Emotion Recognition as Pattern Recognition: The Relevance of Perception

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Abstract: We develop a version of a direct perception account of emotion recognition on the basis of a metaphysical claim that emotions are individuated as patterns of characteristic features. On our account, emotion recognition relies on the same type of pattern recognition as is described for object recognition. The analogy allows us to distinguish two forms of directly perceiving emotions, namely perceiving an emotion in the (near) absence of any top-down processes, and perceiving an emotion in a way that significantly involves some top-down processes (including expectations and background knowledge); and, in addition, an inference-based evaluation of an emotion. Our model clarifies the epistemology of emotion recognition.

Introduction

How do we understand the emotions of others? Answers to this question are constrained by one's underlying theory of what an emotion is. Here we develop a pattern theory of individuating emotions, and on that basis argue for a particular theory of how we recognize emotions. Understanding what another person feels is a special case of our ability to understand other people's minds. Core questions concerning the epistemological problem of other minds are, first, the general epistemological question of how I can be justified in believing that other humans also have experiences at all, and second, the more specific question of how I can be justified in believing that others have the same type of pain, joy, beliefs or desires as I do. The problem of other minds presupposes an asymmetry in our access to our own experiences as compared to our access to the experiences of others. One strategy in the philosophical discussion is thus to deny the existence of an epistemic asymmetry right from the outset. This is what Gilbert Ryle (1949) does when he claims that the epistemic access to one's own and to another person's mental phenomena is of the same nature, the only difference being that I am more familiar with myself than with others—i.e. there is a difference only in the information base and not in the way I access this information.

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In contrast to Ryle, we accept that there is an epistemic asymmetry; however, we do not draw any skeptical conclusions. One way to solve the epistemological problem of other minds is to argue that access to some mental states of others is perceptual and not mediated by inferences: accordingly, we argue that emotions are characteristic cases of perceivable mental states. In the first section of this article we discuss the idea that mental states can be directly perceived in the behavior of others (Gallagher, 2001, 2007, 2008a, 2008b; Zahavi, 2008; Green, 2010). This idea stands in opposition to the traditional view that we have to infer them from behavior; this latter view is called inferentialism.

Perceptual accounts have to explain how the perception of mental states is possible. We will offer such an explanation for emotions. More precisely, we will focus on emotional episodes, i.e. an emotion type which is instantiated in a situation and which usually does not have a long-term duration (in contrast to moods or affective personality traits).

We will suggest a way to spell out the perceptual account by answering two questions. First, what features do emotions have and which ones are perceivable in an interactive situation? We argue that emotions are individuated as emotion patterns comprising a range of characteristic features (Section 2). The second key question is: how does the perceptual process operate when we see the emotions of another person? In Section 3 we will characterize the epistemic access to the emotions of others as a process of emotion pattern recognition constituted by cue combination and cue integration. In Section 4 we conclude by discussing some consequences of our account of emotion recognition for the debate on understanding other minds.

1. Understanding Others through Direct Perception or Inferential Reasoning

Traditionally, understanding other people's mental states has been framed in terms of understanding the beliefs and desires of other people by inferring them on the basis of their behavior and some additional assumptions. A paradigmatic case of social understanding is the so-called false-belief task (Wimmer and Perner, 1983). In this task, subjects observe another person looking for an object. They can only explain or predict her behavior if they understand that she is wrong about the object's whereabouts. In the so-called Theory Theory, these underlying assumptions are law-like generalizations about the relation between behavior and mental states. Together, they form a body of knowledge which is considered either as being anchored in modules (Baron-Cohen, 1997; Carruthers, 2013) or as acquired very much like a scientific theory (Gopnik and Meltzoff, 1997). According to Simulation Theory, no theory-like body of knowledge is needed because we use ourselves as a model for the other. We put ourselves in someone else's shoes, simulate what we would be thinking if we were in his shoes, and ascribe the result to him (e.g. Goldman, 2006). Simulation theory rests on the assumption that others are fundamentally like me (Gallese, 2005; Meltzoff, 2007)—but this is true at best only for basic human needs.

Human personalities vary strongly even under normal conditions and within one culture. Furthermore, if the other suffers from mental disease, or if she is a member of a culture which is radically different from mine and unfamiliar to me, I may have no basis for simulation (Newen and Schlicht, 2009). Both accounts presuppose that there is a gap between observing the behavior of the other and evaluating the mental state she is in, which has to be bridged by some type of *inference*. The inference is realized either by using a minimal folk-psychological theory (which is either acquired, or innate and implemented by modules), or by simulating being in someone else's shoes. Direct perception accounts, meanwhile, deny the existence of such a gap and the need for inferences. According to them, our access to others' mental states is often direct and unmediated, although this still renders occasional simulating or theorizing warranted.

Perceptual accounts of understanding others have mainly developed in an empirically informed phenomenological framework (Zahavi, 2008; Gallagher, 2001, 2007, 2008a, 2008b). Gallagher calls his theory the 'Interaction Theory' in order to emphasize that the paradigmatic case of understanding others involves on-line interaction between a person and the environment, or between two or more people. In contrast, both analytical philosophers and psychologists investigating classic versions of the false belief task implicitly assume that the paradigmatic case is a detached, observant perspective towards the other—a perspective in which the observer is concerned with predicting and explaining the behavior of the people she observes. Phenomenologists argue that in daily life we take this perspective only in exceptional cases (Zahavi, 2008, p. 515).

With on-line interactions as our paradigmatic cases, it becomes more plausible to argue that the inferentialist's premise that mental states are always hidden from us is fundamentally flawed.

> In most intersubjective situations, that is, in situations of social interaction, we have a direct perceptual understanding of another person's intentions because their intentions are explicitly expressed in their embodied actions and their expressive behaviors. This understanding does not require us to postulate or infer a belief or a desire hidden away in the other person's mind (Gallagher and Hutto, 2008, p. 20).

