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Comparison of Four Families of Psychological Emotion Theories

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The current chapter attempts to shed light on some of the complex debates that characterize the emotion domain by situating them within a comparative analysis of emotion theories. The aim is not only to elucidate the inter-species variety, but also the intra-species variety, the variety within theories that are traditionally grouped under the same name. I start by clarifying how scientific theories in general often develop. I then apply this to the case of emotion theories. The reason for making this detour is that it reveals a number of fundamental axes on which emotion theories can be placed. Some sources of disagreement can only be understood if we consider them in a broader philosophy-of-science perspective.

Scientific Cycle

Theory development often proceeds according to a four-step cycle. In the first step, the explanandum (i.e., to-be-explained phenomenon) is provisionally demarcated by providing a working definition. This is often a descriptive or layman definition comprised of a list of superficial features. For instance, the phenomenon of water can provisionally be dermarcated as transparent, odorless, and tasteless fluid, covering 70 percent of the planet's surface. In the second step, an explanation is proposed, in which the explanandum is linked to an explanans (i.e., explaining fact). In the water example, water is linked to the molecular structure of H_2O. The third step consists of the testing of the explanation in empirical research. In the water example, water samples are selected according to the working definition and it is checked whether each indeed has the molecular structure of H_2O. If the explanation is sufficiently confirmed, a fourth step can take place in which the superficial features of

the descriptive definition are replaced with the explanans and the definition has now become a scientific definition. In the water example, water is no longer defined as clear, odorless fluid, but instead as H_2O. The scientific definition allows for the development and testing of new predictions of water, such as how it interacts with other molecules and how it behaves under different thermic conditions.

For the present purpose, I distinguish between (a) structural explanations, which specify the components of a phenomenon and the relations among them and (b) causal-mechanistic explanations, which identify the factors and/or the processes that cause the phenomenon. Both types of explanations cross different levels of analysis or decomposition. Structural explanations decompose the explanandum whereas causal-mechanistic explanations decompose the process causing the explanandum. In psychology, it is useful to distinguish between an observable level, a mental level, and a brain level. The observable level describes processes in terms of transitions between observable inputs and observable outputs. The mental level decomposes these processes into subprocesses, which are again described in terms of their inputs and outputs. At this level, intermediate inputs and outputs are no longer observable entities but mental representations. Mental processes can be described in terms of the type of *content* of their intermediate representations or in terms of the *operations* that are acting on these representations (Bechtel, 2008). Each subprocess can be decomposed further in ever finer-grained subprocesses (at ever lower mental sublevels), until, at the final stages of decomposition, they correspond to brain processes situated on the brain level.

Definitions can take an intensional format or an extensional or divisio format. Intensional definitions list the necessary and sufficient conditions for an exemplar to belong to a set. Extensional definitions list the individual exemplars in the set and divisio definitions list the subsets within a set. In addition to demarcating a set from other sets, divisio definitions also propose a way to organize the set internally.

The adequacy of a scientific definition can be evaluated with criteria such as similarity and fruitfulness (Carnap, 1950). The similarity criterion states that a prescriptive definition should overlap to some extent with the descriptive definition (i.e., common sense; Green, 1992; Scarantino, 2012). The fruitfulness criterion states that a set should allow for scientific extrapolation, that is, the generalization of discoveries of one exemplar to the other exemplars in the set (Griffiths, 2004; Scarantino, 2012). This, in turn, requires the set to be homogeneous in a non-superficial way. Exemplars must share a deep feature such as a common structure or causal mechanism. If the descriptive set that is taken as the starting point is heterogeneous, there is a trade-off between similarity and fruitfulness. This means that maximal similarity comes at a cost to fruitfulness, and maximal fruitfulness comes at a cost to similarity. Unfortunately, there are no guidelines for how to weigh these two criteria, so theorists are left with a choice (Swartz, 1997).

