gut feeling” and “answering spontaneously”, and the second was a ‘deliberative group’, whom we instructed to judge the authenticity of the same facial expressions after careful thought, focusing especially on the eye and mouth region. The reliance on direct instruction is the most frequently used means of manipulating intuitive/deliberate processing modes (Dane, Rockmann, & Pratt, 2012; Horstmann, Hausmann, & Ryf, 2009). Rather than mentioning the explicit labels, the instructions usually focus on processing characteristics (i.e. asking individuals to decide fast/spontaneously, base their decision on [gut] feeling, or view the task holistically to induce intuitive processing) and ask participants to decide accordingly.

Intuition has been linked to a global/holistic processing style (K. A. Dijkstra, van der Pligt, van Kleef, & Kerstholt, 2012; K. a Dijkstra, van der Pligt, & van Kleef, 2014), and – depending on the context – fixation strategies in face perception can rely on either global or local information (Millet et al., 2011; 2013). Based on this, we expected to find evidence for global/holistic processing in the intuitive, but not in the deliberate condition. If intuitive face judgments do indeed involve global/holistic processing, we predicted to find specific eye movement patterns for the intuitive condition that are distinct from the deliberative condition. More specifically, we expected the intuitive condition to elicit fewer fixations, but for these fixations to be longer than those of the deliberate condition. We founded these hypotheses on several theoretical considerations and previous empirical results.

Firstly, in an eye-tracking task requiring participants to judge the femininity of presented stimulus faces, Armann and Bülthoff (2009) found that – without differential instructions – two sub-groups emerged: one group of participants who preferentially fixated on the eye region, and a second group who fixated on the center of the face more often and for longer. Together with participants' verbal reports, they interpreted the group evidencing longer and more centralized fixations as a separate, more holistic strategy. Interestingly, the participants themselves reported performing the task "intuitively" and as trying to gain an "overall impression". Similarly, using a face recognition task in Asian participants, Chuk and colleagues modeled participants' eye movement patterns using hidden markov models (HMMs; Chuk et al., 2014). By clustering the HMMs, the eye movements participants made during the test phase, in which they tried to recognize previously learned faces in a set of new ones, could be classified into either a holistic or an analytic pattern. Furthermore, the participants classified as analytic by the HMMs furthermore showed longer reaction times and produced a higher amount of fixations. These findings are in line with literature on eye movement patterns of experts, as mentioned previously (p. 14ff.). Therein, longer fixation times are interpreted as a function of processing efficiency. That is, experts are thought to extract more information around the point of fixation (thus the longer fixation time) and therefore to need less fixations overall (see p. 14 for details). Notably, expertise (especially domain-specific) is linked to intuitive processing, though intuition and expertise are not identical.

In this context of characterizing intuitive processing, the term 'holistic' refers to the formation of an overall impression akin to the formation of a 'gestalt' (Wenger and Townsend, 2001; Dijkstra et al., 2012) on the basis of rapidly gleaned and integrated information. This is in contrast to the concept of 'holistic' in terms of the spatial relationship between parts of the face, which the term is often taken to denote in the context of face perception.[12] It is important to note that older definitions of holistic face processing as “recognizing the face as a perceptual whole” (Tanka & Farah, 1993) are closer to the notion of ‘holistic’ in the intuition literature. Several highly cited works characterize intuition as a “holistically associative” process (Dane & Pratt, 2007; Gore & Sadler-Smith, 2011; Hodgkinson, Langan-Fox, & Sadler-Smith, 2008; Hogarth, 2001). Thereby the authors intend that the holistically associative intuitive process integrates unstructured parts of stimulus information into a coherent percept, which then leads to action tendencies, such as making a decision or judgment based on the integrated information.

[12] Note that ‚holistic‘ and ‚configural‘ processing are used interchangeably by many authors in the face perception literature. See Maurer et al. (2002) for a review and McKone et al., 2007 for a brief discussion of this.

How these holistic associations are formed remains unclear and, in fact, may depend on the task at hand. Bowers and colleagues, for example, conceive of a non-conscious matching of the perceived stimulus information with exemplars stored in memory (Bowers et al., 1990). This concept has found wider recognition and been grounded in empirical evidence (Bolte & Goschke, 2005; Horr et al., 2015; Topolinski & Strack, 2009; Volz & Zander, 2014; Zander et al., 2016). Speaking about the cognitive architecture of intuition more broadly, Baumann and Kuhl, (2002) argue that upon perceiving a stimulus, extended associationistic networks activate automatically and proceed to initiate the parallel processing of information. This processing is conceived of as being holistic, implicit, and giving rise to an intuitive perception of coherence. In the case of face perception, the notion of an internal 'face space' (p.13ff.) might represent the proverbial 'database' against which the holistically sampled percept is matched rapidly and non-consciously.

As predicted, the intuitive condition did reveal markers of global/holistic processing (i.e. use of fewer diagnostic features/cues). These are a significantly lower number of fixations as compared to the deliberate condition, as well as a pattern of attention localized in the center of the face (for figures and tables see Ch. IV.1).

Intuitive processing is often related to processing the ‘gestalt’ of an object rather than focusing on details. Thus, the formation of a global impression of a facial expression via fast, few, and centrally located fixations might well be enough to elicit a ‘gut feeling’ of the message we interpret the face to be sending, though the conscious knowledge of the specific positions of facial musculature eludes us. Only those having undergone explicit training can consciously retrieve the information about which muscle positions underlie what expression (Ekman, 2006). Miller and Ireland’s definition of intuition as “holistic hunch” supports this conclusion. Therein, “[i]ntuition as holistic hunch corresponds to judgment or choice made through a subconscious synthesis of information drawn from diverse experiences. Here, information stored in memory is subconsciously combined in complex ways to produce judgment or choice that feels right" (Miller & Ireland, 2005, p. 21). Insofar as intuition and deliberation can be considered two different processing styles for the information within the faces of others, it seems quite plausible to postulate that intuitive and deliberative processing strategies will differ in the pattern of attention on a given face. The present study provides further evidence that intuitive processes rely on holistic perception, in an understudied and real world domain of intuition research. Additionally, our work adds to a growing body of literature demonstrating the usefulness of eye-tracking technology for judgment and decision-making research in general (e.g. Russo, 2011) and intuition in particular (Horstmann, Ahlgrimm, & Glöckner, 2009; V. a. Thompson, 2013).

3.3 Reliance on intuition depends on context and (life) experience

Before moving on to the next section, I would briefly like to reiterate the most important points from the previous experiment. Drawing on studies of ‘thin slice’ judgments, I illustrated that evaluative judgments of facial expressions are biologically based and most often occur intuitively, i.e. automatically, outside awareness, and without drawing on conscious, cognitive processing resources (Ambady & Weisbuch, 2010). I further introduced evidence for the claim that the eye movement pattern with which perceivers intuitively judge faces shows features of global/holistic processing (see Ch. IV. 2 this work & Mega & Volz, under review). Furthermore, I showed that the tendency of perceivers to direct attention more towards certain diagnostic features of a face is task-dependent and may in part be due to the involvement of different cognitive processes (Armann & Bülthoff, 2009). In keeping with the overarching goal of this dissertation, the study summarized in the following paragraphs was designed to investigate contexts of use for intuitive processing. The aim was to identify whether individual differences with respect to face perception strategies would map onto decision mode. To achieve this, a task context was chosen in which differences in cognitive style have been shown to map onto differences in judgments.

Examining the politics of differences in sexual orientation judgments, Stern and colleagues (2013) found that differences in cognitive style underlie ideological differences in judgments of sexual orientation. Participants who identified as liberal in their political views engaged in effortful, deliberative processing. Conversely, participants identifying with conservative political values relied on intuitive processing, as evidenced by the fact that higher cognitive load did not disrupt their judgments. Additionally, liberals were less likely to use gender-inversion cues (categorizing 'feminine' men and 'masculine' women as gay/lesbian, respectively). This raises the question whether different sexual orientations also map onto different cognitive styles. Specifically, one might speculate that individuals who identify as queer hold more liberal views than heterosexual individuals do. The 'social vision' framework has outlined the importance of individual as well as social factors in the shaping of perceptual experience. Could differences in the cognitive processing strategy relied on by the perceiver contribute to perceiver attunement, by determining the way in which stimulus information becomes available?

Brief glances at a face are sufficient for person categorization (Bruce & Young, 1986; M. A. Peterson & Rhodes, 2003). In fact, 50ms are sufficient to infer trait characteristics such as trustworthiness from a face (Willis & Todorov, 2006), and 60ms exposure are sufficient to correctly identify the sexual orientation when viewing female faces (Tskhay, Feriozzo, & Rule, 2013). Moreover, even single diagnostic cues are sufficient to characterize another person visually. Seeing a person's hairstyle, for example, suffices as a cue for sex/gender categorization (Martin & Macrae, 2007; Rule, Ambady, Adams, & Macrae, 2008). However, the reliance on information search strategies such as feature-based or configural visual discrimination depends on factors inherent to the perceiver (Albohn & Adams, 2016; Zebrowitz, Bronstad, & Montepare, 2011), such as a perceiver's culture (Kelly et al., 2010) or cognitive strategy (see Ch. IV.2, this dissertation). From an ecological perspective, the perception of a person's facial features and the extraction of meaning thereof guides adaptive behavior and thus moderates a perceiver's sensitivity to stimulus information that reveals particular affordances (attunements). In fact, the layout of a person's face-space (Leopold, O'Toole, Vetter, & Blanz, 2001; Valentine, Lewis, & Hills, 2014) is thought to be the function of an individual's perceptual experiences. Affiliated individuals, for example, are more similar in their facial preferences than strangers are.

Presumably, this effect arises due to greater similarity in the prototypes extracted from the faces in their shared environment (Bronstad & Russell, 2007). That is, an individual's perceptual experience shapes her facial preferences and conceivably her strategy for processing information from faces (Barraclough & Perrett, 2011; Keysers & Perrett, 2004). On a (cognitively) higher level, this is achieved by adaptively tuning attention to stimulus information motivationally relevant for the perceiver. On a lower, perceptual level, previous exposure and experience modulates the 'norm' or 'average' face encoded in the individual's face space. Within the face space framework – and thereby also the ecological approach to face perception – norm-based coding refers to the idea that face identities are thought to be coded in terms of their deviation from an average (norm) face (Leopold et al., 2011; Tsao & Livingstone, 2008). Extensive findings on face aftereffects (Rhodes et al., 2004; Short & Mondloch, 2010), in which exposure to a certain face category changes subsequent perceptions of faces, support this proposition. Adaptation to mixed-race face morphs, for example, shifts the prototype for face race towards the adapted category (e.g. Webster & MacLeod, 2011). In terms of neural activations, this effect is thought to rely on pairs of neural populations, which are adaptively tuned to above-average and below-average values along each dimension of face space (Rhodes et al., 2006).

Furthermore, a key neural region for the processing of rewarding stimuli, the medial orbitofrontal cortex (OFC), is active only for facial stimuli motivationally appropriate for the perceiver. For example, Kranz & Ishai (2006) found OFC activation only when gay men viewed faces of other men, but not of women. In line with this is the finding that gaze (i.e. where a person looks) is generally affected by motivation, such that stimulus information deemed motivationally relevant is attended to more (Isaacowitz et al., 2011). Interestingly, the mOFC is known not only as the center for processing rewarding stimuli, but has also been shown to be involved extensively in intuitive processing, as outlined above.

Based on the evidence and the theoretical framework outlined above, I wanted to test whether:

1. a difference in participant sexual orientation would also map onto differences in cognitive style, such that heterosexual individuals use intuitive processing and queer individuals use deliberative processing to judge the sexual orientation of others.
2. these differences in cognitive style could be revealed via eye-tracking (replicating the findings of the study introduced in section 3.1).
3. analogously to the Stern et al. study, queer individuals would rely less on gender-inversion cues for judgments of sexual orientation than heterosexual individuals would.

To this end, I asked participants to indicate their gender identity and sexual attraction on multiple scales. I thereby attempted to allow options of identification which go beyond the male/female binary used as standard on most psychological tests and are more similar to the variations of sex/gender found in brain structure and function (Joel & Fausto-sterling, 2016)[13].

Participants were shown computer-generated faces within two categories, separable by cues which are stereotypically assigned the labels 'masculine' or 'feminine' in Western-European contexts. These were the categories "lips & lashes" (faces showing what could be considered as lipstick and painted eyelashes), and "beard & brows", which featured a combination of bushy eyebrows and/or noticeable facial hair (beard, stubble, or mustache). Faces in both categories were morphed in four steps along

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[13] See Ch. IV.3 for classification of individuals as 'queer' or 'heterosexual', based on their self-identification.

a continuum of ‘very female’ to ‘very male’ (categories pre-defined by the software), resulting in 192 different stimuli. In two separate task blocks participants were asked to judge the gender identity of the displayed face (task 1), or what gender they perceived the displayed face to be sexually attracted to (task 2). Binocular eye movements were recorded concurringly.

I did not find significant reaction time differences between the two groups, which might be due to the research design (see CH. IV.3 for discussion of this limitation), or because both groups use similar cognitive process types for their judgments. The other dependent variables (confidence in judgments, eye tracking data and phenomenological self-report) point towards the former interpretation. Queer individuals were significantly less confident in their judgments and generally focused more on the eye region than heterosexual individuals. The global/holistic viewing pattern of heterosexual individuals (Figure 4 & 5, see Ch. IV.3, p. 112) is consistent with an intuitive processing strategy for face judgments. Moreover, queer individuals relied less on gender-inversion cues for sexual orientation judgments and generally allowed for greater variations in judgment. Thus, participants' eye movements and face judgments differed by strategy, with queer participants relying more on an analytic strategy of eye movement and less on gender-inversion cues, whereas heterosexual participants showed more of a global/holistic viewing pattern. Although the differences in fixation duration and number did not reach statistical significance after correcting for multiple comparisons, a clear trend in viewing pattern can nevertheless be discerned. I am currently in the planning stages of a follow-up study with larger sample size, in order to test the reproducibility of these findings. The conclusions as to differences in participant sexual orientation mapping onto differences in cognitive style are therefore tentative. However, the convergence of data trends in judgment frequencies, confidence judgments, self-report and eye movement data do point towards a possible difference in judgment process.

Although only tentative, this is among the first batch of evidence for a difference in both eye movement and judgment strategy based on an individual’s sexual orientation mapping onto a difference in cognitive strategy. Furthermore, it is evidence for the contribution of an individual’s experience to the reliance on an intuitive perceptual process to judge the sexual orientation of others (as found for heterosexual individuals), or the reliance on a more analytic strategy (as seen in queer individuals).

A person’s sexual orientation is surely not the only factor shaping her perceptual exposure and experiences. When it comes to judging the gender identity and sexual orientation of others, however, one’s own sexual orientation is surely a highly motivationally relevant factor, not only in the limited time frame of a laboratory experiment, but especially during a person’s lifetime. The thereby moderated differences in attending to and perceiving gender identities and sexual orientation over time thus translate into differences in exposure to and experience with gender identities and sexuality. In a heteronormative society, however, this experience does not seem to be 'different enough'[14] for queer individuals to trust an intuitive perceptual strategy when it comes to judging another person's sexual orientation. Perhaps because of their own experiences in being misjudged, queer individuals rely on an analytical strategy when it comes to sexual orientation judgments. This is in line with findings by Tshkay et al. (2013), wherein participants' sexual identity affected their response bias. Specifically, lesbian and bisexual participants were less likely to label female faces systematically as heterosexual. The authors interpret this as resulting from a higher familiarity with and exposure

[14] Seeing as queer individuals are a minority group and therefore the exposure to individuals of this minority necessarily is small.

to sexual minorities in lesbian and bisexual than heterosexual woman. Speculation aside, the results of the present study point towards a link between individual differences in cognitive strategy and a perceiver's sexual orientation.

Contemporary concepts of intuitive judgment processes complement the adaptive view of social vision by emphasizing the importance of an individual's life experience for the shaping of the intuitive judgment process. Furthermore, duality models explain dissociations between automatic versus controlled processes of judgment formation as originating from separate mental systems (Seymour Epstein & Pacini, 1999; Sloman, 1996; Fritz Strack & Deutsch, 2004) or separate mental representations or processes (Gawronski, Sherman, & Trope, 2014), and responding differentially to the same situational input.

I have shown that whether perceivers rely on an intuitive strategy for the judgment of faces depends not only on the task[15], but also on individual attributes of the perceiver. The present work provides evidence that the reliance on intuitive processes (i.e. rapid, automatic/non-conscious and holistic information integration) for the judgment of a person's sexual orientation depends, in part, on the sexual orientation of the perceiver themselves. Analytic decision-making lends itself for tasks that can be approached sequentially (Hammond et al., 1987). Due to personal experience with a concept of sexuality beyond the heterosexual norm, queer individuals may thus be inclined to approach sexual orientation judgments sequentially, based on rational analysis and reflection, rather than relying on a first, intuitive impression. The present work thereby further supports the notion of intuition as a process mode or strategy, rather than a biased mental system.

[15] Sexual orientation does not affect intuitive judgment of gender identity, but does affect sexual identity judgments.

3.4 What types of feelings are gut feelings?

The discussion on the different feeling types is outlined in the outlook below. For the full paper, see Ch. IV.4 of this thesis.

4. Conclusion

The aim of this thesis is to contribute to the growing body of knowledge on intuitive judgment processes. The present work primarily helps to advance the endeavor of an empirically grounded theoretical framework. Additionally, it elucidates ways in which intuitive processes contribute to the formation of judgments in social interactions. Understanding intuitive processing of social information is the basis for understanding phenomena such as impression formation and person perception. Since the social judgment domain is as of yet underrepresented in the intuition literature, this thesis provides crucial insights into the workings of intuitive judgment processes in this context. Moreover, it illuminates the usefulness of face perception tasks for research on quotidian intuitive judgments. This contribution is achieved by means of four separate investigations, which addressed the posed research questions (p. 11) and revealed the following conclusions:

1) The ‘default-disruption view’ based on literature describing introspective errors provides evidence for the claim that the default-interventionist model cannot be taken as a general explanatory framework for intuitive judgment processes. Similarly, neural predictions of dual systems theory do not hold for the judgment of faces. This engagement with the ongoing theoretical interdisciplinary debate is a prerequisite when investigating a phenomenon as elusive as intuition.
2) The process of intuitively perceiving and judging another person based on their face is holistic & gestalt-like, using global information integration strategies. Thus, the characterization of intuition as ‘holistic’ holds true in the social judgment domain.

3) Intuition facilitates social interaction through fast and automatic processing. Whether individuals employ intuitive processes to judge the sexual orientation of another person, however, depends on individual attributes of the perceiver, such as the perceiver’s own sexual orientation.
4) As often colloquially noted, ‘gut feelings’ play a role in the intuitive processes. Which types of feelings are thus referred to and at which processing stage these are involved in intuitive judgment remains a topic of debate. A first look seems to point towards the notion, that different feeling types may in fact be involved in intuitive processes.

Within social interactions, vast amounts of information need to be integrated *quickly* & *accurately*. Basing judgment on intuitive processes may be the only feasible option to accomplish the herculean task of integrating the multiple facets of people perception within split seconds.