However, emphasizing that most of our understanding takes place in an interactive context—from a second-person perspective—and not from a detached observant third-person perspective, is to be distinguished from the perceptional hypothesis itself, which is the focus of this article.

Perceptual accounts draw on findings from neuroscience, especially on the mirror neuron system (Iacoboni *et al.*, 1999; Rizzolatti and Sinigaglia, 2008). Mirror neuron activity does not represent a bodily movement but rather goal-directed behavior with sensitivity to the actor's intentions. Thus, even basic forms of registering an activity are not just cases of seeing meaningless movements which we have to interpret afterwards; rather, the process of perceiving an activity involves the registration of

intention-based activity. This is partly transferable to emotions: we do not just see facial expressions and then use inferences to interpret which emotion this person may have; rather, the recognition of the emotion is part of the recognition of the face (in nonpathological cases). For disgust, there is evidence that the same brain areas which are active when feeling disgust (i.e. the anterior insula) are also active during the perception of disgust (Calder *et al.*, 2000). For some other emotions such as fear and sadness the same hypothesis has been investigated, but results are still inconclusive (see Lindquist *et al.*, 2012 for a review). The minimal consensus across opposing theories is that mirror neurons support a process of face-based recognition of emotion (Goldman, 2006; Gallagher, 2007).

To what extent does this support a direct perception view? Gallagher (2007) argues convincingly that this is not a process of simulation. Furthermore, (a) face-recognition is fairly modular (e.g. FFA is a central component); (b) face-based recognition of emotion seems to be somewhat modular too, since it is extremely quick and develops early in ontogeny. This excludes the involvement of a theory in terms of a package of systematically interconnected beliefs. For now, it leaves open the possibility that inferences are implemented by an innate module (the modular version of Theory Theory). We will discuss this option in Section 3 when clarifying the details of our view. Taking these points together, though, it seems implausible to hold that the recognition of basic emotions such as disgust must involve inferences realized by simulation or by using a theory as a package of systematically interconnected beliefs (for a discussion of understanding others, see Newen, 2015).

Most proponents of direct perception as well as inferentialists assume the thesis that for non-inferentially perceiving another person's mental state (e.g. Jack's being angry), it would be necessary and sufficient that some constitutive parts of the mental state are embodied and therefore visible (e.g. Jack's angry face).[1] This is a premise of what McNeil (2012) calls the Embodied Perception Theory. Both camps (direct perception accounts as well as inferential accounts) accept this premise, but disagree on the question of whether emotions have embodied and therefore visible parts. This discussion focuses on the question of whether an expression is a constitutive part of an emotion or just an effect of it. Green (2008, 2010) argues that in the case of expressed emotions we can perceive an emotion by perceiving its expression, which is a constitutive part of the emotion. An inferentialist will disagree. Although

[1] The divide between perceivable and in principle non-perceivable features of emotions is to some extent theory-dependent. A phenomenologist such as Gallagher and an inferentialist will not agree as to which features of an emotion are directly perceivable: while the inferentialist holds that feelings are purely private entities, the phenomenologist insists that we directly perceive what the other person is feeling when watching his expressions. We see that another person is in pain; we do not have to infer it from his expressions. The question of what counts as a purely private entity is their principal source of disagreement. While the phenomenologist will dismiss the idea of purely private mental entities as 'Cartesian', the inferentialist will not find Cartesianism so threatening. It is not clear how to decide whether Cartesianism is to be avoided from a theory-independent perspective.

she could agree that typical expressions reliably accompany emotions, she would insist that they are merely causal effects of the emotion that can be taken as clues for the ascription of it. In her view, we would first perceive certain clues such as facial and bodily expression, and then infer the person's emotion from these clues. McNeil argues that the background assumption of the Embodied Perception Theory is false; it is neither necessary nor sufficient that bodily expression is a part of the emotion (and not just an effect) for the emotion to be directly perceivable. Instead, he argues that it is sufficient that we see the angry expression *as a causal effect* of anger, in order to be justified in saying that we directly see the anger. Alternatively, it is sufficient for direct perception that there is a perceptual process which *causes* a person to directly see the other person's emotion.[2] The challenge McNeil poses to proponents of perceptual accounts is to provide a causal story of how we manage to see another person's emotion independent from seeing *specific* embodied features like the facial expression.

Our pattern recognition account will provide such a causal story. It allows us to characterize expression and expressive actions as constitutive features of an emotion, while at the same time maintaining that they are not necessary features of all instances of the relevant type of emotion. To elaborate on this, we need a new understanding of 'being a constitutive feature', which we develop below. Our account of recognizing emotions is dependent on but not determined by our view on what emotions are. We claim that emotions are individuated as patterns of characteristic features. On this basis we will then argue that emotion recognition can be described as a process which is analogous to the perceptual process of object recognition. However, the process is a special form of perception in that a person has to integrate perceptual information from various sources in order to recognize an emotion by recognizing a specific type of pattern. This process of recognizing a pattern is analyzed as involving *cue combination* and *cue integration*.

2. Emotions as Patterns and our Understanding of 'Constitutive Feature'

We will take 'emotion' to be a cluster concept, characterized by a sufficient amount of characteristic features, none of which are necessary.[3] This implies that there are

[2] McNeil uses an analogy in order to argue that seeing parts is not necessary for seeing the whole: you directly see the wood (you see it epistemically in virtue of seeing it non-epistemically) from a plane. You are too far away to see any single tree. What makes you see the wood is that you are causally related to the wood. The same can be true of anger; you are causally related to Jack's anger in virtue of seeing his expression. It does not matter whether the expression is a constitutive part of Jack's anger or an effect (this is why embodiment is not necessary). But this causal relation is necessary also if the embodiment hypothesis obtains (i.e. that bodily expressions are a constitutive part of an emotion). This is why arguing for the embodiment of emotions is not sufficient.