Application of the Scientific Cycle to Emotion Theories

The scientific cycle provides a useful framework for understanding the development of emotion theories and the differences between them. Four families of emotion theories and some of their notable variants are up for discussion: affect program theories (Darwin, 1965/1872; Ekman, 1999; Tomkins, 1962; Tracy, 2014; Keltner, Tracy, Sauter, Cordaro, & McNeil, 2016), network theories (Bower, 1981; Lang, 1994; Leventhal, 1984; Lewis, 2005; Teasdale, 1999), appraisal theories (Ellsworth, 2013; Frijda, 1986; Lazarus, 1991; Roseman, 2013; Scherer, 2009a), and psychological constructivist (PC) theories (Schachter, 1964; Barrett, 2006, 2012, 2014; Russell, 2003, 2012). Emotion theories start from emotions as the explanandum, at least at the start of their first cycle, and they seek an answer to two questions. The first question is how to demarcate the set of emotions from other sets. The second question is how to best organize the set of emotions internally. Each of the four steps of the scientific cycle presents problems for which different theories have provided different solutions. The problems can be seen as axes on which theories and their proposed solutions can be placed and compared. Some axes generate crucial fracture lines between the four families of emotion theories; other axes cut accross families. The next sections home in on the theories' (a) working definitions and outlook on the scientific cycle, (b) structural explanations, (c) causal-mechanistic explanations, (d) empirical research programs, and (e) (in some cases) scientific definitions.

Working Definition and Outlook

To provisionally demarcate the set of emotions, theories have presented descriptive definitions in the form of a list of typical features (e.g., short duration, high intensity, good or bad feeling quality, bodily aspects, and object-directedness) and/or in the form of a list of prototypical emotion subsets (e.g., anger, fear, sadness, fear, guilt, regret, joy). Often, these subsets are also used as the starting point for organising the variety within the set of emotions.

Theories differ in their outlook on whether the cycle will be succesfully completed and the descriptive set of emotions (or a portion of this set) will be turned into an adequate scientific set (**Axis 1**). Optimist theories, such as affect program theories, network theories, and appraisal theories, expect this to be the case. Theory development simply consists in discovering a common deep structure or mechanism that forms the basis for the demarcation of the set. Pessimist theories, such as Russell's (2003) PC theory, have no hope that the descriptive set of emotions will be turned into an adequate scientific set. Instead of vindicating common sense, pessimist theories aim to critically examine it. Optimist theories expect emotion to be like water, a set for which an elegant scientific intensional definition or essence will eventually be found. Pessimist theories, on the other hand, take emotion to be more like air. Air is a descriptive set provisionally demarcated as transparent, odorless gas, filling the atmosphere, but for which scientists could not find an elegant scientific intensional definition. Air turned out to be a collection of molecules, such as oxygen, carbonide, and nitrogen, that each belong to separate scientific sets. An intermediate position is taken by Barrett (2014; see also Schachter, 1964). In her version of PC theory, emotions are like air, in that they lack a physical substrate, but the

fact that emotions and air figure in the content of people's representations, lends scientific status to these sets.

With regard to the second question on internal organisation, theories differ in their outlook on whether the subsets of emotions from natural language will provide a good basis for organising the set of emotions or not (**Axis 2**). Discrete theories expect this to be the case. Dimensional theories, by contrast, expect that the infinite variety within the set of emotions will be better captured by dimensions referring to features. Affect program theories are discrete emotion theories; Russell's PC theory is a dimensional theory. Appraisal theories and network theories each come in a discrete and a dimensional variant. The PC theory defended by Barrett (2014) can again be considered as an intermediate theory regarding this issue.

Structural Explanation

A structural explanation of emotion specifies the parts or components of an emotion. Often-cited components are (a) a cognitive[1] component, with changes in information processing (e.g., appraisal of a stimulus as a threat), (b) a motivational component, with changes in action tendencies (e.g., the tendency to flee), (c) a somatic component, with changes in central[2] and peripheral physiological responses (e.g., an adrenaline rush), (d) a motor component, with changes in overt behavior (e.g., a startled facial expression and actual flight behavior), and (e) a subjective component, with changes in experience or feelings (e.g., feelings of fear). Note that the components listed are not all situated on the same level of analysis: The motor component and the peripheral part of the somatic component belong to the observable level, the central part of the somatic component belongs to the brain level, and the cognitive, motivational, and feeling components belong to the mental level. An information process takes the stimulus and possibly other sources of information as its input and produces a representation with a certain content as its output. An action tendency is a representation of an action that a person wants to engage in. Feelings are the conscious experience of the contents of certain representations.