This thesis provides evidence that in social interactions, intuition is an effective tool for judgment and perception. It relies on holistic information integration and previously stored experience. Whether and how its power is being used, however, may be determined by personal (individual) as well as context-dependent, or task, factors. Understanding intuitive processing of social information is the basis for understanding phenomena such as impression formation and person perception. Developing a better grasp on these phenomena is of utter importance, especially in times were social cohesion and the celebration of plurality cannot be taken for granted. As mentioned previously, the idea of a duality of the mind wherein intuition is pitted against reason and the corporeal against the mental has a vast history. However, as we are continually discovering more of the dynamic entanglements between body, mind and life experience, moving away from the idea of an antagonistic duality and towards understanding the functional characteristics of intuitive processes may provide a more fruitful way to an integrated understanding of the mind. While I do not join Dr. Faust in his fatalistic conclusion that ‘we cannot know anything’, I will acknowledge that many questions remain to be answered and others to be asked. The general efficacy of intuition, for one, will most likely remain a topic of ongoing debate. Nevertheless, this thesis offers a view on a great opportunity for the characterization of intuitive processes in an ecologically valid and motivationally relevant context.

5. Outlook

Most contemporary concepts of intuition include the notion of an emotional or ‘feeling’ component, often colloquially referred to as ‘gut feeling’. In fact, several investigations into the neural architecture of intuition have identified a role of the anterior insula, a region that is known to instantiate subjective feelings (Craig, 2009; Critchley, 2005; Critchley, Wiens, Rotshtein, Ohman, & Dolan, 2004). To unravel the tangle of feeling-types thought to play a role within intuition, I would like to approach this question from the intuition rather than the feeling side. Using two prominent lines of empirical inquiry into intuition as examples, and drawing on theories of emotion as well as embodied cognition, I therefore ask the following questions:

- Do ‘gut feelings’ play a functional role in the intuition process? If so, when do they enter the process?
- If we assume gut feelings to play a role for intuitive processes, what types of feelings are ‘gut feelings’?
- Are they (always) embodied? If so, where in the body are they located?
- Are these ‘gut feelings’ more like visceral sensations, meta-cognitive feelings, or emotional feelings?

While a definitive answer to these questions would surely merit a completely new dissertation itself, in Ch. IV. 3 I provide first evidence for the argument that the term ‘gut feelings’ is used to denote different types of feelings in two prominent contexts of intuition research. These contexts are the (1) the Iowa Gambling Task (which is widely cited within the JDM community as providing evidence for a role of gut feelings, therein termed ‘somatic markers’) and (2) semantic coherence judgments. I argue that the feelings under investigation in both of these widely cited tasks are in fact different types of feelings and therefore should not be used as evidence for a single type of feeling component in intuitive judgments or decisions.

The history of investigating either bodily sensations or affective reactions within tasks requiring intuition is long. Nevertheless, when it comes to integrating this evidence into theoretical frameworks of intuitive processes, the notion of this feeling component seems to be conceptually muddled and used in ignorance of the different feeling concepts existent within the psychology and philosophy of emotions. To advance knowledge on the ways in which intuitive processes contribute to judgment and decision-making, it is fruitful to disentangle these different types of feelings at play in various intuition research endeavors – both conceptually as well as empirically.

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II. LIST OF PAPERS AND MANUSCRIPTS APPENDED

The present dissertation is based on the following published papers and manuscripts. Roman numerals indicate the chapters of this thesis in which the paper can be found.

Chapter IV. I	Mega, L.F. & Volz, K.G. (2014) *Thinking about Thinking: Implications of the introspective error for default-interventionist type models of dual processes*. Frontiers in Psychology: Cognition, 5 (Aug), 864.
Chapter IV. II	Mega, L.F. & Volz, K.G. (2017) *Intuitive face judgments rely on holistic eye movement pattern*. Frontiers in Psychology, 8 (June).

Chapter IV.III	Mega, L.F. & Volz, K.G. (in preparation for submission to "Frontiers in Psychology: Gender, Sex and Sexuality", December 2016) *Reliance on intuition in face perception is context dependent.*
Chapter IV. IV	Mega, L.F. (submitted to "Philosophical Psychology", October 2017) *What type of feelings are gut feelings?*

III. STATEMENT OF CONTRIBUTIONS

Chapters IV.1 – IV.4 of this dissertation consist mostly of collaborative work. Below, I will first outline my own contribution to these papers and manuscripts in preparation, and subsequently the contributions shared with others.

IV.1 Thinking about Thinking

My contribution:

- Development of the theoretical concept
- Research of background literature
- Manuscript preparation
- Revision of manuscript

Shared contributions:

Theoretical ideas were put forward by myself and PD Dr. Kirsten Volz and discussed with Dr. Elizabeth Irvine (Cardiff University). PD Dr. Kirsten Volz made significant contributions to the preparation of the manuscript and its revision.

IV.2 Intuitive face judgments rely on holistic eye movement pattern.

My contribution:

- Research of background literature
- Design of the experiment
- Programming of the experiment in Matlab
- Recruitment of participants
- Data collection
- Statistical analysis of behavioral data (SPSS)
- Analysis of eye-tracking data (SPSS and Matlab)
- Manuscript preparation, including figures
- Revision of manuscript

Shared contributions:

The research questions were put forward by PD Dr. Kirsten Volz and myself. Irem Undeger (Karolinska Institute) helped with programming of the experiment in Matlab. Irem Undeger helped with data collection. Jonas Walter contributed with the eye-tracking data analysis using Matlab. Natalya Zaretskaya (CIN Tübingen) helped with data collection, set-up of the eye-tracking system and programming for data collection and analysis. Results were discussed and interpreted together with PD Dr. Kirsten Volz and Jonas Walter and Prof. Dirk Wildgruber.

IV.3 Reliance on intuition in face perception is context dependent.

My contribution:

- Research of background literature
- Development and design of the experiment
- Programming of the experiment in Matlab
- Recruitment of participants
- Data collection
- Statistical analysis of behavioral data (SPSS)
- Analysis of eye-tracking data (SPSS and Matlab)
- Manuscript preparation, including figures

Shared contributions:

Theoretical ideas were put forward by myself and PD Dr. Kirsten Volz and discussed with Dr. Junpeng Lao and Prof. Roberto Caldara. Ann-Christin Kimmich assisted with data collection, as well as behavioral analyses (SPSS). Junpeng Lao assisted in programming of the eye-tracking data analysis code (Matlab). Results were discussed and interpreted together with Dr. Junpeng Lao, Prof. Roberto Caldara and PD Dr. Kirsten Volz. Prof. Regina Amicht-Quinn and Prof. Ingrid Hotz-Davies assisted in discussing the results with respect to relevant literature from gender- and queer theory.

IV.4 What type of feelings are gut feelings?

My contribution:

- Development of the theoretical concept
- Research of background literature
- Manuscript preparation
- Revision of manuscript

Shared contributions:

Theoretical ideas were put forward by myself and discussed with Dr. Mog Stapleton, Prof. Dr. Jesse Prinz, PD Dr. Kirsten Volz and Dr. Thea Zander.

IV. APPENDED PAPERS AND MANUSCRIPTS

In the following you will find the papers and manuscripts in preparation in full length. Chapter IV.1 and IV.2 are published in the peer-reviewed journal ‘Frontiers in Psychology’. Chapter IV.3 is under review for submission at ’Frontiers in Psychology: Gender, Sex and Sexuality’. Chapter IV.4 is in preparation for submission to ‘Cognition & Emotion’. Please note that the different journals, for which the manuscripts have been prepared, do not all follow the same guidelines for manuscript preparation. Thus, the subsequent chapters differ in formatting, especially with respect to the references.

Chapter IV.1

Thinking about thinking: Implications of the introspective error for default-interventionist type models of dual processes

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Keywords: dual-process theory, default-interventionist model, introspection, meta-consciousness

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Imagine sitting in a grand hall, listening to the keynote lecture of the conference you are attending. At some point your thoughts drift off. When you look around you, half of the audience is staring intently at their smartphones. You ask yourself: what is it about this talk that makes you unable to stay focused? Do you find any aspect enjoyable? How would you behave, if it were you standing at the podium? Answering questions such as these, you are engaging in a process known as introspection.

Introspection describes the ability to explicitly characterize experience. It enables one to say: "I am thinking about what I am thinking about". In other words, introspection allows one to become meta-aware, that is, to have awareness of what one believes to be experiencing. Although agreement exists as to the fact that we all have and make experiences and therefore subjective experience seems indisputable (Schooler & Schreiber, 2004; Winkielman & Schooler, 2011), empirically gaining access to and knowledge of this subjective experience poses a great challenge. It requires us to put a subjective, internal experience into words, such as in the above-mentioned example. This raises the question, if the words we come up with are true descriptions of our experience, or confabulations. Specifically, the dissociation between experiential consciousness (the contents of experience) and meta-consciousness (the belief about the contents of experience) makes us fallible in appraising our own experiences. In some cases, this fallibility has been demonstrated to manifest in translational dissociations, that is, the distortion of experience in an attempt to recount or characterize it; this was termed the "introspective error" (Schooler, 2002). Even though -- or perhaps because -- the paradox of introspection has been studied extensively for a number of decades, it is almost paradoxical itself to find that the resulting implications for the ongoing debate about (dual-) process types in judgment and decision-making (JDM) and specifically for the most widely accepted and experimentally investigated *default-interventionist model* (D-I-Model) of dual-process theory, have not been considered thus far. In the present contribution we set out to fill this gap and point out the implications of the introspective error for the conceptualization of the D-I-Model.

In the (neuro-) scientific community, dual-process models of intuitive and deliberate JDM currently constitute the preferred theoretical construct (e.g., Strack & Deutsch, 2004; Evans & Stanovich, 2013; Glöckner & Witteman, 2010; Kahneman, 2011; Lieberman et al., 2002). These models have been built on the assumption that judgments are formed via two qualitatively distinct process types: automatic “intuition” and controlled “deliberation” or “reflection”. In recent years, an immense influx of publications has arisen, either fervently defending or criticizing a dualistic distinction between rapid, autonomous, intuitive processes and slower, thoughtful, reasoning processes of higher order. In their most recent publication on dual-process models, Evans & Stanovich (2013) -- henceforth referred to as E&S -- described their concept as one, which assumes that automatic processes (Type 1, T1) yield default responses unless an intervention by higher order reasoning processes (Type 2, T2) is needed; a model, which has been termed the D-I- Model. We will focus on this current-most description of dual-process theory, since it constitutes the predominant model being intensively discussed by leading authorities in the field[16]. E&S split the attributes of both process types into defining (necessary/sufficient) and correlated features. The defining features listed for T2 processing are working memory capacity and

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[16] Compare the recent debate in the journal "Perspectives on Psychological Science", Volume 8, 2013.

cognitive decoupling. These are seen to be central in order to be able to reason hypothetically and distinguish supposition from belief, thereby aiding "rational choices by running thought experiments" (E&S, p. 236). Importantly, cognitive decoupling requires a re-representation of automatic (T1) processes so as to be able to interfere with their output. In that way T2 processing allows for "metarepresentational and simulation abilities", and is thus a form of meta-consciousness. T1 processing, in contrast, is defined as encompassing both "innately specified processing modules or procedures and experiential associations that have been learned to the point of automaticity" (E&S, p. 236). Explicitly opposing a general "good-bad thinking idea, the D-I-Model assumes T1 processes to lead to correct answers in benign environments, i.e., whenever the decision maker can use overpracticed cues. However, as soon as conditions for successful T1 processing are not fulfilled (e.g., novel situations), T2 processing will have to intervene on the default intuition. E&S argue that due to peoples' limited capacity of central cognitive resources, T1 processes inevitably will be relied on in most situations. The disposition to override the default intuition and to replace it by effective T2 reflective reasoning is suggested to be a function of several factors; an important one being "measurable thinking dispositions that are inclined toward rational thinking and disinclined to accept intuitions without checking them out" (p. 237)[17]. In other words, cognitive decoupling allowing a re-representation of automatic T1 processes seems to be decisive for intervention processes to become effective.

Literature on the introspective error, however, poses a challenge for this dual-process view insofar as it has been shown that re-representing subjective

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[17] A feature of human intelligence, as E&S assert.

experience can lead to biases and incorrect decisions. Notably, this counterintuitive finding is not limited to T1-specific situations, where overlearned cues elicit the right answer, but also occurs in situations where the problem is hard to solve directly from previous experience or from previously stored cue validities. We will outline how the empirical results on introspection and meta-consciousness, presented by Schooler and others, are incongruent with the D-I-type models' assumption of reflective processes coming to the rescue of automatic response and will sketch a default-disruptive option. Therein, analytical introspection does not come to the rescue of intuitive, holistic recognition but rather disrupts this process, leading to changes in preference and even creating false outcomes (e.g. erroneous memories).

Verbal overshadowing: An exemplary case

The verbal-overshadowing effect, first described by Schooler and Engstler-Schooler in 1990, reveals a source of error in verbally describing a non-verbal stimulus: When individuals verbally introspect (i.e. attempt to describe in great detail) about complex non-verbal stimuli (e.g. recognizing a previously seen face, or the reasons for choice preferences), disruption can ensue. Particularly, individuals show markedly worse performance and make less optimal choices when asked to verbally introspect. In the words of Schooler and Schreiber (2004): “Verbal introspection fails to adequately capture ineffable experience, breaking them apart in a manner that makes it difficult to put back together” (p.24). Interfering effects of verbalization have, for example, been found in a task requiring participants to watch a short video of a bank robbery and later attempt to identify the robber from a photo array. Those participants who had previously written a detailed description of the robber’s appearance were markedly worse on the identification task than the control group (Schooler & Engstler-Schooler, 1990). The engagement of metaconscious representation of subjective experience for subsequent production of a verbal description from memory actually led to a distortion of witness' memory, producing false outcomes. Schooler and colleagues posit that dissociations and omissions such as these can occur even when participants simply think aloud -- concurrently or retrospectively -- to the ongoing experiment. The authors reason that these distortions are due to the fact that participants are forced to verbally re-represent inherently non-verbal experiences (Schooler et al., 1993; Lane & Schooler, 2004; Winkielman & Schooler, 2011). This argument points to the *introspective error* mentioned above, wherein meta-consciousness is seen to misrepresent or distort underlying experience. In other words, the reflective mind lacks awareness of its own subjective state. This, however, would on the other hand be required in order to monitor when an intervention is necessary, according for instance to the D-I-Model.

The verbal overshadowing effect is not limited to visual introspection. Similar evidence comes from studies on preferential choice. Wilson and Schooler (1991) compared college students' preferences for courses with the ratings of experts. Students who were asked to introspect, i.e. analyzed the reasons why they preferred some courses over others, or evaluated attributes of all courses, made choices that corresponded less with experts' opinions than the choices of control subjects.

The two main points in discord with D-I-type models of dual-processes that are raised by the verbal overshadowing effect are as follows:

1. Verbal description of non-verbal memories induces distorting reflective processes (Jack & Roepstorff, 2002).

According to D-I-type models, T2 reflective processes are called upon to intervene on default answers in situations beyond those relying on innate or conditioned response capacities .Here, the engagement of T2 processing is assumed to be more likely to find the (normatively) correct answer. However, evidence from the study of introspection shows that performance may be less accurate when reflective strategies are applied (Dunning & Stern, 1994). Thereby, intervention by reflection disrupts performance (e.g., face recognition performance) rather than enhancing it.

2. "Analytic introspective processes induced by describing memories can disrupt holistic non-verbal recognition processes" (Schooler & Schreiber, 2004, p. 25)].

In the above-mentioned example of the eyewitnesses, as we understand it, the D-I-Model would predict the default rise of a gut reaction (T1) to identify the perpetrator. When overridden by careful reflection (T2), the correct person should be remembered. Instead, as mentioned above, the opposite is true.

Importantly, this misrepresentation of underlying experience is not explained by a monitoring failure. The monitoring failure account describes the introduction of bias, not from a lack of appropriate knowledge or cognitive resources (“mindware”) but a failure to call on this knowledge when it would be needed (De Neys & Bonnefon, 2013). However, the distortion of underlying experience by recall and verbalization is qualitatively different from the failure to draw on the appropriate knowledge. In misrepresenting (subjective) experience, the knowledge of the occurrence of experience needs to be actively called upon by meta-consciousness but the belief about what has been experienced does not align with what was actually experienced. Taken together, these findings lead us to propose an opposing view to the D-I-Model to describe subjective, non-verbalizable experiences; this is the “default-disruptive view”.

The default-disruptive view

We propose tasks requiring introspection about inherently non-verbalizable processes as examples in which a default-disruptive option might more closely represent a mapping of people’s cognitive processes as opposed to the current D-I-type models.

Tasks requiring the re-representation of inherently subjective conscious experience (what could be seen as being processed by the 'autonomous mind'[18]) may elicit a translational dissociation between experiential consciousness and meta-consciousness ('reflective mind'). The recruitment of T2 processes disrupts the default response in non-verbalizable experiences, leading to:

- Distortions of underlying experience (e.g., verbal overshadowing effect)
- Decline in performance (e.g., speed)

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[18] In keeping with Stanovich's "Tripartite Model of the Mind".

- Decline in accuracy (e.g., recognition)

The introspective error challenges D-I-type dual-process models precisely because T1 processes are by their definition affect-laden decisions, based on a gut feeling primarily reflecting (non-verbalizable) experience (Betsch, 2008). Thus, overriding intuitive responses and replacing them by T2, reflective reasoning stringently requires a re-representation of subjective experience – raising the issues addressed above.

The challenge of the introspective error is all the more important since we are constantly encouraged, by self-help books and the like, for example, to carefully re-think (important) decisions in order to make the right choice. For instance, we can vividly imagine a police officer encouraging an eyewitness to carefully reconsider her response, emphasizing the implication a false statement would have; ironically, in doing so the police officer will foster exactly this outcome. Thus, dealing with the implications of research on the introspective error is not only relevant for the conceptualization of D-I-type dual-process models, but additionally has considerable implications for real-life decision making.

In summation, the ‘default-disruptive’ view is a preliminary approximation to an alternate account of dual-process models in situations requiring introspection on internal processes. However, E&S themselves state that they “view the development of dual-process theories as an evolving project. Just as [dual-process theories] have developed and changed a great deal in the past decade, we expect this process to continue” (p.237). In this vein, our work provides a starting point and a fresh view for this evolutionary process.

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Chapter IV. 2

Intuitive face judgments rely on holistic eye movement pattern

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Nonverbal signals such as facial expressions are of paramount importance for social encounters. Their perception predominantly occurs without conscious awareness and is effortlessly integrated into social interactions. In other words, face perception is intuitive. Contrary to classical intuition task, this work investigates intuitive processes in the realm of every-day type social judgments. Two differently instructed groups of participants judged the authenticity of emotional facial expressions, while their eye movements were recorded. Pixel-wise statistical maps of the resulting eye movements revealed a differential viewing pattern, wherein the intuitive pattern closely resembles a global holistic viewing strategy. Interestingly, this difference in cognitive strategy was found even though participants of both groups were Caucasians of a young age. A holistic viewing pattern for faces has previously been shown only in East-Asian individuals. The holistic pattern of intuitive face judgments is in line with evidence showing that intuition is related to processing the "gestalt" of an object, rather than focusing on details. Our work thereby provides further evidence that intuitive processes are characterised by holistic perception, in an understudied and real world domain of intuition research.

Keywords: intuition; eye-tracking; holistic processing; judgment; face perception; dual-process theory

What is Intuition?