[3] The idea is inspired by Wittgenstein's notion of family resemblance and defended in Welpinghus and Newen, 2012.

borderline cases, cases for which it is not clear whether they qualify as an emotion. To a degree, this cluster account also applies to specific emotion concepts such as fear, sadness, pride or jealousy. However, for some emotion concepts, some features are indeed necessary (e.g. test anxiety involves thinking that an exam is going to take place) while others are merely characteristic. We argue first that emotions are individuated as patterns of characteristic features and second that the recognition of emotion is basically a process of pattern recognition.

The idea that emotions are organized in patterns is not new; it is advanced for instance by Izard (1972) and Izard *et al.* (2000). Our approach also bears some resemblance to Klaus Scherer's component model of emotions which lists features typically present during an emotion but does not identify any of them as necessary and sufficient for emotions nor as capturing the emotion's essence (Scherer, 2009).[4] Scherer's model captures *intra-individual* cognitive processes in detail. In contrast to this, we will focus on those features of emotions which can be easily recognized by other people. We will now list and briefly characterize all the types of features relevant for the individuation of emotions, before focusing on the recognition part:

(1) Autonomic physiological responses: William James (1884) famously claimed that an emotion is the perception of bodily changes, especially changes in autonomic nervous system (ANS) activity. Physiological parameters controlled by ANS activity are crucial for Jamesian emotion theories. However, since not every emotion has a clearly distinct ANS pattern, especially when it comes to more fine-grained distinctions, even clearly Jamesian accounts of emotion such as that by Prinz (2004) have to provide an account of emotion which grants that two different emotions need not have different patterns of ANS activity. They are to be distinguished by other features.[5]

(2) Expressive actions and action tendencies: the psychologist Nico Frijda coined the term 'action tendency' (which stems from Arnold, 1960) for a felt urge to perform a certain kind of action. This urge is also manifest in bodily changes which are suitable preparations for these actions. He tends to equate emotions and felt action tendencies (Frijda, 1986, p. 71), a move we do not share. Specific actions or action tendencies, considered by themselves, are neither constitutive for every type of emotion nor can they alone constitute any emotion: emotions such as happiness are not accompanied by a specific action tendency. An action tendency may or may not become manifest in actual expressive actions. Although actions

[4] See also Mees, 2006, for a similar characterization.

[5] Prinz (2004) argues that some emotions are individuated by a calibration file, i.e. a mental file which includes different judgments that are unified because they all bear on the person's well-being in the same way. Prinz's strategy is officially to claim that the calibration file is part of the cause of the emotion but not constitutive for it. Since at the same time he describes the calibration file as being the essential feature for individuating an emotion, this is, in the end, not a consistent position (Barlassina and Newen, 2013).

out of emotions are rather flexible, there is typical behavior for some emotions, such as freezing or fleeing in fearful situations. We routinely rely on expressive actions as well as signs for mere action tendencies in emotion recognition.

(3) Bodily expression: bodily expression can be divided into (a) facial expression, (b) posture, (c) gesture, (d) vocal expression such as screams, roars or laughter, and (e) tone of voice. We subsume these under the heading 'bodily expression' because all depend on muscle contractions and because these components are usually perceived together. We see a proud person talking: we see her smile, her erect posture; we hear her self-satisfied tone of voice. This leads to an overall impression of her as proud; under normal conditions, we do not pay attention to any of these components separately. Laboratory studies point towards an early integration of these visual and auditory cues (Campanella and Belin, 2007). On the other hand, experiments show that facial expression alone (Ekman, Friesen and Ellsworth, 1972) is sufficient to recognize some coarse-grained distinctions, as is posture and gesture (Atkinson *et al.*, 2004).

(4) Phenomenal experience: emotions are normally accompanied by a particular phenomenal quality or feeling. We do not consider phenomenal experience as necessary because there may be rare cases of emotions in the absence of such feelings when typical physiological, expressive and cognitive aspects are present (the paradigmatic case is a person with a strong disposition to repress her fear [Sparks *et al.*, 1999; Weinberger, 1990; Weinberger and Davidson, 1994]).

(5) Cognitive features: these comprise (a) attitudes and (b) shifts of attention and perception. Emotions are often accompanied by cognitive attitudes. Belittling thoughts about the rival are characteristic for jealousy, and a judgment that one has been treated unfairly is characteristic (though neither necessary nor sufficient) for anger, to give two examples. Furthermore, such attitudes are sometimes manifest in behavior or verbally reported. Other cognitive components are shifts of attention, for example being alert to dangers in a state of fear. Through such shifts, emotions can make us perceive things we otherwise would not have perceived. They also make us perceive things in a certain light. Some theorists put characteristic ways of perceiving the world at the center of their theory of emotion (Döring, 2003). We will not equate emotions with ways of perceiving the world, but we do acknowledge that the way we perceive the world during an emotional episode is connected to the emotion's phenomenology and to its role in guiding behavior.

(6) The intentional object: 'intentional object' is a technical term for the object the emotion is about. 'This can be a particular thing or person (that pudding, this man), an event or an action (the earthquake, your hitting me), or a state of affairs (my being in an aeroplane)' (Goldie, 2000, pp. 16–17). It is not always real. The intentional object is crucial for the more fine-grained classification of emotions, for example for distinguishing envy from jealousy.

All the features we have just introduced can be thought of as variables which can take different values (the variable facial expression can take the values 'fearful expression', 'sad expression', etc.). Some values are likely to occur together, others are very unlikely to occur together. This is due to a range of causal mechanisms and constraints, but probably also constitutive and conceptual links. Illuminating these links further is a task for the empirical sciences as well as philosophy. Because some values are likely to occur together, we can learn to distinguish typical patterns of values and form a concept of the overall phenomenon.[6] To illustrate, Figure 1 shows a fear pattern.