Theories differ with regard to the number and nature of the components that they include in their structural explanations of emotions (**Axis 3**). Some theorists conceive of emotions as episodes that contain the entire set of components listed above (e.g., Clore & Ortony, 2000). Others distinguish between emotional episodes and the emotion proper and they identify the emotion proper with only one, a few, or several components. For instance James (1890) and Schachter (1964) identify emotions with the feeling component. The traditional variant of affect program theory (Tomkins, 1962; see also Scarantino, 2014) identifies emotions with neural circuits called affect programs. Frijda (1986) equates emotions with action tendencies plus feelings. Modern affect program theories, some network

[1] Here the term "cognitive" is used in a narrow sense. All components that have representations are cognitive in a broad sense.
[2] Some theorists exclude the central part from the somatic component because all mental components have neural activity on a lower level of analysis (Parrott, 2007).

theories, and some appraisal theories equate emotions with all but the cognitive component (which they treat as a possible proximal cause of emotion), and/or with all but the motor component (which they treat as a possible consequence of emotion).

Russell's (2003) PC theory and some appraisal theories (see Moors, 2014, 2017a) see no arguments for identifying emotion with one, several, or even all of the listed components. This has led them to shift the explanandum from emotions to emotional episodes. Russell (2003) includes many of the components proposed in other theories, but adds subcomponents to some of these components: core affect (neurophysiological activity that is felt as a combination of valence and valence) to the somatic and feeling components, an attribution process to the cognitive component, and attributed affect to the feeling component. Barrett (2006) likewise adds core affect or bodily feelings to the somatic and feeling components, a categorisation process to the cognitive component, and categorized core affect to the feeling component. She identifies the latter subcomponent with the emotion.

Causal-mechanistic Explanations

The unpacking of causal-mechanistic explanations of emotions is complicated by the fact that several theories see emotions as multicomponent episodes and that they expect some of these components to do most of the causal work. For instance, the cognitive component is often seen as the cause of the motivational component, and the latter is often seen as the cause of the somatic, motor, and feeling components. Thus, when considering causal-mechanistic explanations, it is instructive not to just consider the mechanisms that occur before the emotion/episode has begun, but also the causal relations within the emotion/episode (especially when theories include many components). Theories can be grouped according to the components that they primarily want to explain or are oriented to (**Axis 4**). Affect program theories, network theories, and appraisal theories work mainly towards explaining action, which is why emotion episodes can be seen in these theories as special types of action episodes. PC theories, on the other hand, seem primarily interested in explaining feelings. I now turn to the causal mechanisms proposed by the theories (**Axis 5**).

Action-oriented Theories

To be able to compare the causal mechanisms proposed by action-oriented theories, they must be fitted into a common mold. My proposal is to take the relation between the cognitive and motivational components as the backbone and to consider the other components as corollary components. The cognitive component takes care of the extraction of information, as well as of the translation of this information into the motivational component. The latter component, in turn, dictates the behavior that the system must undertake. The somatic component recruits the physiological responses to support this behavior and the motor component simply is the overt behavior. The feeling component supervenes on all the other components in that it houses aspects of all other components as they ooze into consciousness. Feelings can, but do not have to be labeled with emotion words.

Affect program theories assume that stimuli cause action tendencies via the activation of an affect program, an innate neural circuit dedicated to a specific emotion. Activation of the affect

program for fear, for instance, produces action tendencies, responses, and feelings that are typical of fear. There is only a limited set of emotions, called basic emotions, that have such an affect program. Traditional affect programs list around five six basic emotions (i.e., fear, anger, joy, sadness, disgust, and surprise; Ekman, 1999); more modern variants progressively expand this list (e.g., they include pride, shame, etc; Keltner et al., 2016).

Network theories propose that stimuli activate emotions/components via the mechanism of network activation. They assume that each specific emotion is represented in memory in the form of a network. The nodes in the network are (a) representations of previously encountered eliciting stimuli, (b) representations of (or corresponding to) emotional components, such as appraisals, representations of somatic and motor responses, and feelings, and (c) representations with additional information such as emotion labels and societal norms.

Discrete network theories (e.g., Bower, 1981) postulate a separate network for each vernacular emotion. Such discrete network theories are compatible with affect program theories, and are often fused in hybrid theories. A handful of stimuli have the innate capacity to elicit emotions via an affect program, after which the range of stimuli that can activate this affect program is elaborated via conditioning procedures. In dimensional network theories (e.g., Lewis, 2005), networks are not necessarily organized around basic emotions. Learning may shape networks in infinitely many ways, either around basic emotions or not.

Affect programs in affect program theories take care of translation but not of extraction. An account of extraction should specify which stimulus features activate the affect program and how these features are determined. Traditional affect program theories (e.g., Tomkins, 1962) assume that affect programs are activated by purely perceptual stimulus features, such as noise blasts, wild animals, and sudden loss of control. Modern affect program theories (e.g., Tracy, 2014) assume that affect programs are activated by abstract stimulus features produced by an appraisal processes (as proposed by appraisal theories, see next) that precede the affect programs.