> Evaluation of other persons, important as it is to our existence, is largely automatic, one of the things we do without knowing very much about the "principles" in terms of which we operate. (Renato Tagiuri (1958) , p. ix)

The intuitiveness of rapid perceptions made during social encounters and often leading to the judgment and interpretation of race, gender, ethnicity and emotional state of other persons has been reliably demonstrated. In other words: "Intuition is essential to optimal social and interpersonal functioning" (Ambady, 2010). Understanding this intuitive processing of (social) information is of utter importance for general society and policy makers alike. It lies at the basis of understanding social interactions in general as well as specific phenomena such as impression formation, person perception and adaptive social behaviour. Despite the fact that many of our human experiences rely on intuition -especially social interactions, as referred to above -- a clear scientific definition of intuition remains elusive. Intuition has often been theoretically described through the demarcation by a second “type of thinking” (Jonathan St B T Evans, 2008; Witteman, Van Bercken, Claes, & Godoy, 2009), namely slow and effortful deliberation. This dualistic distinction is ancient in origin and can be found widely in both psychological as well as philosophical writing, dating as far back as Plato (Evans & Frankish, 2009, p.2). Among the most widely purported *explanans* of such social judgment behavior are dual-process theories (DPT). The details of the various theories differ from each other, depending mostly on the domain in which they are being investigated (e.g., Lieberman et al., 2002; Strack and Deutsch, 2004; Glöckner and Witteman, 2010; Kahneman, 2011; Evans and Stanovich, 2013). Common to DPT models is the assumption that our mind is governed by two qualitatively distinct systems- or process types: automatic “intuition”

(Type 1) and controlled, effortful "deliberation" (Type 2). These theories propose that T1 and T2 may either compete or cooperate in order to produce observed behaviour (J. S. B. T. Evans & Stanovich, 2013; Strack & Deutsch, 2015).

Despite the prevalence of DPT, both the psychological and philosophical community have been entrenched in critical debates about the characteristics and the interplay between the supposedly two distinct process types, with different alternative accounts and empirical data suggesting a closer similarity between the two process types than previously assumed (Kruglanski, 2013; Kruglanski & Gigerenzer, 2011; Mega, Gigerenzer, & Volz, 2015a; Osman, 2013). The sheer amount of these proposed theories have thus not made the search for a definition of intuition an easy one. Rather than searching for the *truth value* of intuition (i.e. "what intuition really is"), specifically investigating the different underlying processes (Glöckner&Witteman, 2010) as well as the characteristics of its operation (Ferguson, Mann &

Wojnowicz, 2014) has been suggested as a more fruitful endeavour. Existing functional characterizations of intuitive processes differ somewhat from each other; arguably, because the domains in which intuition operates are various and thus its characteristics tend to vary. Some converging characteristics have emerged over the years, however (Gerd Gigerenzer, 2007; Hogarth, 2001; Plessner, H., Betsch, T., Betsch, 2008):

- Intuition relies on a (tacit) knowledge base which is acquired throughout one's lifetime.
- It elicits the colloquially known "gut feeling". That is, intuitive judgment relies on some type of metacognitive experience, such as a feeling of rightness or processing fluency (Proust, 2015; Thompson & Morsanyi, 2012), which lead the decision maker to her judgment or choice.
- The reasons for her judgment remain elusive to the decision-maker. That is to say that intuition operates

> without the decision maker being conscious of the internal processes that are leading her (judgment) behaviour.

Consequently, the present work aims to characterize the cognitive processes involved in intuitive social judgments, by investigating eye movement patterns in a face judgment task.

To date, a large part of research performed to probe intuition has heavily relied on tasks requiring a proficient basis in statistics and sometimes even probability theory. Tasks such as Kahneman and Tversky's classical base-rate neglect problems (Kahneman, D., & Tversky, A., 1973), but also the often utilized problem solving tasks require logical and probabilistic reasoning to arrive at what is considered the normatively 'correct' answer. While seemingly pointing out instances in which intuition leads us astray, what is problematic in many of these tasks is the fact that the laboratory setting individuals are in when solving the tasks create a social setting in which cooperation with the person administrating the study as well as their instructions is the socially preferable behaviour. This approach has been criticized variously, not least of all because of the large gap between the experimental tasks and decision problems faced in everyday life (e.g. Eiser, 2012; Gigerenzer, 2000). [19] A growing body of studies suggests that perhaps only neurological and mental abnormalities foster conformity to norms of rationality (Hertwig & Volz, 2013). The approach also seems problematic insofar as social psychology has shown that intuition plays a major

[19] In fact, proponents of the adaptive rationality hypothesis (G. Gigerenzer, Hertwig, & Pachur, 2011; Hertwig & Hoffrage, 2013) point out that the normative criteria of logic or rational decision theory are too narrow and abstract and instead behavior should be measured against the goals individuals entertain in a particular situation.

role in social encounters. With respect to nonverbal behaviour (i.e. communicative signals sent through channels of face, voice, posture etc.) current literature suggests that evaluative judgments thereof occur automatically, outside awareness and without drawing on conscious cognitive processing resources (Ambady & Weisbuch, 2010). These characteristics are hallmarks of intuitive processing. Pioneers of social judgment research have argued that the study of motivationally relevant stimuli (‘social’ stimuli, in a wider sense) is clearly distinct from the judgment of motivationally neutral stimuli (Sherif & Hovland, 1961). As opposed to traditional decision-making tasks, the objects to be judged in social judgment research have meaning and value derived from social relationships and interactions (Eiser, 2012). It is for this reason that the present work relies on a social judgment task, namely the judgment of facial expressions.

To investigate the cognitive processes involved in the intuitive judgment of faces, we utilized the measurement of eye movements -- a methodology known to "provide an objective insight into the information entering the visual system and into cognitive processes involved" (Armann & Bülthoff, 2009). Intuitive processing is often related to processing the “gestalt” of an object rather than focusing on details. In this vein, several recent studies have suggested that people may in some cases use a global or holistic strategy to process the information present in faces rather than relying on detailed features (e.g. Chuk et al., 2014). By global/holistic processing we refer to processing the gestalt of an object rather than its featural details, such as focusing on the eyes, nose and the mouth. Since the term ‘holistic processing’ has been used to describe different phenomena, we choose ‘global/holistic processing’ to denote the broader sense of a global impression, as used, for example, in visual cognition (see Maurer, Le Grand, & Mondloch, 2002 & McKone, Kanwisher, & Duchaine, 2007 for a discussion of terminology).

A global processing style has been related to intuition on several different occasions. Dijkstra and colleagues, for example, have demonstrated that the effects of decision mode (intuitive versus deliberate) on judgement are mediated by processing style (K. A. Dijkstra, van der Pligt, van Kleef, & Kerstholt, 2012; K. a Dijkstra, van der Pligt, & van Kleef, 2013). Their results suggest that similar mechanisms underlie intuition and global processing. Moreover, trait inferences from faces are considered to be intuitive, relying on less than 100ms exposure for impression formation (e.g. Willis & Todorov, 2006)

However, to our knowledge the question whether relying on one's intuition to judge facial expressions maps onto a global/holistic viewing strategy has not been directly probed. We therefore set out to study the eye movement patterns of two differently instructed groups of participants:

- An “intuitive group”, whom we instructed to judge the authenticity of facial expressions relying on their “gut feeling” and “answering spontaneously
- A “deliberate group”, whom we instructed to judge the authenticity of (the same) facial expressions after careful thought and focusing especially on the eye and mouth region (see Methods for explicit instructions).[20]

The present work relies on a design that has been successfully used to investigate intuitive processing using

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[20] A feature-based face processing strategy has reliably been shown for individuals of the age range and ethnicity of our participants. By asking participants to focus on the eye- and mouth region, we therefore simply explicitly instructed them to focus on the features we expected that these types of individuals are known to focus on. The deliberate group is therefore a kind of control condition.

fMRI methodology (Mega, Gigerenzer, & Volz, 2015). Furthermore, the direct instruction of decision mode in a between-subject design follows the methodological recommendations of leading experts in the field (Horstmann, Hausmann, & Ryf, 2009). We presented 171 happy and fearful faces (342 total stimuli of various ages and genders) and asked participants to judge how authentic they perceived the facial expression to be. We hypothesized that, if intuitive judgments of faces rely on a global/holistic processing style, the intuitive condition should elicit fewer fixations in total and the attention map of the intuitive group should conform to a global/holistic pattern of perception. That is, the fixation pattern should be more narrow/condensed and cluster around the centre of the stimulus (face), rather than conforming to a featural processing strategy, i.e. fixating predominantly the eyes and the mouth region. Conversely, we would expect the intuitive group to show the same pattern as the deliberate one (this being the classical pattern of face processing found in Caucasian individuals), if the intuitive processing of facial expressions does not rely on holistic perception mode.

A number of tasks have revealed two distinct viewing strategies between participants, despite the fact that all participants were instructed equally. In a judgment task of two concurrently presented faces, Armann and Bülthoff found that two sub-groups emerged in the judgment of femininity. While one sub-group of participants preferentially fixated the eye region, the second group fixated the centre of the face (here, the AOI of the nose) more and longer. Together with the verbal reports of the participants, they interpreted the group showing longer and more centralized fixations as a separate, more holistic strategy (Armann & Bülthoff, 2009). Interestingly, the participants themselves reported performing the task "intuitively" trying to gain an "overall impression". Using a face recognition task in Asian participants, Chuck and colleagues modelled participants' eye movement patterns using Hidden Markov Models (HMMs). By clustering the HMMs, participants' eye movements could be classified into either a holistic or analytic patterns. Interestingly, this study showed that the strategy difference lies not only in the location of the fixations, but also in the transitions between fixations (Chuk, Chan, & Hsiao, 2014). Here, a more condensed fixation pattern on the centre of the face was interpreted as 'holistic pattern' (as opposed to an analytical pattern, consisting of fixation areas on both eyes and the mouth).

We set out to further characterize intuition by directly investigating intuitive processing in a motivationally salient task known to engage intuition in everyday life. We studied the eye movements of two differentially instructed groups of participants, while these were engaged in the judgment of facial expressions. Based on previous research providing indications that intuition might be related to a global/holistic processing style, and that fixation strategies in face perception sometimes (but not always) rely on global rather than local information, we expected to find evidence for global processing in the intuitive, but not in the deliberate condition.

Methods

Participants and Instruction

Forty-three healthy, right-handed volunteers were included in this study (32 females; mean age: 25.87; 7 undisclosed gender & age) and compensated monetarily for their participation. Handedness was tested using the Edinburgh Handedness Survey. Eighteen participants were excluded from analysis, either due to technical difficulties during scanning or because post session questioning revealed a non-adherence to instruction, resulting in twenty-five participants in total (13 in the intuitive, 12 in the deliberate group). Informed consent was obtained from each participant prior to the experiment according to the Declaration of Helsinki (Version 2013). The local ethics committee of the University of Tuebingen approved the experimental standards. Data was handled anonymously. All participants were native German speakers, had no history of neuropsychiatric disorders, and were not currently taking psychoactive medications. Participants were pseudo-randomly assigned to two conditions: In the *intuitive* group, participants received the following instruction:

> "Your task is to judge the emotional expression you will see with regard to its authenticity (realness)...Previous studies have shown that people are good at judging the authenticity (realness) of a smiling or fearful expression if they follow their initial feeling, that is, answer spontaneously and without thinking for too long. We therefore ask you to make your judgment quickly, and most

> importantly, to follow your first feeling, thus deciding ‘based on your gut.’”

The term “intuition” was intentionally not used in the instruction in order to avoid bias effects. In contrast, the instruction for the *deliberate* group was as follows:

> “Your task is to judge the emotional expression you will see regarding its authenticity (realness)...Previous studies have shown that people are good at judging the authenticity (realness) of a smiling or fearful expression if they analyse and study the expression well, that is, think about their answer. Therefore, before you respond, study the expression thoroughly—within the given time! Most importantly, pay attention to the matching of the facial muscles in the eye and mouth regions.”

This instruction of strategy relies on a design that has been successfully used to investigate intuitive processing using fMRI methodology (Mega, Gigerenzer, & Volz, 2015) and is proposed as standard in the field (Horstmann, Hausmann, et al., 2009). Similar wording has also been used in other tasks probing face judgments (Rule, Ambady, & Hallett, 2009).

Stimuli

In the experimental session, participants were presented with 340 stimuli, showing either a happy or a fearful facial expression, while their eye movements were recorded. Stimuli were taken from the FACE database established by Ebner, Riediger, and Lindenberger (2010) and presented at 600 x 750 pixels image size on black background. Participants viewed the stimuli from 51cm distance, on a monitor with a screen resolution of 1920 x 1080 pixels.

Apparatus

Eye movements were recorded at a sampling rate of 220Hz with the Arrington ViewPoint Eyetracker, using a chin and forehead rest. Only the dominant eye was tracked (monocular tracking). The experiment was implemented in Matlab (2012b The MathWorks, Natick, MA, USA), using the Psychophysics Toolbox (PTB-3). Calibrations of eye fixations were conducted at the beginning of the experiment using a nine-point fixation procedure using ViewPoint software. Calibrations were then validated with the ViewPoint software and repeated when necessary until the optimal calibration criterion was reached.

Task Outline

The experiment consisted of 340 stimuli, showing either a happy or a fearful facial expression. Participants were tasked with indicating whether they perceived the facial expression to be authentic or not (yes/no response assignment was balanced across participants). 170 happy and 170 fearful facial expressions were presented, wherein gender and age group of the lay actors in the stimulus pictures ("young" [*M*=24.2 years, *SD*=3.4; range 19-31], "middle-aged" [*M*= 49.0 years, *SD*=3.9; range 39-55], and "57 years and older" [*M*=73.2 years, *SD*=2.8; range 69-80] as classified by Ebner, 2010) were balanced across conditions. Happy and fearful facial expressions were presented in blocks of ten, resulting in 34 blocks across the entire experiment. All trials lasted for 6 s: after a short fixation (variable duration), the neutral facial expression of the respective lay actor was shown for 1s, followed by the presentation of the emotional facial expression, which was either shown for a maximum of 2s, or for as long as participants took to make their choice (response-dependent abortion). For the remaining time of the trial, a fixation cross was presented. Finally, participants were debriefed and thanked.

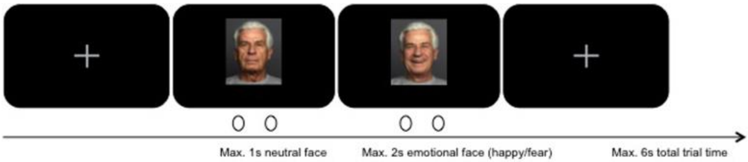

Figure 1

Data Processing and Analysis

Raw eye tracking data was processed by automatically detecting blinks, as well as dropped frames, and removing the resulting artefacts. A running average was used to interpolate data between the start and end points of the blink artefacts. Fixation events were classified using the I-DT algorithm as introduced by Salvucci and Goldberg (2000) with the modifications proposed by Blignaut (2009). Based on recommendations in the literature, the thresholds applied were 100ms (min. time) and 0,8° visual angle (dispersion). Dependent variables were number of fixations and fixation duration (throughout the stimulus space), as well as the data-driven, statistically established attention map (i.e. viewing pattern) of both groups separately and in comparison. Global eye-tracking measures (number of fixations and fixation duration) were calculated using IBM SPSS Version 22 (IBM Corporation and others, 2013). The statistical fixation maps were computed with the iMap toolbox (version 3, Caldara and Miellet, 2011), running on Matlab 2014b (The MathWorks, Natick, MA, USA). iMap establishes significance using a robust statistical approach correcting for multiple comparisons in the fixation map space. A one-tailed Pixel test (Chauvin et al.,2005) was applied for the group fixation maps ($p< 1,0$) and a two-tailed Pixel test ($p<0.05$) on the differential fixation maps. Finally, for each condition average Z-score values were extracted for each observer individually, within the regions showing significance in the differential fixation maps.

Manipulation Check

To assure that participants in the two groups did rely on the instructed strategy (intuitive/deliberate), we compared the response latencies for the two conditions. Indeed, participants in the intuitive group (M = 1.156 s) were significantly faster in judging the authenticity of facial expressions than participants in the deliberate condition (M = 1.528 s).

Results

Global Eye-Tracking Measures

Number of Fixations

A repeated measures ANOVA testing the number of fixations on the entire stimulus (including only those pixels wherein at least 8 fixation events occurred) revealed a significant difference between the intuitive and the deliberate group: $F(1,21) = 5.520$, $p = 0.028$ ($\alpha = 0.05$). The mean number of fixations per group on the stimulus was 5.135 (deliberate) and 3.596 (intuitive). Thus, overall, the intuitive group showed fewer fixations on the face stimuli than the deliberate group.

Fixation Duration

The analysis of fixation durations between the two groups revealed a tendency for longer fixations in the intuitive conditions, albeit this difference did not reach statistical significance: $F(1,21) = 3.553$, $p = 0.073$ ($\alpha = 0.05$). The mean fixation duration per group on the stimulus was 0.183s (deliberate) and 0.211s (intuitive). Neither the test for the effect of expression (i.e. happy or fearful), nor the interaction effect between expression and group revealed any significant differences in the fixation count or duration.

Pixel-wise statistical Analysis (iMap3)

We used the power of iMap3 as statistical mapping method for fixation data to represent and compare the distribution of the number and of the duration of the fixations on the face stimuli. We collapsed the fixation data from all face stimuli into one category, to compare and contrast overall viewing patterns, resulting in two fixation maps (fixation duration and number of fixations) for each individual. We then grouped the individual fixation maps by instruction to compute Z-scores on a pixel-by-pixel basis, resulting in Z-score statistical maps (Fig. 2 and Fig. 3) allowing for direct comparison of the two conditions. This data-driven method allows for direct comparisons of the differential viewing patterns (also referred to as attention map) between the two instruction groups, thus enabling us to go beyond the AOI approach.

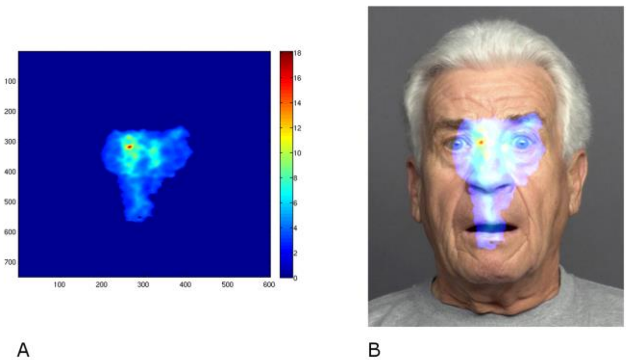

Figure 2

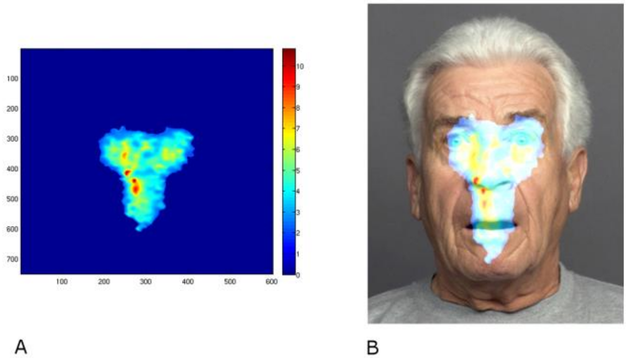

Figure 3

Attention Map

For the intuitive group, the viewing pattern as revealed by the iMap analysis is narrow and centralized in the stimulus space (Fig. 2 a & b). In contrast, the attention map of the deliberate group shows a much wider spread of attention over the entire stimulus space, with several areas of significant attention clustered in a dispersed pattern around the face (Figure 3).

Since fixation durations have been shown to be highly idiosyncratic and judgment strategy itself already is a highly individualized marker, we focus here on the more robust number of fixations to compare the two judgment conditions. The viewing patterns as revealed by fixation duration are analogous, however.

Additional Measures

For each condition we extracted the average descriptive values (i.e. number of fixation [Figure 4] and fixation duration [Figure 5]) for each observer individually, within the regions showing significance in the differential fixation maps.