Are these features constitutive of an emotion? This depends on one's conception of 'constitution'. According to an essentialist conception of constitution, a constitutive part of something is also a necessary part, i.e. a part in all possible worlds. If the part was taken away, the leftovers could no longer form the same type of phenomenon as before. According to our view of emotions as patterns, emotional features are not constitutive in the essentialist sense, because we allow for the possibility that a token of a type of an emotion lacks some features that are characteristic of that type. Even a very few characteristic features can be sufficient for an emotional episode to be a token of the type *anger*. Those features of an emotional episode which contribute to it being a token of a specific emotion type are the constitutive

[6] We should clarify the relationship between our pattern account of emotion and earlier philosophical component theories of emotions which had some deficits which we do not inherit. These component theories analyzed emotions as beliefs plus desires plus (often) feelings (e.g. Lyons, 1980; Robinson, 1983). Goldie (2000) argues that a belief-desire account of emotion does not adequately account for the emotions' intentionality: emotions are about the world, like beliefs, and they motivate us to act, like desires. Goldie argues, however, that there is a peculiar emotional way of being about the world (i.e. of intentionality) which is not reducible to the intentionality of beliefs and desires. Let us assume that Goldie's objection is valid. It does not apply to our account because we do not aim to reduce emotions to beliefs, desires, and an add-on phenomenal quality in order to account for the emotions' intentionality. Neither do we claim that it is only by beliefs or desires that an emotion carries its intentional content. Döring (2009, pp. 31–33) complains that component theories cannot explain how an emotion's components form a new, distinct mental entity. Component theories would only list putatively necessary components without specifying how a new mental state emerges from their combination. Her main criticism does not apply to our account because we emphasize that this characterization does not suffice for a full-blown emotion theory. Spelling out the causal, constitutive and conceptual links between these elements is a further task required for a full-blown theory of emotions. Such a theory should explain how a mental entity with its characteristic aspects is formed. If Döring's criticism is directed to the fact that component accounts cannot explain why an emotion is (usually) experienced as a unitary conscious state, we appeal to a division of labor: providing such an explanation is a problem which concerns the unity of consciousness in general. We fully acknowledge that an emotion is experienced as a unitary conscious state, but we will not provide an explanation of why and how this experience comes about. Providing such an explanation is not necessary for a plausible philosophical account of emotions. Otherwise the problem would also affect Döring's and Goldie's accounts—they merely emphasize the unity of emotional experience, and do not provide an explanation for it either.

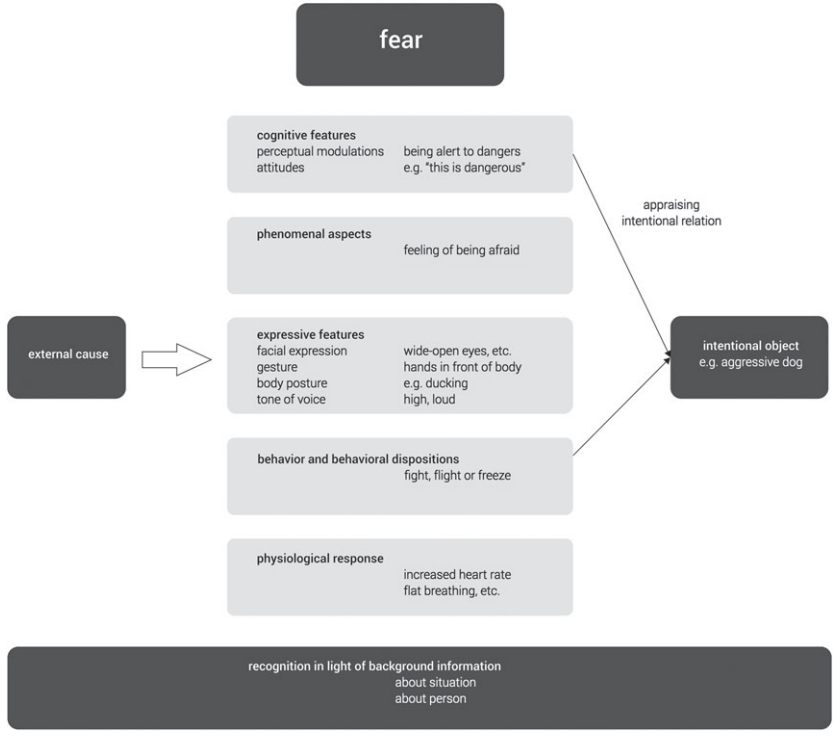

Figure 1 *Fear pattern*

parts of an emotion pattern.[7] The fact that a person is sitting in a car during her angry episode may belong to a token of anger but it is not constitutive of anger.[8] We suggest a notion of being constitutive for X that accounts for X being a pattern. A feature F is constitutive for a pattern X if it is part of at least one set of features which is minimally sufficient for a token to belong to a type X. 'Minimally sufficient' means that these features are jointly sufficient for the episode to be of type X, but if one of them were taken away the episode would no longer count as an instance of X. According to our view, emotions *usually* include overt bodily features (expression or characteristic actions)—if characteristic expressive aspects occur during an emotion episode, they are constitutive and not just an effect of the proper emotion, or a cause for it—but emotions do not always involve expressive components.[9]

[7] We are presupposing a realism about patterns such that in principle for each combination of features it is possible to clarify whether this is an instantiation of the relevant pattern or not. We can of course grant that there are borderline cases.

[8] We thank Kenneth Aizawa for pressing us to clarify this point.

[9] If someone is trained to inhibit any expressive sign of his emotion, we may still be able to recognize the emotion by inference, e.g. by noticing the force that someone uses to inhibit their expressions in a given context.