Appraisal theories propose that stimuli cause emotions via a process called appraisal. This process evaluates incoming stimuli on a number of criteria such as the extent to which they are goal relevant, goal in/congruent (or hence negative/positive), un/expected, easy/difficult to control, and caused by internal/external causes. Together, the values on these appraisal criteria determine the values of the other emotional components. For instance, an appraisal pattern with the values goal relevant, goal incongruent, unexpected, difficult to control, and externally caused, leads to the tendency to flee, the physiological activity required to sustain this behavior, overt flight behavior, and certain feelings. A small change in the appraisal pattern (e.g., from difficult to easy to control) may lead to a different action tendency (e.g., from the tendency to flee to the tendency to fight) and corollary components.

The appraisal process takes care of the extraction of appraisal values, which are abstract stimulus features. Thus, appraisal is a process that is defined in terms of the *content* of its resulting

representations. Appraisal theories do not put restrictions to the *operations* that can produce these respresentations. Possible operations are rule-based inference or the activation of a previously inferred and stored association between a specific stimulus and a pattern of appraisal values (Leventhal & Scherer, 1987).

The translation of appraisal values into the other components happens via fixed links. Discrete and dimensional versions of appraisal theory have a unique proposal about the operations involved in these links. Discrete appraisal theories assume that appraisal values are combined into a pattern and linked to a summary appraisal value. For instance, a pattern of the appraisal values goal relevant, goal incongruent, difficult to control, and externally caused is summarized as dangerous. The summary appraisal pattern subsequently fixes the emotion, in this case fear, which determines the values of the other components. Dimensional appraisal theories assume that each appraisal value separately determines aspects of the eventual action tendency. For instance, an appraisal of goal relevance determines the intensity of the action tendency, goal in/congruence determines its direction (increasing/decreasing contact), and low/high control determines its direction of adaptation (person-to-stimulus/ stimulus-to-person). The action tendency mobilizes physiological responses that prepare and support overt behavior, and aspects of all components make up the content of feelings (Moors & Scherer, 2013). Here the system does not need to determine at any point that an emotion is at stake or which one; the emotion simply emerges from the integrated sum of the values of all components. Note, however, that each link between an appraisal value and an action tendency aspect is again fixed here. Other sources of variability, however, such as planning and regulatory action tendencies are added into the mix, leading to an imperfect relation between appraisals and overt behavior.

In sum, in traditional affect program theories, extraction is covered by the transduction of purely perceptual features. In appraisal theories and modern affect program theories, extraction is done by an appraisal process that produces abstract stimulus features. Network theories incorporate both perceptual and abstract stimulus features. In all three families of theories, the translation of stimulus features in the other components is covered by fixed links between cognitive and motivational components. These links range from being predominantly innate in affect program theories and discrete appraisal theories to being predominantly learned in network theories. Dimensional appraisal theories are less explicit about whether their fixed links are innate or learned.

Feeling-oriented Theories

PC theories deny the existence of affect programs or any other mechanism that ensures fixed cognition-motivation links dedicated to specific emotions (whether they are taken to be few or infinitely many). Russell (2012) argues that strong ties among components cannot be assumed on an a priori basis and that each component must be explained by handing it over to already existing research areas. Behavior-related components are the subject matter of behavior research. Feelings are the subject matter of consciousness research. PC theories (Barrett, 2006; Russell, 2003; Schachter, 1964) do propose a two-factor mechanism in which relatively undifferentiated bodily feelings or core affect

(Factor 1) are causally attributed or categorised (Factor 2), resulting in a representation with the content "emotion" or a specific emotion such as "anger" or "sadness". Crucially, Russell (2003) calls this representation attributed affect, whereas Barrett (2006) calls it an emotion or feelings (see also Schachter, 1964). Barrett (2006) has characterized her categorization process on a lower level of analysis as a pattern completion process in which a script comprising representations of situations, behaviors, and verbal information gets activated by a small piece of that script (Barrett, 2006), much like what has been proposed in network theories[3]. More recently, she has added that the script functions as a prediction that can be confirmed or disconfirmed, leading to readjustment of the prediction (Barrett, 2017), after the model of predictive coding theories of perception (Clark, 2003).