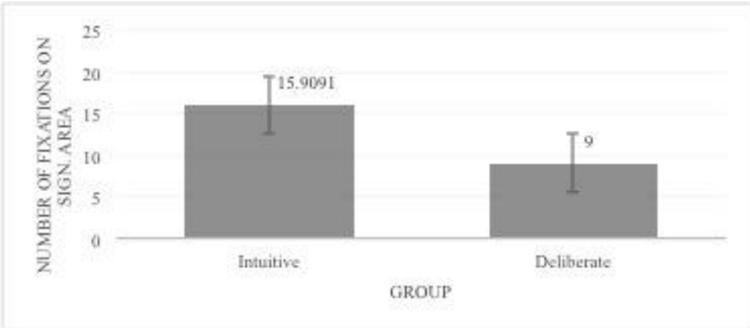

Figure 4

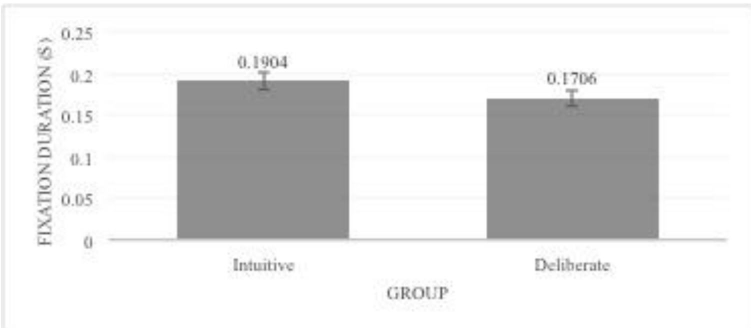

Figure 5

Discussion

We set out to further characterize intuition by directly investigating intuitive processing in a motivationally salient task. Intuitive processing is often related to processing the "gestalt" of an object rather than focusing on details (e.g. Epstein & Pacini, 1999; Shapiro & Spence, 1997). While a *local* processing style is related to a focus on details and concrete features, when in a *global* processing style, people make sense of a stimulus by integrating it into superordinate knowledge structures (K. a Dijkstra et al., 2013).

In this vein, several recent studies have suggested that people may in some cases use a global/holistic strategy to process the information present in faces rather than relying on detailed features. To our knowledge the question whether using one's intuition to judge facial expressions maps onto a global viewing strategy has not been directly probed. To this end, we set out to study the eye movement patterns of two differently instructed groups of participants:

- An “intuitive group”, whom we instructed to judge the authenticity of facial expressions by relying on their “gut feeling” and “answering spontaneously”.
- A “deliberative group”, whom we instructed to judge the authenticity of (the same) facial expressions after careful thought and focusing especially on the eye and mouth region.

The viewing pattern of the intuitive group is distinct from the deliberate one, confirming the elicitation of a difference in strategy by direct instruction (see (see Horstmann et al., 2009 for recommendations on using direct instructions when investigating intuition). In addition to confirming our manipulation, the fixation pattern conforms to theory-based expectations, which suggest the use of a global information search strategy in intuitive processing. The following arguments shall clarify this conclusion in detail.

Centralized attention map in intuitive condition

The attention map revealed by the data-driven iMap analysis provides validation for the finding of global/holistic processing in the intuitive condition. The attention map of the intuitive group is centralized within the face-stimulus space, with the highest number of fixations (i.e. the area of greatest attention) localized around the area of the face midline (between the eyebrows, nose and mouth). The deliberate condition, on the other hand, conforms to the instructed viewing strategy, landing on both the eyes and the mouth region and generally more spread out across the stimulus-space. This pattern constitutes the average pattern of face perception, reliably found for young Caucasian individuals viewing static face stimuli in eye-tracking studies (e.g. Saether et al., 2009). Furthermore, several face perception studies, which did not directly instruct differential viewing modes, nevertheless found separable viewing patterns interpreted to be differential viewing strategies (cp. Armann & Bülthoff, 2009; Chuk, Chan, & Hsiao, 2014).

Reliability of data by the use of data-driven approach with iMap3.

Areas (or regions) of interest in eye tracking studies are often defined manually by the investigator and thereby what is termed as the “nose” in one study might well correspond to the area defined as “left eye” in another. For example, Barton et al. (2006) defined the mouth region as irregularly shaped region of interest around the mouth, whereas (2005) included part of the cheek in their definition of the “mouth” region of interest. Thus, eye movements of participants to the cheek would be defined as landing on the “mouth” in one study, but not in the other[21]. To avoid this confusion and lack of generalizability, we used a data-driven approach based on pixel-wise statistical comparisons with multiple comparison correction (iMap, Version 3, Caldara & Miellet, 2011). This approach allows for robust direct comparisons of the differential scanning patterns between conditions. The imap3 analysis revealed areas of significant difference between the two conditions in the amount of fixations, located in the centre of the stimulus space. In other words, the centre of the face was fixated significantly more often in the intuitive condition, than in the deliberate one. The distribution of fixations in the deliberate condition was more distinctly localized on the eye, nose and mouth region of the stimulus faces. Thus,

[21] see the Eye Data Quality Standardization Project [http://www.cogain.org/info/eye-data-quality] of the COGAIN Network of Excellence for an attempt at unifying method-wide standards of measure

this condition shows less fixations landing on the centre on the face than the intuitive one. We take these findings as further evidence in support of the hypothesis that intuitively judging faces relies on global/holistic face processing.

Significantly fewer, but relatively longer fixations in the intuitive condition

The finding of fewer fixations for the intuitive as opposed to the deliberate condition is in line with previous findings investigating intuitive and deliberate judgment processes using eye-tracking, albeit in a lexical task (Horstmann, Ahlgrimm, & Glöckner, 2009). However, it is imperative to not interpret the number of fixations and fixation duration should not be interpreted in isolation of the fixation locations (viewing pattern). The (average) three fixations of the intuitive group could have also landed only on the eye region (cp. Armann & Bülthoff, 2009), or the eyes and mouth. If it was simply the difference in judgment speed that underlies the viewing differences between the two groups, that pattern would be expected. Instead, the few fixations required for the intuitive group to make their judgments fell in a centralized location of the stimulus faces, in accordance with our theoretical predictions. Intuitive face judgments seem to rely on “focusing on the forest rather than the trees”, or in this case, forming a holistic gestalt-like impression of the face rather than focusing on specific local featural cues (such as eyes, mouth or nose). Making few (but relatively long) fixations in a centralized location of the face can give a general impression of the facial expression.

Intuitive face judgment uses global viewing pattern

When investigating face perception mechanisms of Western-Caucasians, as well as participants of a ‘young’ age group (i.e. around the mean age of the participants in this study, i.e. 25.87), the viewing pattern typically found is a feature-based one. That is, young Westerners usually seem to rely more on local information in the face (mostly the eye and mouth region) especially when compared with the viewing pattern of Asian participants (cp. Kelly, Miellet, & Caldara, 2010 and Sébastien Miellet, Vizioli, He, Zhou, & Caldara, 2013 for an overview of the effects of culture on eye movement strategies). Since the present study was conducted solely with participants of a Western-Caucasian cultural background, one could expect a local, feature-based processing strategy (focusing on eye- and mouth region) for both instruction groups. Therefore, we take the differential markers for holistic/global processing revealed in the intuitive condition (fewer overall fixations, centrally located in the face) to be a specific function of the instructed judgment condition. Seeing as global viewing strategies of faces have been demonstrated reliably as an East Asian viewing pattern, the present investigation raises the question whether East Asians might rely more on their intuition to view faces than people of a different cultural background. This question, however, is beyond the purview of the present study and will need to be investigated more in the future.

Questions for further research:

From research on eye movement patterns in reading, a quite well documented effect is the extrafoveal sampling of information in the stimulus. Recently, Millet and colleagues (2012; 2013) showed that the sampling of extrafoveal information also plays a role in face recognition. Therefore, finding a centralized fixation pattern may point towards the sampling of the other cues in the face extrafoveally. Since we did not directly investigate this matter, we can only speculate on the involvement of extrafoveal sampling in the present study. We believe, however, that extracting extrafoveal information does not speak against intuitive processing being a distinguishable viewing pattern. Rather, sampling of information that is not directly fixated conforms to the characterization of intuition, describing it as a process whereby information is sampled but does not reach consciousness (Bowers, Regehr, Balthazard, & Parker, 1990; Horr, Braun, & Volz, 2014; Mega et al., 2015b). Further investigations are needed to shed light on the role of extrafoveal information sampling for intuitive face judgments.

Differential viewing strategies are also discussed as a function of task demands and individual differences. Within the community studying intuition, individual differences have long been recognized as an important factor. Since the characteristics demarcating intuition (automatic processes relying on a tacit knowledge base that reaches consciousness through some form of metacognitive experience (e.g. fluency), thereby leading the decision-maker to her judgment) are heavily based on internal representations, it is not surprising that individual difference effects should arise/play a role. Furthermore, Millet et al. argue for task-induced differences, a logic which we very much agree with (see Introduction).

Since we believe the centralized location of the area of significant viewing difference between the two conditions to be a function of global processing, we do not make inferences as to the role of this specific facial region for the differences in face judgments. We would like to refrain from speculation about the role of the fixated regions, especially because no reliable community-standard of measurement and location yet exists for eye tracking studies (as opposed to fMRI studies, for example, which make use of anatomical atlases such as the Talairach Atlas [Talairach & Tournoux, 1988]). However, the gaze contingent expanding spotlight method has recently been introduced as a means to assess the visual processing of peripheral versus central retinal inputs (Miellet et al., 2013). We hope that in the future this method may provide insight into understanding not only which locations in the face are fixated but also which of the fixated information reaches consciousness.

Limitations of this study

The high amount of drop-out we experienced is clearly a limitation. While the results of the present work should therefore be interpreted conservatively, they are in line with theoretical predictions for intuitive face judgments and present a further case for the global/holistic nature of intuitive processes.

What does this mean for the study of intuitive processing?

To our knowledge, these results constitute one of very few studies that directly investigate intuitive judgment processes in the context of a socially relevant task. Intuitive processes rely on a (tacit) knowledge base acquired throughout one's lifetime. Being surrounded by faces and the need to quickly glean meaning from facial categories and expressions all of our lives, it is unsurprising that having a global impression of a facial expression might well be enough to elicit a "gut feeling" of the message we interpret a face to be sending. Only those having undergone explicit training in subtle expression detection or micro expression detection (Ekman, 2006) consciously can retrieve the knowledge about which muscle interplay leads to what expression (though there seem to be some naturals, see O'Sullivan & Ekman, 2005). Nevertheless, as humans we are able to move through social spaces and have natural conversations with each other, relying on our intuition to interpret others' facial expressions for successful social interactions.

Conclusion:

In the present work, we have shown that participants who are asked to listen to their gut feeling and decide spontaneously if they judge the facial expression they are presented with as authentic, reveal markers of global/holistic processing. These are a pattern of attention localized in the centre of the face, as well as a significantly lower number of fixations as compared to the deliberate condition. This, to our knowledge, constitutes one of the first studies linking intuition and holistic processing in a socially, and thereby motivationally salient task. Of course, further studies using different ways of operationalizing intuition as well as different task-types are necessary to validate our findings. Nevertheless, we show that the study of eye movement patterns using social stimuli is fruitful in the endeavour to elucidate the operating characteristics of intuition.

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Figure Captions:

- Figure 1: Overview of trial design using exemplary stimulus from the FACES database kindly provided by Ebner et al (2010).
- Figure 2: Pixel-wise statistical map showing the number of fixations in the stimulus space of the intuitive group as revealed by the imap3 analysis. Panel (A) shows the statistical pattern of distribution of fixations. The colours of the map correspond to fixation counts on that particular area (see colour scale on the right). Panel (B) shows the same pattern mapped onto an example stimulus. A one-tailed Pixel test (Chauvin et al.,2005) was applied for the group fixation map (p< 1,0). Finally, for each condition average Z-score values were extracted for each observer individually, within the regions showing significance in the differential fixation maps.

- Figure 3: Pixel-wise statistical map showing the number of fixations in the stimulus space of the deliberate group as revealed by the imap3 analysis. Panel (A) shows the statistical pattern of distribution of fixations. The colours of the map correspond to fixation counts on that particular area (see colour scale on the right). Panel (B) shows the same pattern mapped onto an example stimulus. A one-tailed Pixel test (Chauvin et al.,2005) was applied for the group fixation maps ($p< 1,0$). Finally, for each condition average Z-score values were extracted for each observer individually, within the regions showing significance in the differential fixation maps.
- Figure 4: Average number of fixations on the significant area. Error bars indicate standard error.
- Figure 5: Average duration of fixations on the significant area. Error bars indicate standard error.

Chapter IV.3

Reliance on intuition depends on context and (life) experience

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When it comes to the perception of a person, deviations from the (stereotypical) norm can have dire consequences. Simply put, whether I am perceived as a woman, or a man, or perhaps not easily placed into a binary gendered category has immediate and far reaching consequences, such as societal inclusion/exclusion, but also access to economic wealth, health care and personal safety, to name just a few. Similar stereotypic effects take place in the perception of sexual diversity. As stated in a recent critical discourse analysis of ‘gaydar’ research: “Reducing people to a stereotype based on appearance negates their personhood as being more than their sexual orientation” (Heitner et al., 2015). Examples of these implications with respect to gender identity and sexual orientation abound in the contemporary social landscape.

In an emergency session held on March 23rd 2016, the state of North Carolina passed a bill which restricts a person's access to "single-sex public restrooms" to those that conform to the sex as "stated on a person's birth certificate". This law effectively discriminates against individuals whose gender expression (i.e. the outward expression of their gender identity) does not match the 'sex' category on their birth certificate. Moreover, since most people do not carry their birth certificates around with them on a regular basis, individuals who do not conform to stereotypical forms of gender expression are thus barred from entering those public restrooms that conform to their gender identity. Plainly said, a person who is perceived as male cannot enter a female restroom, even if said person identifies as female. The importance of this matter is underscored by a recent analysis conducted by the Williams Institute and published in June 2016 (Flores et al., 2016), which found that about 1.4 million adults in the United States identify as transgender – a number that is twice as large as previously estimated. As Kath Woodward succinctly put it: “While there is increasing acceptance, at least in some parts of the world, about the right to adopt the sexual orientation which feels appropriate and possibly natural, the freedom to identify with either sex is more troubling in that sex is embedded in systems of governance; it is usually the second box you have to fill in on official forms after your name” (Woodward, 2016).

Research on person perception has uncovered valuable insights into areas such as impression formation and the effect of stereotypes both in how people are perceived and how people (unconsciously) alter their behavior due to the knowledge that they are being perceived (Allport, 1954; Brewer, 1988; Uleman, 1999; Fiske et al., 1999; see Schiller et al., 2009 for a discussion of the neural basis of impression formation).

Still, the basic perceptual and cognitive processes which contribute to the formation of judgments and impressions warrant closer attention. Therefore, with the present work we seek to elucidate differences in perceptual processes between heterosexual and queer individuals when categorizing the gender identity and sexual orientation of target faces. The relationship between visual perception and the social/cultural practices these visual processes are trained on is dynamic and bi-directional. We know today that person perception (face perception being a subset of this) is an intuitive process. That is, perceiving category and trait characteristics of others happens automatically, without much conscious thought or effort and accompanied by some (metacognitive) ‘gut feeling’ (Ambady, 2010; Rule and Ambady, 2008; Willis and Todorov, 2006). However, we also know that intuition is trained on variables learned throughout one’s lifetime (Betsch, 2008b; Hogarth, 2001; Hodgkinson et al., 2008). This is often termed a ‘tacit’ knowledge base, i.e. knowledge that drives behavior but is not consciously accessible (Bowers et al., 1990). Taken together with findings on the malleability of social judgments (Johnson et al., 2015; Blair, 2002), this means that while the perceptual mechanisms underlying the categorization and judgment of others may appear to be somewhat inevitable because of their automatic and implicit occurrence, there is actually much work to be done by individual members of society and policy makers alike to influence the formation of the knowledge base on which intuition relies. In fact, knowing that impression formation relies heavily on perceptual experience, and perceiver preferences are geared towards prototypical category exemplars (Lick and Johnson, 2014) underscores the importance of ensuring a diversity in potential perceptual experience to combat detrimental effects such as prejudice formation.

Furthermore, elucidating ways in which harmful social practices such as prejudice and discrimination can be combatted requires us to not only ask the question how (do we perceive others), but also what motivates us to perceive them in the way we do. We do not make inferences about other people based on their face because we are at the mercy of our intuitive perceptual processes, but because intuitive face perception functions as a tool for adaptive behavior. We want to quickly glean information from another person's face because we have intrinsic goals and motivations, such as finding a mate or knowing who poses a threat to our personal safety (or our privileged space in society). This complex interplay between perceiver characteristics and the perceived stimulus is outlined in detail in the ecological theory of face perception (Zebrowitz-McArthur and Baron, 1983; Zebrowitz et al., 2011), which will be explained in more detail below.

How a person's sex/gender is perceived by others is an issue that has also kept the International Olympic Committee busy for a number of years now. When Caster Semenya finished the 2009 World Championship final 8oo meter race well before her competition at 1:55.45 seconds, voices calling her sex-gender into question were soon raised high. What followed was her suspension from competition by the International Association of Athletics Federations (IAAF) and the administration of 'sex testing' by both IAAF and IOC. Amid a flurry of speculations and accusations, Semenya retreated into hiding to escape public scrutiny and humiliation (Karkazis et al., 2012). Gender verification tests in sport constitute the attempt to establish some “scientific, incontrovertible truth about sex” (Woodward and Woodward, 2009). Alongside issues of transgender and intersex persons’ rights, stereotypical cultural notions of 'masculinity' and 'femininity' have a firm hold on personal lives and come entangled with issues of social hierarchy, power and history, to name just a few. Feminist discourse continues to outline the entanglements of sex/gender differences in behavior and biology in detail (e.g. Fine, 2012; Joel and Fausto-sterling, 2016; Springer et al., 2012; Jordan-Young and Rumiati, 2012) such that addressing all of the different angles and tensions would go beyond the scope of this article.

Researchers have been called upon to examine “how perceptions may change as a function of exposure and attitudes towards sexual minorities” (see Brambilla et al., 2013) and with this first study we would like to begin our contribution to answering that call, in a critically reflected and non-essentialist manner. Thus, our aim with this study was two-fold. We set out to study the following two research questions:

1) Does sexual orientation predict the reliance on gender-typicality to categorize the gender identity and sexual attraction of faces?
2) Do individuals who self-identify as heterosexual differ from queer individuals in the cognitive processing strategy employed to judge the gender and sexual identity of others?

Faces are among the most important social signals for primates (Atkinson and Adolphs, 2011). It is therefore rather unsurprising that we humans (along with several non-human animals) have developed dedicated neural systems – starting with specialized neural cells and including processing pathways – preferentially forged for faces as stimulus/input (Kanwisher and Yovel, 2006; Kanwisher et al., 1997). Dominant models of face perception trace their origins back to Bruce and Young (1986), who first proposed a dual process distinction between extracting category and identity information (early processing) and expressive information (later in the process model) from faces. This framework has since been adapted and expanded, and garnered considerable support from both cognitive and neurological data (Fusar-Poli et al., 2009; Haxby et al., 2002, 2000).