One might wonder whether our list of features is exhaustive. Should we include neural correlates, for example? Features like ANS response, behavior, cognitive attitudes, perceptual shifts and expression all have neural correlates: neural correlates are thus not an extra component in addition to the others—we might mention them as an informative aspect for the individuation of features of emotion, but we do not have to, since they concern the same features already mentioned only with information accessed in a different manner.[10] They may be used in a clinical or scientific context to infer whether a person is having emotions, but are not used in ordinary contexts since we cannot access them in ordinary interactions.

It is also crucial to distinguish the factors relevant for individuating emotions from those which facilitate (or impair) the recognition of emotions. Contextual factors for the recognition of emotions include most prominently (a) the pragmatic context in which it occurs and (b) the personality, goals, beliefs etc. of the person having the emotion. These features do not belong to the emotion pattern but are only relevant for the recognition of other people's emotions.[11] One may also wonder whether the list of features includes too many features and whether some can be reduced to others: this may be possible—and desirable—in principle, but given the state of the art in cognitive science we have no convincing candidate for a theory which reduces emotions to fewer features and would still allow us to describe the great variety of emotion phenomena.

3. Emotion Recognition as Pattern Recognition

The main idea developed in this section is that emotion recognition is a process of pattern recognition: Empirical support for this approach is provided e.g. by Wieser and Brosch's (2012) review of the factors that influence how we evaluate the emotional expression of faces, among them body posture, affective prosody and other contextual cues. We also perceive the incongruence between, for instance, a happy face and negative affective prosody and try to establish the most probable registering of one type of emotion.

In providing a new version of explicating emotion recognition as pattern recognition we propose a new variant of a perceptual theory of recognizing emotions. We will characterize the process of pattern recognition as one of cue combination and

[10] This is at least true if we presuppose an identity theory of mental and physical states. We tend to favor this view, but at the same time we presuppose that the relevant physical state involves more than just a neural state, i.e. the whole body and perhaps part of the environment.

[11] Test anxiety may be an emotion Peter is having by thinking about the exam in the upcoming week (having the characteristic intentional object and attitudes together with bodily states) even if he is just sitting in a coffee bar. But it is much easier to recognize his emotion if I can see Peter anxiously walking up and down in front of a professor's door with the sign 'oral exams today'.

cue integration that culminates in an activation of the most plausible representation of an emotion pattern. The latter presupposes observers possessing normal conceptual[12] competences. We will distinguish between two types of emotion recognition: (1) (a basic form of) perceiving an emotion in the (near) absence of any top-down processes, and (2) perceiving an emotion in a way that significantly involves some top-down processes (a strongly concept-modified form of perception). Both types of perceiving emotions can be distinguished from (3) inference-based evaluation of an emotion pattern. The latter presupposes a stable evaluation of an emotion as being F, which then may be modified or reevaluated by reflecting on the information.

We understand top-down processes as specific processes involving prefrontal activation of the brain, presupposing as a minimal consensus that prefrontal activation of the brain is necessarily involved in the activation of complex cognitive processes which can be loosely understood as conceptual. Here we can rely on studies which show that such prefrontal activation is at least sometimes involved in standard perceptual processes.[13]

To develop this distinction we first introduce the central model of cue combination and cue integration that constitutes the pattern recognition of emotion. This enables us to contrast this account with inferentialism (Section 3.1) and to characterize in more detail the two types of emotion recognition and the third case of inference-based evaluation mentioned above (3.2). Finally we illustrate the proposal by discussing the case of recognizing jealousy (3.3).

We characterize the process of pattern recognition as one of cue combination and cue integration that culminates in an activation of the most plausible representation of an emotion pattern in the same way the process of object recognition leads to a stable percept of an object. We take the relevant model of object perception from Ernst and Bülthoff (2004). It describes how a stable percept is developed by merging the senses. The process involves the following core principles: (i) the bottom-up processes that start with sensory cues lead to a first sensory estimate. (ii) The relevant sensory cues are used for cue combination and cue integration: cue combination is a process of binding together non-redundant features of the same entity from different senses to enlarge the class of relevant features. Cue integration is a process of systematic weighting redundant information to exclude some irrelevant features. (iii) The development of a stable percept relies on both processes to establish a Maximum Likelihood Estimate (MLE) relying on Bayesian principles. (iv) This process of establishing a MLE can be influenced and constrained by top-down processes (Pompe, 2011; Newen and Pompe, 2009). So we distinguish between two variants

[12] We allow for the case of emotion recognition without ascribing it to the other, i.e. without conceptualization, but this case will not be the focus of this article. For the sake of argument we can equate conceptual and linguistic abilities. For a fine-grained distinction between linguistic and non-linguistic concepts in the context of animal cognition, see Newen and Bartels, 2007.

[13] We are not discussing here what it means to possess concepts since it is sufficient to account for top-down influences to establish a general picture of perceiving emotions.

of the process of establishing a MLE that may occur together. (iv.a) Sensory inputs may trigger relevant conceptual background information that directly influences the process of searching for the most probable percept (MLE). (iv.b) In addition, the percept can trigger a cognitive evaluation (a judgment) of the object that may influence the percept, e.g. modulating the focus of attention in the context. Thus, the percept of an object is a product of sensory cue combination and integration influenced by two types of top-down processes.