Empirical Testing

This section first discusses empirical research carried out in support of discrete theories (affect program theories, discrete network theories, and discrete appraisal theories) followed by a criticism of that evidence, and attempts of discrete theories to salvage their approach. Next, I discuss research aimed at testing the predictions of dimensional appraisal theories. I close with a discussion of research conducted by PC theories.

Discrete Theories

Affect program theorists have sought direct evidence for the existence of affect programs (neural signatures) for basic emotions (e.g., fear; Johansen, Cain, Ostroff, & LeDoux, 2011; Öhman & Mineka, 2001). They have also sought indirect evidence for the existence of affect programs based on the following premises (Ortony & Turner, 1990): If each basic emotion has a dedicated innate affect program, it should have specific components such as a specific physiological response pattern (reviews in Ekman, 1992; Kreibig, 2010; Levenson, 2014) and a specific expressive behavior (reviews in Ekman, 1999; Keltner et al., 2016; Matsumoto, Keltner, Shiota, Frank, & O'Sullivan, 2008), and these specific components should be universal (i.e., present in all cultures; physiological responses: Levenson, Ekman, Heider, & Friesen, 1992; facial expressions: Ekman, Sorenson, & Friesen, 1969; Elfenbein & Ambady, 2002; Tracy, Shariff, Zhao, & Henrich, 2013) and even present in congenitally blind people (Matsumoto & Willingham, 2009, but see Galati, Scherer, & Ricci-Bitti, 1997). Moreover, the components of each basic emotion should show strong concordance (e.g., an appraisal of a controllable goal obstacle should co-occur with the tendency to fight, fighting behavior, and angry feelings; see reviews in Levenson, 2014; Matsumoto et al., 2008).

In order to investigate whether a basic emotion indeed is characterized by a specific component, researchers should examine the relation between the basic emotion and the component. The problem is that there is no other way to measure or manipulate the emotion than via one (or more) of its components, so that researchers always end up studying the relation among two (or more)

[3] Note that network theories are one-factor theories: Emotions are caused by the network or script, but this script is not used as a source of information next to core affect.

components (Fridlund, 2017; Moors, 2012, 2017a). For example, to examine whether basic emotions are characterized by specific physiological responses patterns, Ekman, Levenson, and Friesen (1983; Levenson, 1992) examined the relation between emotions manipulated via facial expressions (i.e., the motor component), on the one hand, and physiological responses (i.e., the somatic component), on the other hand. For another example, to examine whether basic emotions are characterized by specific facial expressions, Rosenberg and Ekman (1994) examined the relation between emotions induced via stimuli that were most likely processed in some way (i.e., the cognitive component), on the one hand, and facial expressions (i.e., motor component), on the other hand. Thus, research designed to examine the specificity question coincides with research to examine the concordance question. Note that evidence for concordance is supportive of the discrete view only when the concordance among the components of one basic emotion (e.g., feelings of anger and a scowling face) is stronger than that among the components of different basic emotions (e.g., feelings of anger and a startled face; for a discussion of other constraints see Moors, 2017a, 2017b).

Discrete appraisal theorists have tried to show that different appraisal patterns lead to different emotions. Again, this research examines the relation between two components: the appraisal component and another component that is supposed to measure the emotion. Note that emotions are often not even manipulated or measured via one of their components, but instead via an emotion label. This is the case in discrete appraisal research in which appraisals are manipulated via an imagination or recall procedure and ratings of emotion labels are collected. This is also the case in facial recognition studies, where participants match facial expressions with emotion labels, but also in instructed production studies, where participants are asked to produce facial expressions based on emotion labels.

Network theorists have shown that new stimuli can acquire emotion-eliciting power via classical conditioning procedures (see literature on fear learning; Beckers, Krypotos, Boddez, Effting, & Kindt, 2013). Moreover, they have sought evidence for the assumption that emotions can directly be activated via the somatic and motor components (see research on the facial feedback hypothesis, Strack, Martin, & Stepper, 1988; but see Wagenmakers, Beek, Dijkhoff, & Gronau, 2016, for a meta-analysis of failed replications). As is the case for affect program theories, it is crucial for discrete network theories to find evidence for emotion-specific response patterns. Indeed, if it is true that a specific emotion network (e.g., the network for anger or fear) can directly be activated via responses, then these responses should be emotion specific. If smiling is supposed to trigger joy, it should trigger joy and not embarassement, for instance.