Recently, attempts have been made to include an ecological perspective into the study of face processing, drawing on a Gibsonian approach to perception (Gibson, 1979) by including the idea of social affordances[22]. Zebrowitz and colleagues draw on both the classical work of the dual process model as well as the face space approach (Leopold et al., 2001; Valentine et al., 2014), which holds that "the information provided by faces is coded relative to an average face on a mental face-space" (Zebrowitz-

[22] Opportunities for acting or being acted upon that are provided by other people

McArthur and Baron, 1983; Zebrowitz et al., 2011). In proposing the ecological theory of face perception, the dual process and face space models are joined with the Gibsonian idea of social affordances to draw attention to the function of face perception. *"We can expect different social interactions with people who have different identities, show different facial expressions, or look toward or away from us. Other attributes revealed in the face include familiarity, age, and attractiveness, and each is also associated with the perception of behavioral affordances"* (Zebrowitz et al., 2011). Keeping the ecological lens to look at the question of categorization, a framework emerges in which the person perception system is attuned to stimulus properties which afford it the best possible opportunities to guide goal attainment of the perceiver. With regards to gender identity and sexual orientation judgments, the attuned-to properties might include (but are not limited to) social threat (coming out as queer to a heterosexual person can pose threatening consequences ranging from ostracism to the death penalty, depending on cultural background and social situation), mating choice, and economic opportunity. The ecological approach thus assumes an interplay between stimulus and perceiver through (social) behavioral affordances, i.e. opportunities for goal-directed action, and perceiver attunements. Anchored in this ecological framework and the knowledge that face categorization is most often intuitive and perceivers rely on overall impressions of the compatibility of sex and gender cues to determine the sexual orientation of others (Freeman et al., 2012; Johnson et al., 2015; Rule et al., 2008) we propose the following two hypotheses:

- H1: Because of differences in perceiver attunement (e.g. visual exposure, implicit attitudes, and personal motivation) we predict that heterosexual individuals rely on an intuitive processing style to judge the sexual orientation of faces.

- H2: Because of differences in perceiver attunement (e.g. visual exposure, implicit attitudes, and personal motivation) we predict that individuals identifying as heterosexual rely more on gender typicality cues than individuals identifying as queer.

Before delineating the research design of the present work in further detail, a closer look at vocabulary seems necessary to avoid confusion. Firstly, the terms “sex” and “gender” are often understood as a base/superstructure model, where sex represents the material body and gender the social or cultural inscription thereof (Hood- Williams, 1996; Kirby, 1991). However, “sex is not a pure bodily and material fact, but is deeply interwoven with social and cultural constructions of gender” ((Kaiser et al., 2009), p.50). That is, gendered life experiences become embodied. To draw attention towards this entanglement of the social and biological (Springer et al., 2012; Dussuage & Kaiser,

2012) and step away from the notion of "sex" and "gender" as instantiated by two separate and opposing "natural kinds" (i.e. male/female, masculine/feminie; Rippon et al., 2014), we follow Kaiser et al. (2009) in using the term *sex/gender*.

Furthermore, in the context of our study, we use the term "queer" to refer to individuals who identified (marking 4 or above) as being sexually attracted to persons within their same gender identity category (whether exclusively, or in conjunction with marking 4 or above in another category), or the category 'other genders' (4 or above). The word "queer" was historically reclaimed by lesbians, gays, bisexuals and transgender persons to subvert its derogatory meaning (Jagose 2001, 97). However, as Hofstätter (2008) points out in her introduction to Queer Science and Technology Studies: "the term has not automatically become neutral: Its meaning depends on the respective context and on the attitude of the person using it." It is also worth making the disclaimer, that the results presented in the present work and the interpretations thereof are based on the study of Caucasian-European individuals who were asked to judge Caucasian-European faces. The results are therefore limited in their scope to the Caucasian-European cultural space, wherein sex/gender and sexuality are conceptualized differently than in other cultural contexts. A broadening of the scope to include different cultural and ethnic contexts would have been challenging insofar, as not only concepts of sex/gender and sexuality differ among cultures (Connell, 2012; Schippers, 2007; Fausto-Sterling, 2000), but also eye-movement patterns are differentially influenced by cultural upbringing (Caldara et al., 2016). These confounding factors would therefore have introduced added layers of complexity, thereby limiting the realm of interpretation of the study's results.

II. Research Design

II.1 Participants and Instruction

Twenty-nine healthy, right-handed volunteers were included in this study and compensated monetarily for their participation. Three participants were excluded from analysis, either due to technical difficulties during scanning or because post session questioning revealed a non-adherence to instruction, resulting in 26 participants in total. Informed consent was obtained from each participant prior to the experiment according to the Declaration of Helsinki (Version 2013). The local ethics committee of the University of Tuebingen approved the experimental standards. Data was handled anonymously. All participants were native German speakers, had no history of neuropsychiatric disorders, and were not currently taking psychoactive medications.

II.1 Self-Assessment of participants

One of the methodological criticisms raised by critical feminist scholars is that biases about a person's gender identity and sexual orientation exist not only as area of scientific inquiry, but also *within* science itself (see e.g. AG Queer STS, 2013; Kaiser & Dussauge, 2015). More specifically, as scientists we are not immune to (implicit) biases and as such should strive to critically reflect on the way our own positions and values may influence our research. Following from this, we decided to create a self-assessment by which participants were asked to indicate their gender identity and sexual attraction towards others on multiple scales, allowing for a mosaic of gender and sexuality categories, as has been shown for the biological and behavioral determinants of gender (Joel et al., 2015). We thereby attempted to allow persons to report their gender and sexual identity without being restricted to the male/female binary used as standard on most psychological surveys.

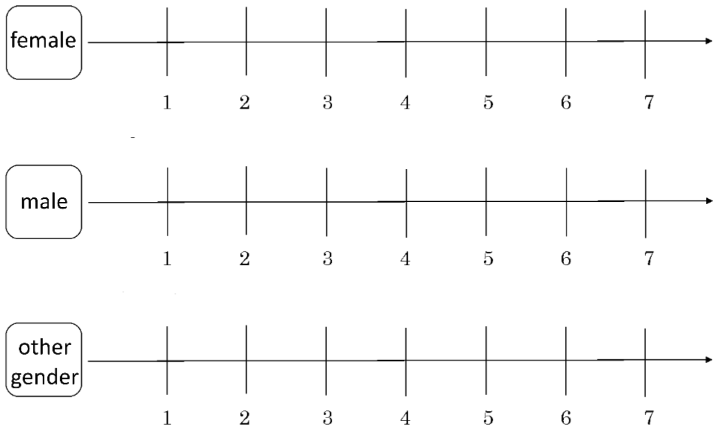

Figure 1: Scales for self-identification of gender identity of the participants.
The scales were modeled after recommendations of the Trans Student Equality Resources (TSER; http://www.transstudent.org/gender). We used the term "queer" to refer to those individuals who marked themselves as sexually attracted within their same gender identity category (choosing 4 or above), or in conjunction with marking 4 or above in another category, or marking their attraction as 4 or above

on the 'other gender(s)' scale.[23] *Sexual attraction scales were identical, with the preceding question: "Which gender(s) do you feel sexually attracted to?"*

II.2 Task Outline

The experiment was divided into two tasks, both of which were performed directly after each other.

Gender:

Participants were asked to judge the gender identity of the displayed face (Response options: (1) female, (2) male, or

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[23] While we realize that by grouping participants in this manner we are re-introducing a kind of classification or categorization that the self-assessment was designed to avoid, with a study design as complex as the present one, data analysis would have been impeded tremendously if this categorization had not been performed. We do hope, however, that by giving participants many more degrees of freedom than is standard in psychological studies and basing our classification on participants' answers, to have moved at least one step closer to capturing 'real life'.

(3) other gender). After completing each gender identity judgment, participants indicated how confident they were in their answer, on a scale from one (low confidence) to 7 (high confidence). This confidence rating is a standard test of metacognitive judgment, which is implicated in intuitive processing. Specifically, metacognitive evaluations such as the 'feeling of rightness' have been shown to act as a kind of monitoring mechanisms, arising as the output of an intuitive judgment to determine whether further analytical reasoning is engaged (Thompson et al., 2011).

Sexual Attraction:

Participants were asked to judge what gender they perceived the displayed face to be sexually attracted to (Response options: (1) female, (2) male, or (3) other gender). Following each judgment, participants indicated how confident they were in their answer, on a scale from one (low confidence) to 7 (high confidence).

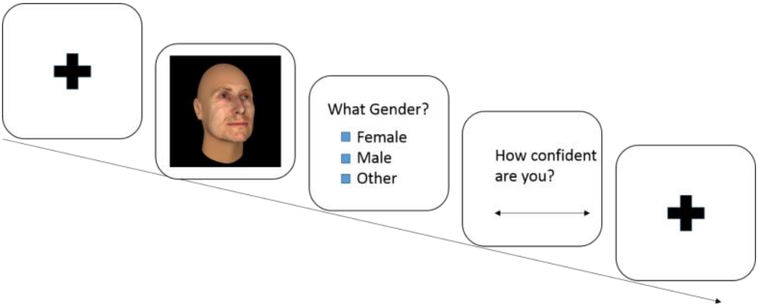

Figure 2: Exemplary overview of task outline (here: gender identity task).

II.3 Stimuli:

The stimuli, created using FaceGen 3.5 (Singular Inversion Inc.), were broadly divided into two categories, separable by cues which are stereotypically assigned the labels ‘masculine’ or ‘feminine’, in Western-European contexts. We chose eight detail textures pre-defined by the program. Four of these contained what could be considered as lipstick and painted eye-lashes (subsequently termed category *“Lips & Lashes”*), the other four featured a combination of bushy eyebrows and/or noticeable facial hair (beard, stubble, or mustache; hereafter termed category *"Beard & Brows"*). For each texture, we used the random face generator provided in FaceGen to create six different face identities per texture (achieving 24 identities per category)[24]. All 48 identities were subsequently morphed (shape and texture) in four steps ranging from 'very female' and 'female' to 'male' and 'very male', using the pre-defined gender-morph options provided by the software. These phenotypic features are based on parameters observed in several hundred three-dimensional face scans of the human population (Blanz and Vetter, 1999). We thereby created 192 individual stimuli, differing in the

[24] The race morphing option of FaceGen was locked to 'European Racial Origins', since the participants of the present study were exclusively of European and gender/sexuality categorization as well as viewing patterns of faces show cultural variation and culturally diverse faces would therefore have introduced a confound.

stereotypically gendered facial features ("Lips & Lashes"/ "Brows & Beard") and morphed along a continuum from very female to very male.

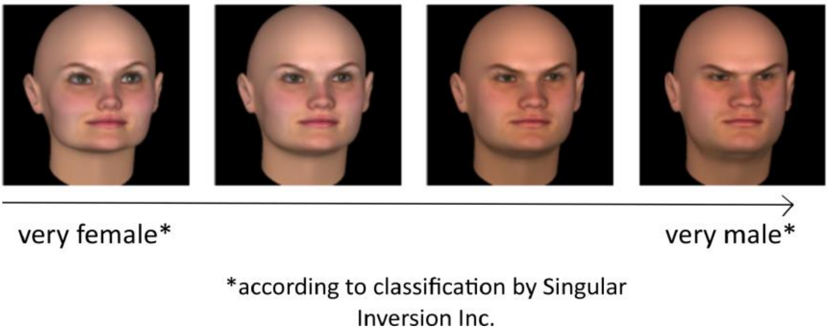

Figure 3: Example face identity in category "Lips & Lashes", along the morph-level continuum: 'very female', 'female', 'male', 'very male'.

We chose to keep the faces without hairstyle to facilitate an intuitive judgment mode via the stimulus material. Previous research has shown that the process by which social category information is extracted depends in part on the presence of obvious cues (such as hairstyle for sex/gender judgments), such that if participants cannot rely on obvious cues an intuitive judgment mode is preferred (Rule et al., 2008).

While the use of computer-generated faces may seem an odd choice, it allowed us to systematically alter and control various facial features and thereby allow for more accurate interpretation of cue-directed eye movements and participant judgments. Furthermore, the perceptual mechanisms underlying gender-related judgments have successfully been tested using a stimulus set modeled on FaceGen (Lick and Johnson, 2014).

II. 4 Procedure

Participants first filled out the self-assessment sheets mentioned in the previous section. Upon completion, they were given written instructions for the task and allowed ample time for reading and asking clarifying questions (for detailed instructions, see supplementary information). The experimenter then asked participants to repeat the instructions in their own words, to ensure that everything had been understood. Subsequently, participants were led into the behavioral room in which the study was conducted. Individuals were seated in front of a screen (17’ TFT), on which the stimuli and task were presented. First, a five-point calibration routine was shown to participants, in order to calibrate the eye-tracker to the individual. Afterwards, participants familiarized themselves with the design of the task in three test trials and were given time to ask any final questions. Finally, participants began the study by pressing a button, starting with either the gender or the sexual orientation task. All instructions were shown on the computer screen, allowing participants upon completion of the first task to proceed to the second one on their own.

II. 5 Aparatus

Stimuli were presented and eye movements recorded at a sampling rate of 60Hz with the Tobii T60 Eyetracker (Tobii

Technologies), using binocular tracking. The experiment was implemented in Matlab (2012b The MathWorks, Natick, MA, USA), using the Psychophysics Toolbox (PTB-3). Calibrations of eye fixations were conducted at the beginning of the experiment using a five-point fixation procedure provided in the software development kit. Calibrations were then validated with a customized Matlab script (Tobii Calibration Psychtoolbox) kindly provided by Brian Sullivan[25].

II. 6 Data Processing and Analysis

Behavioral data was analysed using the Statistical toolbox running on Matlab 2014b (The MathWorks, Natick, MA, USA) as well as SPSS Version 23 (IBM). Eyetracking data was analysed using the iMap toolbox (version 4, Caldara

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[25] freely available online: https://visionresearchblog.wordpress.com/2014/10/31/masterclass-follow-up/

and Miellet, 2011), running on Matlab 2014b. Eye movement data was filtered for fixations using a velocity threshold of 30ms (REF: I-VT). The resulting single trial fixation map was convoluted with a 2D gaussian kernel function (FWHM at 1° visual angle) to account for spatial offset of the eye movement recordings. Spatial normalization was performed by Z-scoring the fixation map across all pixels independently for each trial. We then applied a full model on the single trial fixation duration map:

PixelIntensity ~ Participant Sexual Orientation + Task + Stimulus Category + Morph + (1| subject)

The model was subsequently fitted with maximum likelihood estimation, entering subject as random effect. After model fitting, we performed an ANOVA to test main effects and interactions. A bootstrap test using 1000 resamples with cluster density as criterion was performed to account for multiple comparisons.

II. 7 Post-Session Questionnaire

After the two tasks were completed, participants filled out a questionnaire detailing their judgment strategy, as well as answering specific questions about where they focused first and which features they perceived as being most important for their judgment choice (see suppl. information).

III. Results

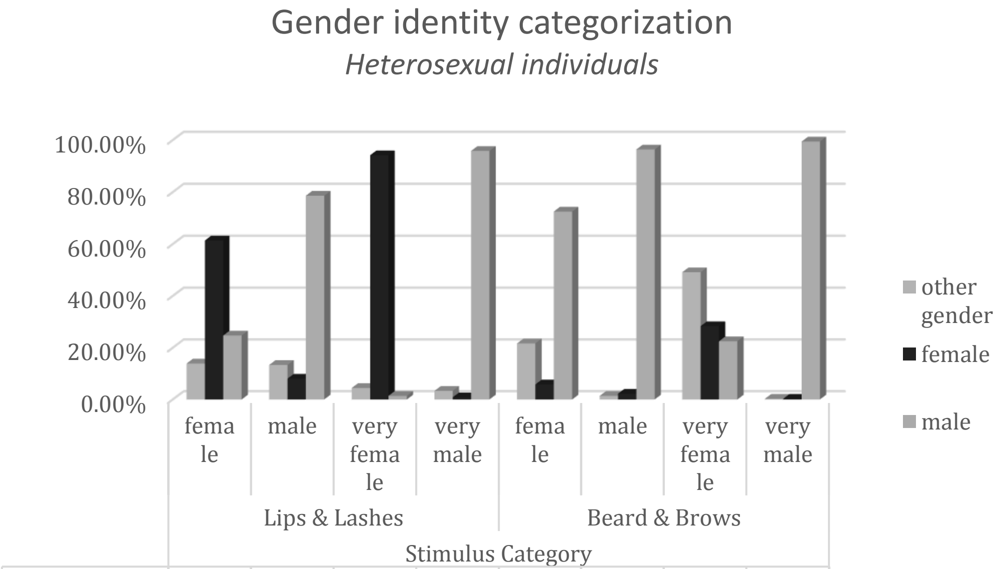
III.1 Behavioral

Two independent general linear mixed model analyses were conducted, modelling the effects of task, group, stimulus category and morph-level on the target judgments of (1) male and (2) female on a trial-by-trial basis. Subject was entered into analysis as random variable. Participant sexual orientation did not have a significant effect on male or female response option for the judgment of gender identity (see table 1 below). However, judgments of sexual attraction did differ significantly between the two groups, for both 'male' and 'female' responses. These differences will be revealed in more detail in the following (section III.1.2).

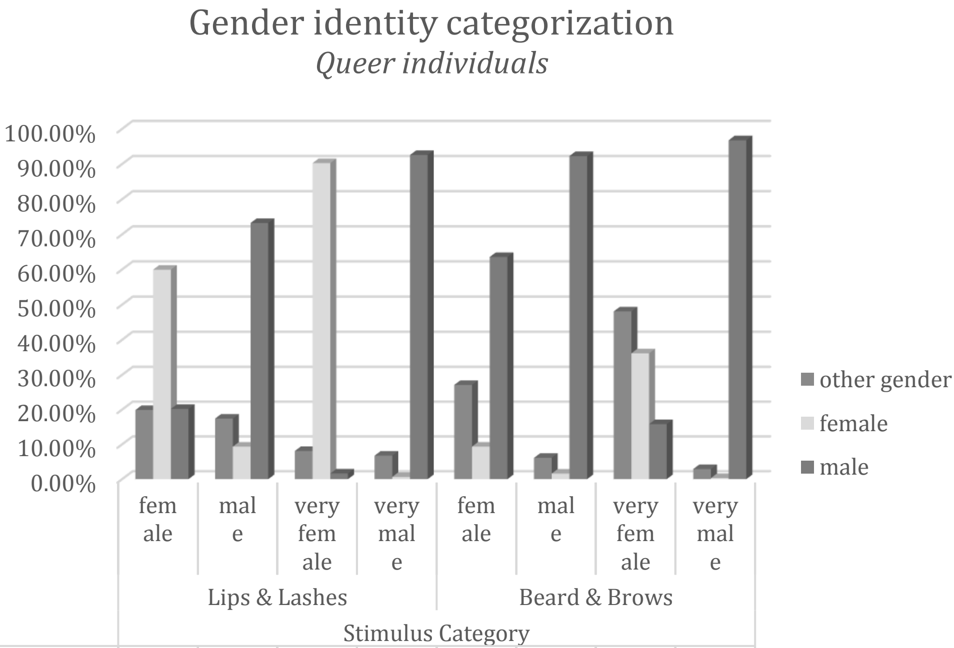
Table 1: Highest significant interactions of the model coefficients in the GLMM analyses

Response Option	Task	Coefficient	F-stat	p-Value
female	Gender ID judgment	Group:Morph	5.061	0.002
male	Gender ID judgment	Group:Category	10.352	0.001
		Group:Morph	2.640	0.048
female	Sexual attraction judgment	Group:Category :Morph	7.165	0.001
		Group	5.338	0.0209
male	Sexual attraction judgment	Group:Base: Morph	2.777	0.040
		Group	3.892	0.049

III.1.1 Gender Identity Judgments



	female	male	very female	very male	female	male	very female	very male
other gender	13.89%	13.33%	4.44%	3.33%	21.67%	1.39%	49.17%	0.28%
female	61.39%	8.06%	94.17%	0.83%	5.83%	2.22%	28.33%	0.28%
male	24.72%	78.61%	1.39%	95.83%	72.50%	96.39%	22.50%	99.44%



other gender	19.87	17.42	8.12%	6.77%	27.10	6.13%	48.06	2.92%
female	59.94	9.35%	90.26	0.65%	9.35%	1.61%	36.13	0.32%
male	20.19	73.23	1.62%	92.58	63.55	92.26	15.81	96.75

III.1.1.1 Categorization trends across groups:

Category "Lips & Lashes":

Morph levels 'female' and 'very female' were categorized as female by both groups, whereas morph levels 'male' and 'very male' were categorized as male.