This model of object recognition can be directly transferred into a model of emotion recognition including all four aspects while only the input is different in the case of emotion recognition. The process of pattern recognition involves a multifactorial weighting process organizing sensory cues (facial, gestural, further bodily cues, fearful tone of voice etc.) from different sense modalities, on the one hand, and accounting for other cues like social and personal background information, on the other. Thus, there is a plausible sense in which we can say that we see an emotion while seeing a person having the features mentioned above. The percept we have is directly associated with the activation of an emotion pattern which we are able to distinguish from others. Furthermore, the development of an emotion percept may be influenced by exactly the same two types of top-down processes which have been identified for object recognition: situational and person-specific background information can trigger the two types of top-down influences, either directly modifying the basic bottom-up processes of forming an emotion percept or modifying only the judgment based on an emotion percept. Thus, the percept of an emotion is a product of sensory cue combination and integration influenced by two types of top-down processes. Evidence for the claim that emotion recognition are essentially based on a process of perception integrating several features into a pattern (parallel to object perception) are also delivered by a review of the recognition of emotional status (Macrae and Quadflieg, 2010, esp. pp. 431 ff.). Now we want to deliver an argument for why the process of cue integration and cue combination is best characterized as noninferential.

3.1 Arguments against Inferentialism as the only Recognition Strategy

We will analyze the case of an inference-based re-evaluation of an emotion pattern to show that this is not a case of pattern recognition but a different type of cognitive process that transcends the process of perception. Inferentialist accounts take this model as providing an adequate account for all cases of recognizing emotions. As already noted in Section 1, we disagree. To argue against the inferentialist account, let us consider a very simple paradigmatic case of emotion recognition: Peter is afraid of Susie's dog. Susie watches him and notices that he is afraid. How does she notice this? According to inferentialist accounts, Susie perceives only Peter's expression and behavior: his wide-open eyes, his stepping back, moving his hands between the dog and his body, freezing, etc. The content of Susie's perception consists only of these single entities. Susie has to infer Peter's emotion from this perceptual content, either by using an acquired, systematically interconnected folk-psychological theory, or an

innate module for inference (according to Theory Theory), or by using herself as model (according to Simulation Theory).

Two of the three possibilities (using a folk-psychological theory or a simulation strategy) over-intellectualize the process of recognizing fear under favorable conditions: there is no need of a folk-psychological theory for young infants when they *recognize* fear in another person; it is sufficient that children learn to recognize a typical pattern of fear.

Basic emotions like fear, anger, joy and sadness are accompanied by the same type of facial expression in all cultures (Ekman, Friesen and Ellsworth, 1972; Ekman, 1988), and the recognition of basic emotions is observable very early in childhood (for an overview of the developmental data, see Zinck and Newen, 2008). At least under favorable conditions (when the characteristic expressive and behavioral features are clearly perceptible and the context is consistent with the emotion), they are recognized quickly and cross-culturally. Folk-psychological theories understood as a systematic package of beliefs presuppose at least a rich conceptualization involving a rich inferential net. The assumption that basic emotions can only be recognized by employing such a theory overintellectualizes this process. As we have seen, there is no need to accept either the involvement of a systematically interconnected, acquired theory or of a simulation process. The latter can be denied since the recognition of disgust is essentially based on mirror neuron processes and these processes lack the features which define a (high-level) simulation process (see Section 1).

Let us summarize the main points canvassed so far against the view that emotion recognition is an inferential process, and add some more. First, inferential processes are cognitively too demanding to explain early infants' understanding of others (telling against the involvement of folk-psychological theory or simulation processes). Second, there are unconscious and automatic evaluations of others' emotions (Kouider *et al.*, 2009), which is also an indicator against an inferential view. Gallagher and Hutto (2008) have highlighted that most everyday cases seem to be of this automatic type. Third, evidence for neural activity during emotion recognition points towards a mechanism which is different from inferential reasoning (a lot of nonprefrontal areas are involved) despite the fact that top-down processes shape the recognition process (Adolphs, 2002).[14]

So far we have left open the possibility that the recognition process includes inferences that are implemented by a module which does not entail an acquired, systematically interconnected rich theory but rather a set of rules for inferences which is simpler in structure.[15] If this is understood in a strong sense of

[14] It is, however, still controversial whether the mechanism for a basic form of seeing an emotion is better described as perceptual or as low-level simulation (Gallagher, 2007 versus Stueber, 2012). In any case, low-level simulation processes are distinct from simulation in the sense of deliberately putting oneself in the other's shoes, as we described above. The latter is sometimes called 'high-level simulation' (Goldman, 2006).

[15] We thank an anonymous reviewer for pressing us to consider this possibility.

modularity (innate, informationally encapsulated, domain specific, etc.), this view cannot account for the improvement of face-based recognition of emotion with age (Durand *et al.*, 2007). If it is understood in a weak sense of a module (which is not informationally encapsulated etc., but is supposed to implement some inferences), it remains an open question whether we are able to develop an argument against such a specific inferential view.[16] Although our positive account of two types of directly perceiving emotions might be compatible with the weakly modular inferential account, we are not committed to it, since it is possible to characterize the process of perceiving emotions without referring to inferential processes, as we will argue in Section 3.2.

This is not to say that emotions are never ascribed as a result of an inferential process. We accept that humans frequently draw inferences from environmental cues as to what the other person must be feeling. This might also be the case for ascribing an emotion which can, on other occasions, be directly perceivable. Thus, a phenomenologist such as Gallagher can also agree that we routinely use information which is not directly perceivable in the recognition of emotion, especially, but not only, when it comes to fine-grained classification.[17]

We allow for two kinds of uses of inferences. If the information is too sparse such that the type of emotion is underdetermined by the observable information, and such that no pattern of an emotion type is activated, we may use inferential reasoning relying on additional background information to reach an evaluation. In other cases, we have a first evaluation of an emotion but we are prompted by further information or memory to start a reevaluation by inference.[18] Let us complete the picture with an example of the second case of drawing inferences: if I know that a person is suffering from Parkinson's disease and therefore has a severe limitation in controlling her facial expression, I will evaluate the same facial expression quite differently. I have a standard 'reading' of the emotion expressed in the face but my knowledge about

[16] Since we conceive of inferentialism as an account which denies that emotions are directly perceivable, we do not argue against accounts which characterize perceptual processes themselves as inferential on a computational level: first, we think that such a claim is compatible with the direct perception of emotions, and second, we allow for top-down processes as part of direct perception which are basically realized as processes of pattern recognition (whatever computational processes may be involved in the underlying realization).

[17] The fact that not all of our understanding of emotions is a perceptual process is indeed acknowledged by Gallagher and Hutto by describing a sophisticated form of understanding others, i.e. understanding through narratives (Gallagher and Hutto, 2008).

[18] One important factor that fosters emotion recognition is the ability to experience the type of emotion in question. If I am not able to experience disgust, I may have difficulties recognizing disgust in others (for a review, see Barlassina, 2013). The same is true for anger and fear (for a review, see Goldman and Sripadab, 2005). Although we cannot go into the role of self-experience for emotion recognition in the present article, our ontological view that emotions are individuated as patterns can easily account for this observation: the phenomenal experience is one feature of an emotion pattern, and if it is activated (e.g. via mirror neurons) then this supports the recognition of the relevant type of emotion (without determining it completely).

Parkinson's disease helps me to override my spontaneous interpretation. Instead of interpreting the face as showing that the person is unfriendly or not interested in communication, I will start to focus much more on the linguistic communicative interaction to figure out which emotion is instantiated.

3.2 Two Types of Perceiving Emotions

To enrich our perceptual account of emotion recognition, we characterize two types of perceiving an emotion. Let us now consider the distinction between (1) perceiving an object in the (near) absence of any top-down processes being involved, and (2) perceiving an object with top-down processes strongly modulating the bottom-up processes of emotion recognition. To develop this view, we benefit again from the analogy with object perception since there is already a body of psychological knowledge regarding top-down influences on perception.

We argue that the integration of perceptual cues with contextual background information is realized by a combination of bottom-up processes triggered by sensory inputs with top-down processes contributing relevant background knowledge. According to recent theories of perception, object recognition is, on the one hand, based on a bottom-up process that starts from input into the eye which activates the LGN, the primary visual cortex, and then leads to an activation of the dorsal and ventral processing streams, the parietal cortex, the inferotemporal cortex and the perirhinal cortex in a standard sequence (Pompe, 2011). Bottom-up processes are at least partially local; this can be shown by dramatic deficits in the case of local lesions: in one patient, a lesion of V4 and V8 caused a complete loss of color vision, i.e. the person could see the world only in shades of grey (Motter, 1994). Top-down processes could never compensate for such effects.

But top-down processes can influence the bottom-up processes in the sense of cognitive penetration (MacPherson, 2012; Vetter and Newen, 2014). This happens in semantic priming: objects are recognized faster and more accurately after a verbal cue (a prime), which is semantically related to the object, has been subconsciously presented to the subject (Eger *et al.*, 2007). Expectations grounded in noticing the situation and activating relevant background knowledge can help to reduce the number of possible interpretations concerning the object's category (Bar, 2003; Goh *et al.*, 2004; Oliva and Torralba, 2007). Background knowledge may change our attention such that we focus on different features when observing, or it may induce a new grouping of features. An object in a picture of a bathroom might be perceived as a hairdryer while the same perceptual input would have been identified as a gun in a different context (Bar, 2004). In addition, Bar's (2004) model proposes two separate systems, one for the interpretation of objects and one for the interpretation of scenes, which work together in the top-down facilitation of object recognition.

According to our hypothesis, in the case of perceiving persons and their emotions, the same types of processes are activated. So the types of bottom-up and top-down processes modulating object recognition in general can also be found to modulate the perception of a person and her emotions. (Gendron *et al.*, 2012; Adolphs, 2002).

Let us illustrate the two different noninferential cases of emotion recognition: on the one hand, we are able to see the fear, joy, anger or sadness in the face of a person while relying basically on a single feature, or small group of features, connected with facial expression (Ekman, Friesen and Ellsworth, 1972; Ekman, 1988). This can be done through a bottom-up perceptual process that involves almost no top-down influences, especially if the facial expression is very characteristic of an emotion pattern. On the other hand, there is evidence that face-based recognition of emotion is modulated by higher-order cognitive processes. If we see a typically fearful face in a neutral context, we recognize the fear immediately. If we first hear a story describing a very unjust situation which makes us expect that the person we are going to see is angry, we have a strong tendency to see this 'typical fear-type face' as an angry face: for example, if I am told that the relevant person made a reservation at the restaurant, waited for an hour while many other persons who had come in later were served first, and that after an hour she was informed that she had to wait at least for another hour, I have a strong expectation of seeing anger. This has been shown to make us see a typical fearful face as an angry face (Carroll and Russell, 1996). Analogously, the same study shows that a person with a typical angry face (in a neutral situation) is seen as being in fear if the contextualizing story makes us expect her to be in fear. We evaluate the data from Gendron *et al*. (2012) along the same lines: their study shows that the availability of emotion words shapes our recognition of the emotion. While Gendron and colleagues conclude from their results that emotions are recognized only if a concept or word for an emotion is available, the pattern theory of emotion invites a more modest reading of these results. We suggest that they provide another example of the many top-down influences shaping emotion recognition in a way analogous to cognitive penetration in the case of perceiving objects. Unlike Gendron and colleagues, we allow for the recognition of basic emotions under favorable conditions without any top-down processes.

Finally, we want to clarify that involvement of top-down processes does not mean that this process must phenomenologically appear to be more difficult than seeing fear without such processes. The intuition of fluency is dependent simply on training in recognizing complex emotions: in the same way that a professional chess player is able to see a threat to his strategy by seeing his opponent's move in the given situation, an expert in recognizing emotions can fluently and without deliberation deal with recognizing emotions which strongly involve top-down processes. We account for this by accepting that the important difference in characterizing types of perceiving emotions is not the phenomenal ease or difficulty in recognizing the emotion but the type of information processing that we can distinguish.