Category "Beard & Brows":

All morph levels except for 'very female' were categorized as male by both groups, with slightly more variations in categorizations by queer participants. The morph level 'very female' shows the highest variation of all categories independent of participant sexual orientation, and is the only stimulus category to be categorized most often as 'other gender'.

III.1.1.2 Categorization trends across stimulus categories:

Comparing morph levels across stimulus categories, we can see that the addition of facial hair significantly changes the gender identity judgment for both heterosexual and queer participants. The morph level ‘female’ is most often judged as male by both groups (hetero: 72.50%; queer: 63.55%), followed by other gender. This stands in contrast to the judgment of morph level ‘female’ in the “*Lips & Lashes*” category (that is, without facial hair and with the addition of eye and lip make-up), for which the judgments are predominantly female (hetero: 61.39%; queer: 59.94%).

Overall, the judgments of gender identity closely resembled the morph-level of the stimuli, when in accordance with the secondary cues (such as facial hair). In those categories, where dissonance was created between secondary cues (e.g. facial hair, ‘painted’ lashes) and morph level (such as faces from category B, morph-level f), judgments followed the secondary cues rather than morph level (i.e. faces in above mentioned category were judged as “male” in more than 60% of cases).

III.1.1.3 Explicit confidence judgments

The explicit confidence judgments arguably represent data points on an ordinal scale. We therefore conducted an independent-sample Mann-Whitney U test to compare the mean confidence judgments of both groups. On a single trial level, we found significant differences in mean confidence between individuals identifying as queer and those identifying as heterosexual (Standardized U =3.246, p = 0.001). However, aggregated by overall mean confidence judgment per participant, the Mann Whitney U test did not reveal significant differences between queer and heterosexual individuals (Standardized U = 0.763, p = 0.763). Tests were adjusted for multiple comparisons using Bonferroni correction.

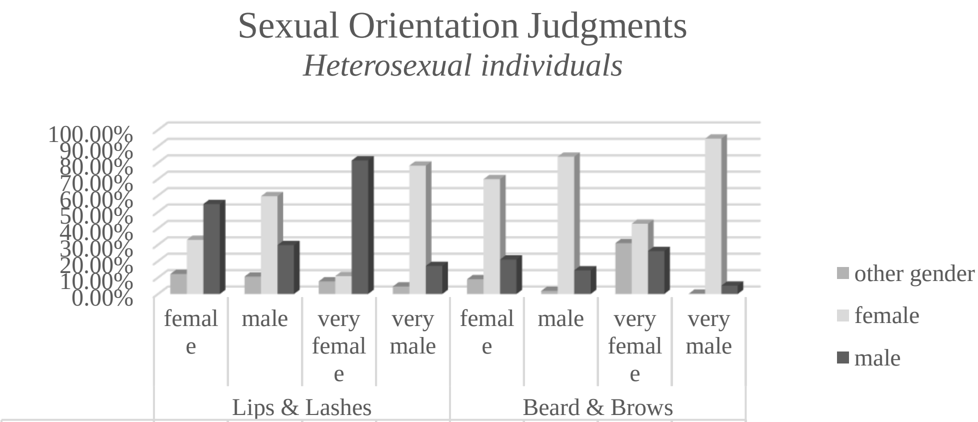
III.1.1.4 Reaction Time:

Participant reaction time was modeled as a function of participant group, stimulus category and morph using a repeated measures analysis of variance. The speed of gender identity judgments did not differ significantly between the two groups (F (1,24) = 0.480, p = 0.495).

III.1.2 Sexual orientation judgments

In the judgments of sexual attraction overall, the difference between groups is much more pronounced that in the gender identity judgments, with the non-heterosexual group showing more variance in judgments. Nevertheless, sexual attraction to a gender that is not within the same category (i.e. heterosexual preference) remains the favored judgment.

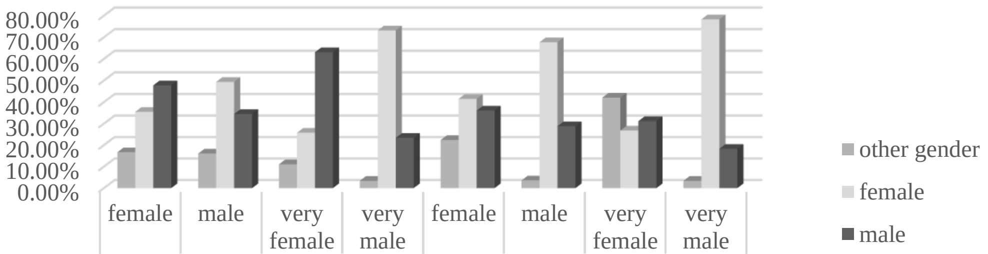
III.1.2.1 Categorization trends across groups:



	Lips & Lashes				Beard & Brows			
	female	male	very female	very male	female	male	very female	very male
other gender	12.20%	10.60%	7.70%	4.60%	9.00%	1.90%	31.00%	0.20%
female	33.00%	59.60%	10.90%	78.20%	70.00%	83.70%	42.80%	94.70%
male	54.80%	29.80%	81.40%	17.10%	21.00%	14.40%	26.20%	5.10%

Sexual Orientation Judgments

Queer individuals



	Lips & Lashes				Beard & Brows			
	female	male	very female	very male	female	male	very female	very male
other gender	16.70%	16.10%	11.10%	3.40%	22.40%	3.60%	42.10%	3.40%
female	35.50%	49.40%	25.80%	73.20%	41.50%	67.70%	26.80%	78.30%
male	47.80%	34.50%	63.10%	23.40%	36.10%	28.80%	31.20%	18.30%

Category “Lips & Lashes”:

Morph levels ‘female’ and ‘very female’ were judged as sexually attracted to males by both groups, whereas morph levels ‘male’ and ‘very male’ were judged as sexually attracted to females. When compared with the gender identity ratings, a pattern of heterosexual categorization emerges as most often chosen sexual orientation judgment, independent of the participants' own sexual orientation. However, queer participants show a higher variance in judgments of sexual attraction over all morph levels than the heterosexual group.

Category "Beard & Brows":

While morph levels 'male' (hetero: 83.7%; queer: 67.7%) and 'very male' (H: 94.7%; Q: 78.3%) are both judged most frequently as sexually attracted to females, morph levels 'female' and 'very female' reveal the most divergent judgment pattern between the two groups. Morph level female is most frequently judged as sexually attracted to females, by heterosexual participants (70%). Queer participants judged this morph level to be attracted to females (41.5%) almost as often as attracted to males (36.1%). These difference in judgment drive the significant difference between the two participant groups. Importantly, both participant groups most frequently categorized morph level 'female' faces of category "*Beard & Brows"* as male in the gender identity judgment task. Taking this into account, heterosexual participants judge this stimulus category as heterosexual, whereas queer participants judge this stimulus category as either heterosexual or queer. Morph level ‘very female’ again revealed itself to be the most divergent stimulus category in terms of participant judgments. Whereas heterosexual participants judged faces of this type to be sexually attracted to females (42.8%) most frequently, followed by attraction to other genders (31%) and males (26.2%), queer participants most frequently judged these faces to be attracted to other genders (41.2%), followed by attraction to males (31.2%), and females (26.8%).

III.1.2.2 Explicit confidence judgments:

An independent-samples Mann-Whitney U Test revealed significant difference in confidence intervals between the two groups (Standardized $U = -9.595$, $p < 0.001$) on a single trial level, such that queer participants were less confident in their judgments of sexual orientation (M= 4) than heterosexual participants (M= 5). However, aggregated by overall mean confidence judgment per participant, the Mann Whitney U test did not reveal significant differences between queer and heterosexual individuals (Standardized U= -1.178, p = 0.270). Tests were adjusted for multiple comparisons using Bonferroni correction.

III.1.2.3 Reaction Time:

A repeated measures analysis of variance testing the effects of stimulus category and morph-levels (within-subjects) and group (between-subjects) on participant reaction time did not reveal a significant main effect of group ($F(1,24) = 1.309$, $p = 0.264$).

III.1.2.4 Post-Session Answers

Almost half of participants identifying as heterosexual (47%) mentioned using an intuitive strategy, relying on their gut feeling or the overall impression of the face to judge the gender identity of the depicted person. On the other hand, only 17% of participants identifying as queer mention the above named markers. However, both 67% of heterosexual and 40% of queer participants mentioned reliance on specific facial features as strategy – most often the mentioned feature was facial hair. Much less participants reported a specific strategy for the judgments of sexual attraction task. Of the participants who answered this question, 17% of queer participants and 33% of heterosexual participants reported a reliance on intuition/gut feeling/holistic impression. Interestingly, both groups of participants overwhelmingly reported looking at the eyes of the presented face as first fixation (Hetero: 62%; Queer: 63%). However, more heterosexual than queer individuals reported looking at the overall shape first (H: 23 %; Q: 18%), whereas more queer individuals reported first looking for signs of facial hair in the face (H: 8%; Q: 25%).

III.2 Eye-Tracking Analyses

To represent and compare the distribution of the number and of the duration of the fixations on the face stimuli, we relied on the analysis tool *imap4* as statistical mapping method for fixation data. This data-driven method allows for direct comparisons of the differential viewing patterns between the two groups without relying on pre-determined areas of interest.

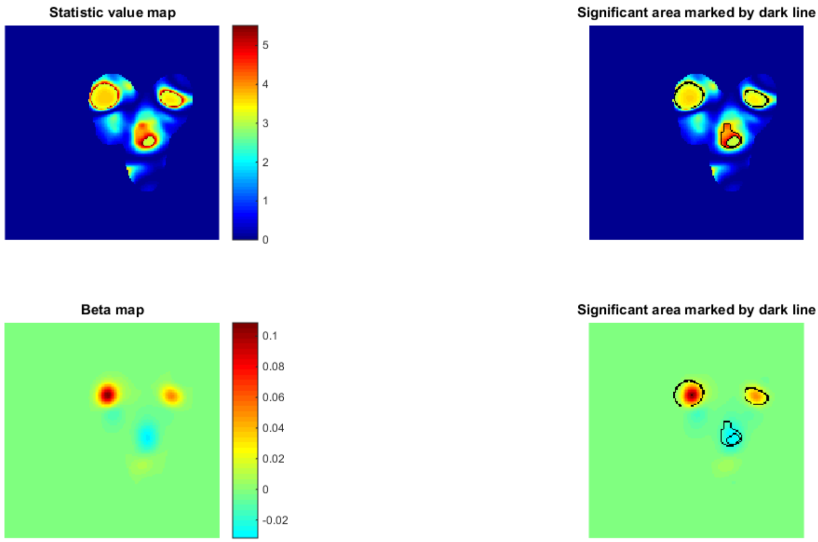


Figure 5: Comparison of viewing map for heterosexual (yellow) versus queer (blue) participants, while viewing stimuli of category "Lips & Lashes", during the sexual orientation task.

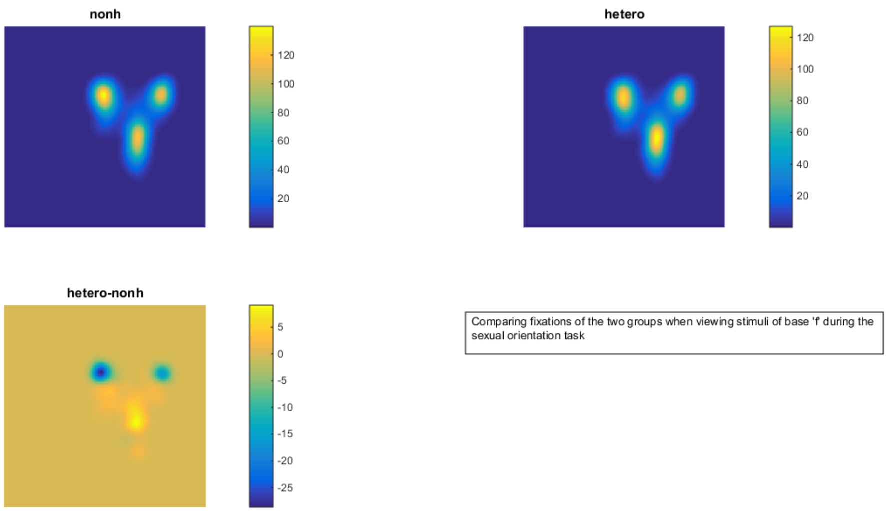


Figure 6: Comparison of viewing map for queer (red) versus heterosexual (blue) participants, while completing the sexual orientation task. Areas of significant fixation differences (uncorrected for multiple comparisons) are surrounded by a black line.

The fixation map of heterosexual individuals is consistent with an intuitive processing strategy for face judgments, relying on a global/holistic eye movement pattern located centrally in the face. Although the differences in viewing patterns did not reach statistical significance after correcting for multiple comparisons, a clear trend in viewing pattern can be discerned nevertheless. We are currently in the planning stages of a follow-up study with larger sample size, in order to test the reproducibility of these findings. At this point, the conclusions as to differences in participant sexual orientation mapping onto differences in cognitive style are therefore tentative.

IV. Discussion

Motivated by the call to examine changes in perception as a function of exposure and attitudes towards sexual minorities, and the necessity for a critical and non-essentialist look at cognitive and perceptual processes involved in categorizing gender identity and sexual orientation, we set out to study the following research questions:

- Does group membership predict cognitive processing style, i.e. do individuals who self-identify as heterosexual or non-heterosexual differ in cognitive strategy when making gender identity and sexual orientation judgments?
- Does sexual orientation predict the reliance on gender-typicality cues to categorize the gender identity and sexual orientation of faces?

The theoretical basis for our study was three-fold. Firstly, a characterization of intuition as fast, automatic judgment process based on tacit knowledge learned throughout the lifespan, but unable to be accessed consciously (Gaissmaier and Gigerenzer, 2006; Betsch, 2008a; Hodgkinson et al., 2008). In our understanding of intuition, the acquisition of the tacit knowledge base depends on external factors such as an individual's social and cultural environment, as well as internal factors such as personal believes, motivations, and attitudes.

With the limited amount of time available to make judgments about others in social situations and cognitive resources being a precious commodity in the market of every-day life, reliance on intuitive processing for quick and accurate social judgments is almost inevitable. In fact, intuitive judgments of female sexual orientation, to name just one example, are more accurate than when based on thoughtful deliberation (Rule et al., 2009).

Secondly, the nascent field of 'social vision' (Adams et al., 2011a; Johnson et al., 2015) has shown that face perception is intuitive and people are able to accurately judge gender identity and sexual orientation from faces, even with near sub-liminal presentation times (Ambady, 2010; Willis and Todorov, 2006). However, a large part of this research has utilized binary categories of 'male/female' (gender identity) and ‘masculine/feminine’ (facial features), presupposing a notion of a bipolar division of sex/gender. Impression formation relies on overall evaluations of (what is termed) facial masculinity/femininity, such that violations of a (culture specific) gender-norm has direct consequences for gender identity and sexual orientation judgments. In fact, the gender typicality of facial phenotypes determines judgments of sexual orientation, such that ‘masculine’ women and ‘feminine’ men tend to be judged as ‘gay’, whereas ‘masculine’ men and ‘feminine’ women tend to be categorized as ‘straight’ (Freeman et al., 2010). This result holds for judgments of faces as well as bodies (Freeman et al., 2012; Johnson et al., 2015). The present work extends these findings by directly manipulating various facial features, as well as allowing for non-binary classifications in both tasks and in the self-identification of the participants.

Also part of the new ‘social vision’ paradigm, the ecological theory of face perception (Zebrowitz-McArthur and Baron, 1983; Zebrowitz et al., 2011) provides the third part of our theoretical framework. This ecological perspective draws on a Gibsonian understanding of perception to posit that the face perception system is attuned to stimulus properties which afford the best possible opportunities for adaptive behavior of the perceiver. Both the encoding as well as the decoding of facial features are innately, individually, socially, and culturally tuned (Adams et al., 2011b). In other words, the ecological approach to face perception invites us to look at perception as an interplay between stimulus and perceiver through behavioral affordances and perceiver attunements. With regard to gender identity and sexual orientation judgments, the attuned-to properties might include (but are not limited to) social threat, mating choice and economic opportunity, to name just a few. The amalgamation of classic face perception models with an ecological perspective, and the knowledge base provided by intuitive judgment processes lead to the proposition of the following two hypotheses with respect to our research questions:

- H1: Because of differences in perceiver attunement (e.g. visual exposure, implicit attitudes, and personal motivation) we predict that heterosexual individuals rely on an intuitive processing style to judge the sexual orientation of faces.
- H2: Because of differences in perceiver attunement (e.g. visual exposure, implicit attitudes, and personal motivation) we predict that individuals identifying as heterosexual rely more on gender typicality cues than individuals identifying as queer.

VI. 1 Summary of the Findings

Even though we did not find differences in gender identity judgments moderated by participant's sexual orientation, specific differences did occur in the judgments of sexual orientation. Specifically, people who identified as queer showed more variance in judgments of sexual orientation, irrespective of stimulus category or morph-level. Additionally, queer participants relied less on gender typicality cues for judgments of sexual orientation than heterosexual participants.

Despite these differences in judgment, heterosexual desire and male identity emerged as category prototypes for sexual orientation and gender identity judgments, respectively. Prototypicality is an important construct in face perception, since the categorization of faces is modulated by the facial typicality of encountered exemplars (Blair, 2002; Livingston and Brewer, 2002). Seeing as the layout of a person's 'face space' is postulated to be a function of that individual’s perceptual experience (O’Toole et al., 2001; Leopold et al., 2001), and heteronormativity is the dominant construct governing social spaces (Connell, 2012), this finding is not particularly surprising. It remains important and relevant, nevertheless, since it underscores long-standing feminist criticisms of heteronormativity, extending them by a cognitive/perceptual dimension.

These results will be discussed in more detail below, taking recent findings in social vision as well as feminist neuroscience into account. Since the study of sex/gender and sexual orientation has important and direct implications for social life, we conclude with some ethical considerations with regard to our results as well as to research on gender, sex and sexuality in general.

VI.2.1 Male as prototypical gender identity

Over 60% of all stimuli, regardless of morph-level or secondary stimulus category (facial hair/make-up), were judged as “male”, suggesting that male is the category prototype for gender identity of unknown faces. Importantly, this result is based on ‘bald’ faces. Hairstyle usually is one of the most important cues for perceivers to judge the gender identity of faces (Brown and Perrett, 1993; Martin and Macrae, 2007). Nevertheless, this result suggests that the prototypical gender category for faces devoid of hairstyle but differentiated by physiognomy, skin color and further secondary cues such as facial hair and make-up, is “male”. In a construct central to the sociology of gender, Connell (1995) postulates a gender hegemony, which operates through the subordination of femininity and other (marginalized) masculinities to hegemonic masculinity; a process which serves to cement the societal structuring through heteronormativity. Conversely, identification of a face as ‘female’ seems to require a hyper-feminization of so-called feminine features, as evidenced by the categorization of all faces except morph-levels ‘female’ and ‘very female’ in category “Lips & Lashes” and 'very female' in category "Beard & Brows" as male. This finding is further supported by studies showing that (in Western contexts) female actresses, reporters, politicians and models tend towards hyperfeminine features (e.g. a high brow line, high cheekbones, wide eyes, small nose (Lick and Johnson, 2014; Johnson et al., 2015) as well as a cross-cultural bias for feminine female faces.[26]

One might have expected to find a greater variety in gender identity judgments for queer individuals based on the notion that these individuals are exposed to a greater variety in gender expression. Social vision research has offered the hypothesis that "visual exposure may affect social biases by shifting perceptual norms for targets' appearances. That is, stimuli may appear increasingly

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26 This restriction of the category 'female' to a very narrow window of features is in some ways reminiscent to the out-dated surgical practice of categorizing clitoris length (see Fausto-Sterling, 2000).

normative as perceivers gain additional exposure to them, leading to enhanced evaluative judgments.” (Lick and Johnson, 2014). In fact, Tshkay et al (2013) interpret the differential response bias between heterosexual and queer women in their investigation of female sexual orientation judgments to be based on the increased likelihood of queer women to be familiar with other sexual minorities and exposure to sexual diversity. This notion, however, relies on presuppositions of queer life and visual exposure that – on second glance – do not hold up to scrutiny. Homosexual men and women can fall just as squarely within binary gender categories (if they so choose) and even define themselves based on gendered attributes such as ‘masculine’ or ‘feminine’ (Kippax and Smith, 2001; Tskhay et al., 2014). The history of ‘gender inversion’ as sign for homosexuality dates as far back as the Victorian Era (Fausto-Sterling, 2000). Puzzlingly, the concept has pervaded throughout the ages and is even used to categorize sexual orientation in animals. Female rats, who show 'mounting' behavior, for example, were classified as lesbian whereas male rats who responded to being mounted were classified as gay (Beach, 1979). The questions of visual exposure and personal attunement become more relevant in the judgments of sexual orientation.

VI.2.2 Heterosexuality as prototypical sexual orientation

The sexual orientation of participants did influence differences in the sexual orientation judgments of the presented faces, confirming the second hypothesis. Gender typicality cues were used more by participants who self-identified as heterosexual, while non-heterosexual participants showed greater variance in judgments. These differences were most pronounced in visually ambiguous conditions, especially morph-level 'very female' in category *"Beard & Brows"*.

The ease of processing (i.e. fluency) perceptually ambiguous facial stimuli has been associated with guiding first impressions (Lick and Johnson, 2015), such that faces which perceivers experience as difficult to classify are rated less positively than easily classifiable faces. Similarly, fluency has been associated with intuitive processing in a number of different task domains (Topolinski & Strack, 2009). The difference in sexual orientation judgments with regards to the perceptually ambiguous stimulus categories might therefore be driven by a difference in processing fluency. More specifically, individuals who self-identify as heterosexual and rely more on gender typicality to categorize sexual orientation may process perceptually ambiguous target faces more fluently, leading to faster judgments and higher levels of confidence in these judgments. Conversely, queer participants reported more difficulty (i.e. less ease of processing) and less confidence in sexual orientation judgments, along with taking more time to make judgments than heterosexual participants. These results further support a possible difference in cognitive strategy as revealed by participants' sexual orientation.

A recent analysis of several investigations into 'gaydar' found that stereotypic cues confound the detection of sexual orientation from facial cues (Cox et al., 2016). This highlights the importance of the fact that facial features activate stereotyped knowledge about sex/gender norms in people's minds, rather than there being irrefutable truth behind the fact that, e.g. facial hair is associated with masculinity and therefore any face exhibiting facial hair must be male. Social categorization is not simply based on perceptual mechanisms. Rather, perceiving category differences is impacted by a number of sub-personal factors. An example of this are implicit attitudes, such as evidenced in the extensive literature on the other race bias (Stanley et al., 2008; Xiao et al., 2013; Liu et al., 2011; Zhao et al., 2014). Individuals who score highly on measures of racial prejudice perceive the intensity of anger on a racially ambiguous face as stronger, when they also categorize that face as Black rather than White (Hutchings & Haddock, 2008). Similarly, the stereotypical use of gender a-typicality to categorize women as lesbians drives the judgment of the so-categorized women as physically unattractive (Lick & Johnson, 2014). However, the reliance on a systematic labeling strategy has been shown to be effected by participants' sexual identities, such that in a judgment task of female sexual orientation, heterosexual women were more likely to assume the depicted female faces to be heterosexual than women identifying as homo- or bisexual (Tskhay et al., 2013).

Similarly, women's expression of personality traits which are termed 'masculine' (such as assertiveness) responds to shifts in cultural norms on a group level (Twenge, 2001), while on a personal level gendered behavior is "flexibly responsive to social context and experience" (Rippon et al., 2014). This is consistent with the ecological view on face perception, stating that individual factors such as personal motivation and attitudinal differences influence how we perceive another person’s face. Put differently, “what a person perceives in faces depends on what information exists, what information the person is able to detect, and what information is useful to that perceiver." (Zebrowitz et al., 2011). An example of this is the finding that homosexual women show enhanced sensitivity towards female faces at ovulation, highlighting the importance of sexually relevant factors over reproductive relevance in the sensitivity of these perceivers to the sex/gender of faces (Brinsmead-Stockham et al., 2008).

Our findings extend the current literature on the influence of perceivers’ own sexual orientation on judgments of sexual orientation and gender identity of faces, by testing individuals who were allowed to self-identify their sexual orientation on a broader spectrum than is typically used. Furthermore, by directly manipulating facial cues and morphology we were able to investigate the differential impact of these cues on gender identity and sexual orientation judgments, rather than simply testing judgment accuracy.

VI. 3 Ethical Considerations

The persistence of social inequalities such as access to resources, health care, education and personal security along lines of gendered- as well as ethnic and economic disadvantage remains a global phenomenon[27]. Seminal research on prejudice (Allport, 1954) has already equipped us with the warning that social categorization coupled with a perceiver's affective state can contribute to prejudice against certain social groups. The ability to perceive another as member of one's one in-group can be advantageous for personal and social belonging. Conversely, the categorization of persons also has

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27 UN Women Reports, S. (2015). Available at:

http://unstats.un.org/unsd/demographic/products/Worldswomen/WWreports.htm important implications for privacy and safety concerns (Heitner et al., 2015), including discriminatory and prejudicial practices on the personal as well as national level. “Reducing people to a stereotype based on appearance negates their personhood as being more than their sexual orientation” (Heitner et al., 2015).

With facial recognition software becoming increasingly ubiquitous and computer vision algorithms starting to be trained on transgender face databases to accommodate for changes in physiognomy (Mahalingam and Ricanek, 2013), the ethical responsibility of researchers is becoming ever more relevant/pressing. Taking on this responsibility, it is important to us to note that the present research is not intended to further possibilities of picking out persons according to their sexual orientation from crowds. Rather, the present research is intended to further the knowledge on how our perceptual system interacts with (higher) cognitive processes to apply or override stereotypical categories to others. We seek to join other colleagues in social vision research in showing that perception has as much to do with the perceiver, as with the cues that are being perceived. If as a society we seek to change the application of stereotypical knowledge, the proverbial “ball” (of responsibility) remains squarely in our court.

VI. 4 Limitations of the Study

The use of computer generated faces naturally creates certain limitations for the study of sex/gender and sexual orientation judgments. Firstly, the pre-defined gender morph settings rely on what can be considered exaggerations of gendered physical features (e.g. skin color, bone structure). These features were modeled after research on phenotypic parameters observed in several hundred face scans of the human population (Blanz & Vetter, 1999), however, to try to reflect natural variations in facial physiognomy (though this research can, of course, be viewed critically as well).

Secondly, by broadly dividing participants into ‘heterosexual’ and ‘queer’ groups, we may seem to reify the same essentialist beliefs about sexual diversity which we aimed to dispel with our elaborate self-assessment. This unfortunate loss of complexity was a necessary trade-off to analyze the multifaceted research design. It might be fruitful to conduct future studies with less independent variables and rather a focus on keeping the complex self-identification of participants.

V. Conclusions

Differences in judgments between the two groups were revealed based on the task, stimulus category and morph-level. Analyzing the judgments more closely, we see that these differences are driven by the sexual-orientation task and by the higher reliance on gender typicality for heterosexual participants (see below). Previous (perceptual) experience or exposure, which arguably forms the tacit knowledge base for intuitive face judgments, may be a factor in this differential reliance on intuitive processing and on gender typicality to judge the sexual orientation of others.

The key feature of intuitive processing, according to Betsch (2008), is the automaticity by which it operates on a subconscious level. Through automatic processes, multiple pieces of information can be sampled and considered simultaneously, making intuition the perfect process mode for social cognitive tasks, such as person perception. Taking perceiver attunement into account, however, one could conceive of persons belonging to a 'sexual minority' considering multiple factors in sexual orientation categorization in a thoughtful and sequential manner – a mode of processing that is associated with deliberate judgment strategies. Simply put, queer persons might be motivated (or have learned) to override their intuitive judgment, knowing that they themselves do not fit into the stereotypical categories or would not wish to be categorized according to these stereotypes (which rely on categories learned while living in heteronormative society). While the slower reaction time, lesser confidence and greater overall variety in sexual attraction judgments all point towards this interpretation, this claim needs to be further substantiated. To this end, the preliminary eye tracking data, while not reaching significance, can tentatively be interpreted as further support for a difference in cognitive strategy.

Based on the results of the present study, it would seem that individuals use similar cognitive processes to judge the gender identity of a person, irrespective of their own sexual orientation. When it comes to judging the sexual orientation of another person, however, there are differences in cognitive style and judgment behavior, which are moderated by the perceiver's own sexual orientation. Despite these differences in judgment, heterosexual desire and male identity emerged as category prototypes for sexual orientation and gender identity judgments, respectively.

According to Atkinson and Adolphs (2011), “the ultimate goal of constructing a theoretical model of face processing is to put both the social back into the face as well as the person back into the perceiver (p.363). Mirroring this notion, feminist philosopher Elizabeth Grosz insists that we cannot merely “subtract the environment, culture and history and end up with nature or biology” (Grosz, 1995). Both perspectives highlight the importance of acknowledging the entanglements of the person (and all of the elements that come with being a person, e.g. culture, history, environment) with the act of perceiving another person. Contemporary concepts of intuitive judgment processes complement this adaptive view of social vision by emphasizing the importance of an individuals’ life experience for the shaping of the intuitive judgment process. In the words of Tilmann Betsch (2008), “Experience provides the organism with a rich database on which intuition can unfold its power.”

By using the knowledge of intuitive judgment processes in the context of gender, sex and sexuality studies we can draw attention towards experiential factors (instantiated through social, cultural and political spaces) and thereby step away from reifying essentialist notions of gender/sex/sexuality. This perspective highlights the importance of directly investigating how intuitive judgment processes factor into social perception. It further calls on researchers to allow for variations beyond the stereotypical in the design as well as the interpretation of their data. Last, but perhaps most importantly, these approaches continue to show us the importance of acknowledging and promoting diversity in society.

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Chapter IV.4

What type of feelings are gut feelings?

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The equating of one's intuition to a diffuse, intangible kind of feeling in the bottom of one's stomach or gut is a pervasive one. Utterances such as "I have a bad feeling about this person" or "My gut tells me that we need to turn left at the next light" are commonly used in every-day conversation to verbalize an intuitive judgment. This notion of intuition being synonymous with *gut feelings* is also echoed within psychology. Gerd Gigerenzer's widely cited book "*Gut feelings*: The intelligence of the unconscious" is just one (prominent) example of this tendency. In his work, Gigerenzer notes early on that he uses the words "intuition" and “gut feeling” interchangeably, to describe: *“A judgment that appears quickly in consciousness, whose underlying reasons we are not fully aware of, but that is strong enough to act upon.”* (Gigerenzer, 2007)

Despite theories of embodied cognition gaining popularity within cognitive science and psychology alike, as well as rigorous philosophical discourse around the nature of feelings, their role in cognition and correlated bodily sensations, the concept of “*gut feelings*” within the literature on intuition seems to be used in ignorance of the different feeling concepts. Using two prominent lines of empirical inquiry into intuition as examples, I will argue that the ‘*gut feelings*’ under investigation are in fact different types of feelings. In order to disentangle the conceptual mash-up behind the concept of *gut feelings*, I will draw on theories of emotion as well as embodied cognition. I ask the question: If we assume *gut feelings* to play a role for intuitive processes (or even be synonymous to intuition), are the same type of (gut) feelings at play in every kind of intuitive process?

The structure of my treatment of this question is as follows: Section one outlines different concepts of intuition that propose a role of emotions or feelings, as well as an overview of different feeling concepts. Sections two and three attempt to answer the question, whether *gut feelings* might map onto the concepts of somatic markers (2), or epistemic feelings (3). In sections four and five I introduce two independent lines of research into embodied components of intuition and attempt to show that the notion of *gut feelings* relies on very different concepts in each one. I conclude with an outlook of further interesting avenues of research in order to answer the questions posed above.

Intuition and Feelings

Many theories related to intuition include the notion that intuition has an emotional or affective component. Some even go so far as to postulate an "emotions revolution"

(Weber & Johnson, 2009, p. 64), which has put affective processes on an equal footing with cognitive processes. Examples of this can be found not only in the aforementioned book by Gerd Gigerenzer, but also within dual-systems theory, first proposed by Sloman (1996) and later integrated into Daniel Kahnemann's seminal heuristics and biases approach (Kahneman, 2003; Kahnemann, Slovic, & Tversky, 1982). The theory of dual systems divides mental capacities broadly into two systems which generate judgments and decisions: an intuitive system (1) and a reflective (2) system. Important for the current argument is that, according to Kahneman and colleagues, System 1 operates in a *"fast, automatic, effortless, associative, implicit (not available to introspection), and often emotionally charged"* (Kahneman, 2003, p. 698) manner. Slovic and colleagues even coined a specific heuristic, the affect heuristic, in which decision makers may base their choice simply on the use of their *"intuitive affective reaction toward an object or behavior"* (Slovic, Finucane, Peters, & MacGregor, 2002). Similarly, dual-process theories (DPT) -- which are among the most widely perceived classes of theories on intuition -- mention a role of “emotions” for intuitive (type 1/T1) processes (e.g. Jonathan St. B. T. Evans & Frankish, 2009). This purported emotional component of T1 processes falls prey to similar issues as the notion of *gut feelings*. Namely, it is unclear which theory of emotions is ascribed to by the authors who propose emotions as one characteristic of T1 processes. Recent work to shed light on the underdetermination of ‘emotions’ in decision research found that there has been disappointingly little progress in modeling the interaction of emotions with decision making, despite a surge in studies probing this interaction. The authors conclude: *“it would seem that neuroscientific investigations of the interplay between emotions and decision making are particularly guilty of a ‘grab bag’ approach to emotions.”* (Volz & Hertwig, 2016).

In Plessner and colleagues widely received book on intuition in judgment and decision making, four chapters were devoted to “Emotion & Intuition” (Plessner, H., Betsch, T., Betsch, 2008). The definition of intuition put forth by the authors sees intuition as primarily reflecting prior experience and capitalizing on stored representations. Their view includes a greater contribution of affect and emotions to judgment and decision making than many other JDM models. It specifically conceives of a *feeling* that guides judgments and decisions as the output of an intuitive (thinking) process, such as the feeling of liking an entity or a feeling of risk (Betsch, 2008). That is, intuition uses feeling as decision criterion. The notion of *gut feelings* has also been utilized directly by myself and others to induce an intuitive judgment strategy, by instructing participants to follow their gut feelings (e.g. Mega, Gigerenzer, & Volz, 2015; Mega & Volz, in prep) or gut instincts (e.g. Rule, Ambady, & Hallett, 2009) during a particular task. This outline of the conceptual and empirical engagement with the contribution of emotions and feelings in the intuitive process is by no means an exhaustive overview of the ways in which (gut) feelings are treated in the intuition literature. The former are merely examples of what part emotions and feelings are conceived of playing in the intuitive process, taken from some of the most widely cited research of intuitive judgment processes.

Feelings

One difficulty in disentangling the various notions of *gut feelings* lies in the fact that the nature of feelings, their relation to emotions and their function remains a topic of debate within and between various disciplines. Are they limited to visceral sensations? Or do they include musculoskeletal sensations? In a review of the literature on interoception and embodiment, Herbert and Pollatos (2012) define bodily feelings as the processing of internal (and external) signals; the sense of our physical and physiological condition. According to Alston's classic definition, feelings are spontaneously occurring phenomenal experiences that form part of the stream of consciousness (Alston, 1969). Perhaps the most prominent work on feelings within neuroscience comes from the laboratory of A.D. Craig. His research suggests that the anterior insular cortex is the neural substrate both of subjective feelings from the body and feelings of emotion. Craig thus concludes that subjective awareness is built on homeostasis and *"the homeostatic neural construct for a feeling from the body is the foundation for the encoding of all feelings"* (Craig, 2009).

Psychologist Tillman Betsch, sees feelings as informing conscious thought about the work of the unconscious (Betsch, 2008): *"They are immediate, nonsymbolic, nonverbal; they evolve from experience, demanding only a minimal amount of cognitive resources and can serve as a basis for judgment and decision."* However, Betsch endorses the view that not all kinds of feelings are emotional, or, as he puts it *“map on the affective dimension”.* Feelings that inform the organism about properties of experience such as time, space, and number as well as feelings are feelings about cognitive processes, such as the “feeling of knowing” (Hart, 1965), are examples of non-emotional feelings, according to Betsch.

On the other end of the spectrum lies the work of William James and Carl Lange, who both endorsed the view that emotions are caused by bodily expressions (James, 1884; Lange, n.d.). In an extension of the James-Lange Theory, the philosopher Jesse Prinz views bodily sensations as the standard (though non-essential) causes of emotions (Prinz, 2004, 2005). According to Prinz: *“Feelings are brain states in perceptual systems. [...] An emotional feeling is an embodied appraisal that is broadcasting to working memory, [...]”* (Prinz, 2004, P.242). Zeelenberg and colleagues endorse the view that “feeling is for doing”. The authors, who also follow the James-Lange tradition, equate feeling with emotion.

Importantly for the discussion of *gut feelings*, they understand emotions as *“programs for intuitive decision making, imposing on the decision maker inclinations for action that, in a given situation, most adequately serve current strivings.”* (Zeelenberg, Nelissen, & Pieters, 2008). Having gained a small glimpse into what feelings are thought to be (nature) and to be for (function), we are still left with many questions. For example: are these kinds of feelings located somewhere in the body? When do they enter awareness, thereby influencing the judgment process? If they are the output of an intuitive process, why is it that *gut feelings* are by some authors conceived of being synonymous to intuition?

Table 1: Summary of different feeling concepts

Feelings are spontaneously occurring phenomenal experiences that form part of the stream of consciousness.	(Alston, 1969)
Subjective feelings from the body are the foundation of all feelings	Craig (2009)

Feelings evolve from experience, do not require many cognitive resources and can serve as basis for judgments and decisions. Feelings can either be emotional/affective or non-emotional (such as metacognitive feelings).	Betsch (2008)
Emotions are caused by bodily expressions (i.e. feelings)	William James (1884)
Feelings are brain states and emotional feelings are embodied appraisals	Jesse Prinz (2004)
Feelings are emotions and emotions are "programs for intuitive decision making" by evoking action tendencies towards goal attainment.	Zeelenberg, Nelissen & Pieters (2008)

Are gut feelings somatic markers?

Based on the plethora of feeling-concepts outlined above, it seems prudent to take a closer look at two strands of research to better understand the types of feelings underlying the notion of *gut feelings*, namely (1) the somatic marker hypothesis (henceforth referred to as SMH) and the (2) literature on metacognitive (or epistemic) feelings.