3.3 Illustrating the Model: Jealousy in Romantic Relationships

After mainly working with basic emotions like fear, we now want to apply the model to a more complex case: the recognition of romantic jealousy.

The main feature that distinguishes jealousy from other emotions is its intentional object, i.e. the dynamics of the relations between the relevant people. Jealousy is a

reaction to the withdrawal of attention or affection by a beloved person in favor of a third person, the rival. Often, this withdrawal is only suspected or anticipated rather than actually experienced. Since the intentional object is an integral part of the pattern of jealousy, we must have an idea of what a person is troubled about in order to recognize jealousy. In addition, we can identify typical cognitive attitudes and foci of attention in jealous individuals: examples would be resentment against the rival and doubts about one's own attractiveness. Jealousy involves a shift of attention: the beloved's behavior is watched much more carefully than in situations not seen through the prism of jealousy. However, emotional arousal, as manifest in physiological changes, expression or feeling, is also crucial for jealousy. A jealous person might manifest a number of expressions which are similar to anger, fear, despair and contempt, but none of them *has* to be present during a jealous episode. Jealousy motivates specific behavior. Thus, jealousy is a typically rich emotional pattern with characteristic features in the categories of vegetative features, behavior and behavioral dispositions, expressive features, phenomenal experience, with an intentional object and cognitive features.

What does it take for an adult to recognize that another person is jealous? The general answer is obvious: it involves the recognition of the respective pattern. Furthermore, we have already developed the view that pattern recognition can be a process that is either mainly a bottom-up perceptual process or may intensely involve top-down processes.[19]

Furthermore, the process of pattern recognition differs depending on how many characteristic features are perceivable in a situation for an observer: this can range from a single feature to almost all features of the emotion. The latter is the case where a person observes a scene at a party involving a couple, John and Mary. Mary, however, is attracted to Mark, who talks to her and dances with her for almost the whole evening. The observer overhears Mark expressing his desire to date her. When the observer sees John approaching Mary with an angry face and furiously and with a trembling voice demanding that she stop interacting with Mark in this way the observer directly perceives an episode of John's intense jealousy on the basis of having seen a wide range of features constituting the pattern of jealousy.

Now consider an encounter between the same people ten days later. This time, the observer, who remembers the party well, observes only a short encounter in which Mary is speaking to Mark in a friendly manner while John observes them with a facial expression similar to anger or hate. Here the observer directly observes another episode of John's jealousy. Here, very little input (observing John's facial expression as he observes Mary and Mark) is (at least sometimes) sufficient for the observer to activate the whole memorized pattern of jealousy due to her background knowledge. In both cases it is plausible to presuppose that top-down processes are involved in emotion recognition since jealousy in a romantic relationship is quite a

[19] This distinction is inspired by the distinction between basic perception and smart perception in Gallagher, 2008b.

rich emotion pattern—in contrast to basic emotions like fear, joy, anger etc., it is not possible to recognize jealousy only by recognizing a characteristic facial expression. Both cases of recognizing jealousy should be distinguished from the inference-based understanding of emotions.

4. Conclusions

Why should we accept that emotions are patterns at all? To describe emotions as patterns fits nicely with the way in which we actually do individuate emotions: via characteristic but not necessary features. It is also the most fruitful level of analysis if we want to use emotions to explain the behavioral dispositions of a person having an emotion (to be more parsimonious would leave a lot of the phenomena of emotion out of focus; to be more liberal would destroy the generality of the ascription of emotions by accounting too much for the individual features of a token of an emotion). If emotions are individuated as patterns, it is convincing to spell out emotion recognition as recognition of the respective pattern. We have argued that this also fits nicely with common-sense observations and evidence from psychology and neurosciences. Once we allow that emotions are patterns, emotion recognition is pattern recognition.

Here we have worked out three types of recognizing emotions to account for the different roles top-down processes may play. While any recognition of an emotion starts with perceiving a person in a concrete situation with some typical expressions (face, gesture, posture and further behavior), the top-down influences may vary widely. We can distinguish (1) direct perception almost without top-down processes, (2) direct perception essentially involving top-down processes (but still no inferences) and (3) inference-based recognition of emotion. The different strategies are analyzed in our model as a consequence of the fact that recognition of emotions functions in a manner strictly parallel to recognition of objects. Both recognition of emotions as well as that of objects are seen as relying on the same functional processes constituting perception of entities (of any kind). Thus, our model has the advantage of being parsimonious.

Finally, our model offers a way to clarify the epistemology of emotion recognition with a variant of a direct perception account in conjunction with an outline of a plausible metaphysics of emotions: emotion recognition takes place as a process of pattern recognition on the basis of constitutive features such as bodily expression, actions, action tendencies, etc. Our metaphysical view that emotions are individuated by dynamic patterns of characteristic features allows us to hold a variant of a direct perception account of emotion without holding the embodied features of emotions as essential for them. This makes our account relevant to various camps. It is a way to spell out the embodiment thesis that we directly perceive emotions by perceiving their bodily features as characteristic features of the emotion pattern. Contra the embodiment thesis, we allow that sometimes bodily features are not involved in emotion recognition. For internalists about emotions, who hold that

emotions do not have any visible parts, the model can still provide an account of our access to other people's emotion which is primarily perceptual as opposed to inferential. Finally, it is of interest to those, like McNeil, who hold that seeing parts is neither sufficient nor necessary for non-inferentially seeing the emotion. According to him, what is needed instead is a causal process in virtue of which we come directly to see an emotion. Pattern recognition as cue combination and integration is just such a process.

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