Evaluating the nature of *gut feelings* and attempting to clarify the use of such feelings in intuition cannot be attempted without taking a close look at the somatic marker hypothesis (hereafter: SMH), which has greatly influenced the concept of gut feelings in intuition (Bechara, Damasio, Damasio, & Anderson, 1994;Bechara, Damasio, Tranel, & Damasio, 1997). Following in the tradition of the James-Lange Theory, SMH theorists view emotions as arising from bodily expressions. According to the SMH, somatic markers are brain states that index changes in the autonomic nervous system, while at the same time becoming associated with the representations of objects or events in the world that trigger them (see Bartol & Linquist, 2015, for a review of the somatic marker hypothesis in decision making). Thus, on Damasio's view, emotional feelings are constituted by meta-representations of bodily states. It is the conscious access of these emotional feelings which provide the "*gut feelings*" that guide our decision processes. Notably, the SMH to this date remains one of the few – and certainly, the most widely cited – theories of the function of bodily signals for (intuitive) decision making.

One of the classical tasks used to study the SMH is the Iowa Gambling Task (IGT; Bechara, Damasio, Tranel, & Damasio, 1997). The IGT is a card selection task in which individuals learn which of four decks of cards is the most rewarding. Participants select cards from these decks and immediately either earn a (facsimile) cash reward, or a penalty. Card selection earns participants monetary rewards or punishments. The decks are differently valued and without the knowledge of participants, valence of the decks is switched half-way through the experiment. Results of the IGT have shown that autonomic responses (measured by skin conductance) predict the switch to more rewarding decks. This autonomic response is defined as somatic marker or "gut feeling". According to Damasio, *gut feelings* are especially relevant indicators in situations of uncertainty and complexity, when we are free to decide upon our own actions. Most often, however, *gut feelings* are mentioned as "warning signals" of negative outcomes (Bechara, Damasio, Damasio, & Anderson, 1994; see also Herbert & Pollatos, 2012).

Despite the prevalence of the SMH, we cannot unquestioningly rely on the account of *gut feelings* as outlined in its theory. For one, this would simply replicate the mistake made by authors who use the term *gut feelings* in their investigation of intuition without specifying the feelings-concept underlying their use of the term. Secondly, the SMH has not remained without criticism, even within the emotion community itself. Among the most often voiced complaints are vagueness and ambiguity in the definition of the SMH (Colombetti, 2008; Dunn, Dalgleish, & Lawrence, 2006). The widespread adoption of the SMH for empirical investigations notwithstanding, it remains unclear which functional role(s) somatic markers are thought to play in decision-making.

In a comprehensive review of the SMH literature, Linquist and Bartol identified no less than 38 different interpretations of the SMH as alternatives (Linquist & Bartol, 2013). The authors follow Colombetti's (2008) division of the SMH literature into SMH-general theories (emotions play a role in decision making) and SMH-specific (lesions to the ventro-medial prefrontal cortex impair one's ability to form long term plans). Importantly, in both families of theories, somatic markers are seen as positively or negatively valenced and this information is thought to be (somehow) included in decision-making.

Perhaps most importantly for the claim of the present work, the SMH operates on a definition of intuitiveness which relies on concepts of good/bad choices, following the 'heuristics and biases' framework. This is problematic for several reasons. Firstly, the concept of intuition as heuristics is certainly not shared by everyone in the intuition community, neither is it applicable for every task used to investigate intuitive judgment or decision making. Testing semantic coherence using the word triads task (Bolte & Goschke, 2005), for example, does not presuppose correct or incorrect choices. Participants are presented coherent or incoherent word triads, such as “playing”, “credit”, and “report”. Coherent triads are defined to indirectly have a fourth word in common, whereas incoherent ones do not. The example above is an example of a coherent triad, since all three words are weakly associated with the solution word “card”. Those trials in which participants accurately judge a triad to be coherent but are unable to name the solution word are considered cases of intuitive coherence judgments (cp. Bolte & Goschke, 2005; Zander et al.,; Ilg et al.). A situation in which somatic markers could act as valence indicators – signaling the “bad” choice -- simply does not exist. A similar logic underlies the test of visual coherence (Volz & von Cramon, 2006). Therefore, an optimal behavioral strategy in which anticipatory bodily signals point to advantageous choices simply cannot be learned in these types of tasks. Bodily signals may be taken as indicators of coherence, however, which I will explain in further detail in section six. For now, suffice it to say that *gut feelings* can not only be related to the valence marker idea as proposed by the SMH in every conceivable situation in which a person makes use of her intuition.

Are gut feelings epistemic feelings?

Several indications point to the possibility that *gut feelings* might (in some cases?) be considered epistemic feelings (de Sousa, 2008). Epistemic feelings, sometimes also referred to as metacognitive feelings or noetic feelings, are feelings concerning the subject's own mental capacities and mental processes. Examples of epistemic feelings are the feeling of confidence, the feeling of knowing, the feeling of error, and the feeling of familiarity. Some of the most active investigations of epistemic feelings draw on dual-process theories (see section 1 above). Examples of this abound in the literature on metacognition (e.g. Proust, 2015), (Thompson, Prowse Turner, & Pennycook, 2011), (Koriat, 2006) and (Dokic, 2012). Dokic even uses DPT in his definition of epistemic feelings: *"E-feelings are cross-level states, produced by implicit, type1 monitoring but available to participate in explicit, type 2 reasoning"* (Dokic, 2012).

Extending from the previously mentioned dual-system's theory, DPT distinguishes two types of mental processes used in judgment and decision making: rapid autonomous intuitive processes (T1) and reflective higher order reasoning processes (T2; Evans & Stanovich, 2013). Notably, DPT are among the most widely purported theories underlying both empirical as well as theoretical investigations into the nature of intuitive processes[28]. Further indications that intuition (and, by extension, *gut feelings*?) is somehow related to epistemic feelings, comes from the view that even partial information can lead to a

28 Though the prevalence of DPT has come to be criticized in recent years (Keren & Schul, 2009; Mega & Volz, 2014; Osman, 2013).

strong "feeling of knowing" by making use of sub-personal heuristics (such as cue familiarity). This idea is reminiscent of Gigerenzer's proposal of an adaptive toolbox of (subpersonal) heuristics, such as the recognition heuristic, as intuitively used and building blocks of ecological rationality (Gigerenzer & Todd, 1999; Goldstein & Gigerenzer, 2009). Equally related to the adaptive toolbox account (and, in some ways, the SMH) is the notion that feeling-based metacognition evolved as a coping mechanism for mental uncertainty (Arango-Munõz & Michaelian, 2014). Thus far, I have presented evidence of a link between epistemic feelings and intuition. Some researcher's even go so far as to equate epistemic feelings with intuitions[29] (Arango-Muñoz, 2014). Could *gut*

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29 It has been pointed out, however, that the term "intuition" is conceptually and theoretically loaded with very different concepts in philosophy than in psychology, which

feelings, then, be conceived of as epistemic feelings? Let's look at this a bit more closely. Beyond establishing a link between intuition and epistemic feelings, we need to ask whether epistemic feelings also have a bodily component. Are they embodied in the way that *gut feelings* imply a bodily component of intuitive processing? There is increasing evidence that this is indeed the case.

Epistemic feelings, like other types of feelings, are embodied: they are directed to an internal condition of the subject's body, in the sense of being caused by or attached to certain bodily reactions (Arango-Muñoz, 2014; Prinz, 2004). On the Water Diviner Model of noetic feelings proposed by Dokic, noetic feelings are first and foremost experiences about bodily signals (Dokic, 2012). Evidence for the embodiment of noetic (or epistemic) feelings can be

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is why some philosophers prefer to avoid the term "intuition (Arango-Munoz, personal correspondence).

found in the study of facial expressions. Facial feedback influences the felt experience during a given task (e.g. Niedenthal, Mermillod, Maringer, & Hess, 2010). Furrowing one's brow, for example, enhances the feeling of mental effort or uncertainty (Asher Koriat & Nussinson, 2009), as well as undermining perceived judgments of fame (Strack & Neumann, 2000). When people are asked to decide whether they recognize a certain target (i.e. whether they have encountered it previously), people attribute artificially enhanced perceptual fluency to memory for prior occurrence (Goldinger & Hansen, 2005). A subliminal somatic cue ("buzz") that was administered to participants unrelated to the test items presented to them increased the likelihood of participants responding that they had previously seen the item. This effect only occurred for subjectively more difficult items. Thus, the sensation of the buzz seems to be credited to stimulus familiarity. Notably, this illusion of familiarity did not occur in participants who experienced an obvious buzz. In discussing their results, Goldinger and Hansen argue that: *"Given difficulty in recollection, people rely on ''gut feelings'' […], which are susceptible to manipulations of fluency or arousal."*. Similar evidence for afferent feedback from the autonomic nervous system influencing recognition-memory was found in a face recognition manipulation using faces presented during cardiac systole (maximal visceral feedback) versus faces presented during cardiac diastole (minimal visceral feedback). In a series of elegant experiments, Fiacconi et al (Fiacconi, Peter, Owais, & Köhler, 2016) were able to show that faces presented during cardiac systole were more likely to be judged as "old" and this influence of cardiovascular feedback was specific to those trials in which participants reported a feeling of familiarity without successful recollection of contextual detail. The evidence reviewed here supports the hypothesis that at least some epistemic feelings are based on bodily feedback, mirroring the theory of emotions as based of the feedback from one's own bodily experience (James, 1884). Might '*gut feelings*' simply be a poorly defined container term for the different kinds of embodied epistemic feelings which play a role in judgment or decision-making?

Playing games with intuition

The first task I would like to introduce is the "Intuitive Reasoning Task" (IRT), which evolved out of the classical IGT. The authors' definition of intuition follows Daniel Kahneman's concept of intuition as: "automatic, emotional judgment about whether the contemplated response is a good or bad option" (Kahneman, 2003). In the IRT, participants learn to distinguish profitable decks of cards from unprofitable ones, over the course of 100 trials. The intuitive ability of participants is defined, in the context of the IRT, as the degree to which an individual learns the so-called *optimal behavioral strategy*, following the completion of all trials. In each trial, participants choose one of four displayed decks and subsequently guess if their chosen card is the same color as a single, upturned card displayed in the center of the screen. Monetary loss or gain on each trial indicate the correctness of an individual's guesses. Unbeknownst to participants, the outcomes of each deck are predetermined by a computer. In the study by Dunn and colleagues, which I will use as representative example, anticipatory bodily measures (defined as somatic markers) were measured using heart rate detection and EDA (Dunn et al., 2010). After completion of the IRT, interoception was measured using the Schandry heartbeat perception task (Schandry & Bestler, 1995). Dunn and colleagues found that anticipatory bodily responses (ABRs) differed between profitable and unprofitable decks. Moreover, ABRs influenced intuitive ability more strongly as interoceptive ability increased.

Taken together, the definition of intuition as well as that of intuitive ability make use of quite strong normative presuppositions. Learning an optimal behavioral strategy in a rigged (online) card game boils down to the individual learning to mistrust their own (previous) experience. This conceptualization of "intuitive ability" seems like the polar opposite of what humans learn as optimal behavior in the wild. It certainly is contrary to the definition of intuition proposed by Betsch and colleagues (section 1), in which intuition is seen to primarily reflect prior experience and capitalizing on stored representations. It is, however, in line with the puzzling finding that many studies of rational behavior actually find that, contrary to popular belief, it is neurological and mental abnormalities seem to foster conformity to norms of rational decision making, while fully intact cognition stands in the way of rational behavior as defined by these (neuro)economic and psychological studies (Hertwig & Volz, 2013).

Why is this difference in definition important? On the view of the study authors (Dunn et al), intuition seems to boil down to a valence indicator. Which is precisely the result they find. The feeling under investigation is operationalized as anticipatory bodily signal, directly used as valence or value indicator. Thus, this *gut feeling* could perhaps be conceptualized as bodily appraisal that is directly integrated into the decision process, but not as emotional or epistemic feeling. As I pointed out in the previous section on epistemic feelings, the bodily component of epistemic feelings has (thus far) only been shown to indirectly influence decisions via changing the subjective experience of the individual. The subliminal buzz changed the feeling of familiarity and the furrowed brow the feeling of mental ease, while those epistemic feelings in turn then changed the individual's judgment.

It seems that in IGT/IRT participants learn (with immediate feedback!) the "normatively correct" answer to the task. In social judgments, learning occurs across your lifetime and feedback is much more indirect (wondering if the couple sitting across from you are lovers or friends, you may never actually know the correct answer to, unless you get up and ask). Perhaps this is why, in such situation, we rely on e.g. a feeling of knowing as a proxy for experiential feedback. Thus, bodily feedback such as heart beat detection might actually be much more *directly* integrated into judgment in the IRT tasks than during impression formation.

Feeling intuitive coherence judgments

The second example is an investigation into the subjective experience of intuitive coherence judgments in the semantic coherence task, by examining the effects of affect and fluency on such judgments. To reiterate, the semantic coherence task requires participants to judge word triads as coherent, if they perceive them to have a common solution word (such as the triad “playing”, “credit”, and “report” for which the common associate is “card”). The study by Topolinski & Strack (2009) discussed in the following section was based on material developed by Bolte and Goschke (2005). Participants were informed about the hidden semantic coherence of the triads and were given examples of both coherent and incoherent ones. In each trial, participants were presented with a word triad and subsequently asked to judge the triad as coherent or incoherent. This judgment was restricted to a reaction time of 500ms. During the experiment, participants were exposed to background music via headphones. To achieve reattribution, individuals in the fluency-reattribution condition were told: *"Previous research showed that this music influences the easiness of reading and the fluency with which the meaning of words is recognized."*, whereas in the affect-reattribution condition it was mentioned that: *"Previous research showed that this music influences the emotional reactions of individuals"* (Topolinski & Strack, 2009).

Participants' experience of reading fluency was thus reattributed to an unrelated source, in order to discount either fluency or affect from their intuitive coherence judgments. The authors' argued that if individuals have the experience of both fluency as well as affect upon judging a triad as coherent, their intuitive judgments (i.e. judging triads as coherent without being able to name the solution word) should remain diagnostic in both reattribution conditions, since they could switch from relying on the feeling of fluency to affect and vice versa (Topolinski & Strack, 2009). However, when participants discounted affect from their intuitions, they lost the ability to detect coherence (even though they could still rely on processing fluency as diagnostic cue). The authors conclude that the internal cue that drives intuitive judgments of semantic coherence is not fluency of processing, but the positive affect triggered by fluency (following the hedonic marker hypothesis by Winkielman and colleagues; P. Winkielman, Schwarz, Fazendeiro, & Reber, 2003). Further supporting the link between affect and fluency, Unkelbach & Greifender (2013) show if the increase in positive affect is high or rapid enough, it may be experienced as a cognitive feeling of ease. Thus, in the work by Topolinski and Strack, both affect and fluency are attributed to intuitive judgments (of coherence), although fluency itself is not seen to be enough of an internal cue. Summarizing this kind of evidence, Winkielman and colleagues argue that: *“the* *integration at the level of subjective experience interacts with high-level decisional processes. That is, the exact impact of experience on stimulus judgments depends on the perceiver's beliefs about the sources and relevance of the experience for the task at hand"* (Piotr Winkielman, Ziembowicz, & Nowak, 2015).

Despite the fact that the authors do not use the notion of *gut feelings* in describing their work, Topolinski and Strack do link intuition to a feeling and refer to the work of Damasio and colleagues (1997) in their definition: *"intuition is predominantly seen as a feeling that emerges from processes operating outside of awareness and then enters the individual's experiential awareness."* However, in contrast to the SMH literature and the first empirical example in the section above which used the IRT as task, the 'feeling' under investigation by Topolinski and Strack does not map onto the same kind of feeling concept as the one used by Damasio. First and foremost, the feeling of fluency and the fluency-induced positive affect cannot be seen as valence markers which are “biasing” an individual’s judgment in the present study. Rather, the affect cue enters into the intuitive judgment as an internal sense of coherence, whereas the coherence-triggered fluency does not enter into awareness but remains in the fringe of consciousness. Nevertheless, since the feeling of fluency is the basis of the affective component of the intuitive coherence judgment, both affect (‘liking’) and fluency are feelings involved in these intuitive judgments. Thus, there are arguably two types of *gut feelings* involved in this particular task: affective or emotional feelings and epistemic feelings (here: fluency).

In a similar vein, attempts to empirically investigate the arousal and valence elicited by intuitive versus deliberate processing strategies via EDA actually came up with results contrary to the standard findings in the SMH literature. Zander and colleagues employed a semantic coherence task (the same one as used in the work by

Topolinski and Strack introduced above) to test whether arousal and valence markers would differ between task blocks in which individuals employed an intuitive versus a deliberate strategy for their judgments of coherence. Contrary to the classical finding that autonomic (skin conductance) response heightens with intuitive ability, Zander and colleagues found lower EDA signals for intuitive than deliberate task (Zander et al., 2016). However, as has been rightfully pointed out elsewhere (Herbert & Pollatos, 2012), most of the findings that highlight the visceral component of cognitive processes are based on correlational data and a causal involvement of interoception still needs to be proven. Based on the evidence discussed thus far, one might ask in objection: Can *gut feelings* be measured by measuring interoception? The answer to this may well depend on your definition of *gut feelings*.

Conclusion

"Human rational behavior is shaped by scissors whose blades are the structure of task environment and the computational capabilities of the actor." – HERBERT A. SIMON

I started out by claiming that the term "*gut feelings*" is used to denote different types of feelings in the context of intuition research. It is unclear what type of "feeling" concept is alluded to by the use of the term (*gut feelings*), or if it denotes any particular concept beyond a colloquial synonym for the word intuition. If, however, *gut feelings* boil down to simple valence (and/or arousal?) markers, as some seem to suggest, then using the terms intuition and *gut feelings* synonymously, as several authors have been wont to do, does not do the strength and usefulness of intuitive processes justice.

Characterizations of intuition differ and not all of them mention a component of *gut feelings*. What you take *gut feelings* to be also depends heavily on your definition of intuition – which differs widely across disciplines (cp. Strack & Deutsch, 2015 for an excellent review on this topic). As Glöckner and Wittemann put it: *"We suggest that intuition is used as a label for different kinds of automatic processes"* (Glöckner & Witteman, 2010).

The present work is by no means an exhaustive overview of the different uses of the concept of *gut feelings* in intuition research. Rather, it is meant as an invitation to intuition researchers, to pay attention to the concepts they are conjuring through their choice of words and to use rigor in defining their theoretical basis such that empirical investigations might lead to fruitful results. It might be further interesting to look at the intuition literature through the lens of critical discourse analysis, to disentangle the myriad ways in which '*gut feelings*' are being appealed to linguistically, as part of the intuitive process.

If by invoking a notion of *gut feelings* the respective author is trying to draw attention to an embodied component of intuitive judgment or decision-making, it would be more useful and less confusing to do just that: speak of embodiment and thus make use of the knowledge base of embodied cognition and emotions. Then, perhaps, new avenues of investigation might be illuminated, such as testing the three-dimensional model of interoception proposed by Garfinkel and colleagues (Garfinkel, Seth, Barrett, Suzuki, & Critchley, 2015) in different modalities of intuitive judgment. A prerequisite for this endeavor, however, is clarity about what types of feelings are expected to be constitutively linked to intuition and when they are expected to enter the process.

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IV. LIST OF ABBREVIATIONS

D-I-model	default interventionist model
DPT	dual process theories
E&S	Evans and Stanovich
fMRI	functional magnetic resonance imaging
HMMs	hidden markov models
IGT	Iowa gambling task
JDM	judgment and decision making
mOFC	medial orbitofrontal cortex
OFC	orbitofrontal cortex
SMH	somatic marker hypothesis
T1	type 1 processes
T2	type 2 processes

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