Criticism. Recent meta-analyses suggest that evidence for emotion-specific neural circuits and emotion-specific peripheral physiological response patterns is weak to non-existent (e.g., Cacioppo, Nerntson, Larsen, Poehlmann, & Ito, 2000; Murphy, Nimmo-Smith, & Lawrence, 2003; Larsen, Berntson, Poehlmann, Ito, & Cacioppo, 2008; Phan, Wager, Taylor, & Liberzon, 2002; Quigley & Barrett, 2014). The evidence for the existence and universality of emotion-specific facial expressions

has extensively been criticized on methodological grounds (Nelson & Russell, 2013; Russell, 1994; Russell, Bachorowski, & Fernández-Dols, 2003; Gendron, Roberson, van der Vyver, & Barrett, 2014). Many studies make use of a recognition method, while they should be using a production method instead, preferably one in which events elicit spontaneous facial expressions. If participants are asked to recognize emotions from posed facial expresions or to produce artifical facial expressions, they may tap into their learned stereotypical scripts to solve the task (Barrett, 2011; Fridlund, 1994; Lindquist & Gendron, 2013; Parkinson, 2013). Recent spontaneous production studies, however, do not replicate previous evidence, neither in the laboratory (Reisenzein, Studtmann, & Horstmann, 2013) nor in the field (Fernández-Dols & Crivelli, 2013).

Other points of criticism concern the indirect status of indirect evidence, and the validity of some of the premises used as a basis for this evidence (Ortony & Turner, 1990). For instance, evidence that congenitally blind people produce the same facial expressions as sighted people is not proof of the existence of innate affect programs, because most likely, the blind people also have a history of being rewarded for producing culturally appropriate facial expressions. Likewise, evidence for the universality of a facial expression is not proof of the existence of an affect program because universality may also indicate that different cultures developed the same behavioral solutions to similar problems (convergent cultural evolution; Fridlund, 1994). Moreover, the premise that the existence of an innate affect program leads to universality can be called into question because natural selection may also produce diversity, and not just uniformity, among cultures (Crivelli, Jarillo, & Fridlund, 2016; Fridlund, 2017).

Large-scale meta-analyses of discrete appraisal research are lacking, but the evidence is mixed (Kuppens et al., 2007). Support for causal links between appraisals and discrete emotions comes for the most part from self-report studies (e.g., Roseman & Evdokas, 2004). Here also, participants may tap into stereotypic scripts linking specific appraisal patterns with specific emotions to solve the task (Frijda & Zeelenberg, 2001; Moors & Scherer, 2013; Parkinson, 1997). Studies in which appraisals are manipulated with real stimuli and emotions are measured via one or more components are fewer (e.g., Neuman, 2000) and often fail to confirm the hypothesized appraisal-emotion links (e.g., Bossuyt, Moors, & De Houwer, 2014).

Replies. Advocates of discrete theories insist on a more favorable reading of the evidence (Ekman, 1999; Keltner et al., 2016), and when deviations from the hypotheses do occur, they turn to at least four strategies to salvage their theories. A first strategy is to call on methodological constraints of past research and to continue the quest for emotion-specific signatures using more sensitive methods, both for the discovery of affect programs (Vytal & Hamann, 2010), emotion-specific peripheral physiological activity (Kreibig, 2010), and emotion-specific expressions (Keltner et al., 2016). Expression researchers have argued that past weak results stem from the use of static stimuli in a single modality, such as pictures of faces, and they now search for evidence of specificity when

dynamic stimuli are used (e.g., facial movements, vocal expressions) and across different modalities (patterns of changes accross facial, vocal, gestural, postural, and tactile stimuli; Keltner et al., 2016).

A second strategy is refinement. For affect program theories, refinement comes down to considering the basic emotion subsets as families composed of various sub-subsets. If feelings of anger turn out to not always go together with the tendency to fight, theorists may suggest that there are different types of anger (e.g., hot vs. cold anger; annoyance, anger, and rage) and only some types are associated with fighting. For discrete appraisal theories, the refinement strategy comes down to demarcating appraisal criteria from other, related, criteria or by splitting appraisal criteria into sub-criteria. If a goal-incongruent stimulus for which one has a high level of control does not always lead to the tendency to fight, then theorists may suggest that control is different from power or status, or that there are different types of control (such as control over oneself or over the environment) and only one type is linked to the tendency to fight.

A third strategy is the search for moderators. Moderators can be manifold. Two types of moderators especially worth mentioning are moderators that represent more of the same and moderators in the form of additional processes. In affect program theories, more of the same means that more than one basic emotion is at play because more than one affect program was activated (i.e., mixed emotions). In discrete appraisal theories, more of the same means more (unstudied or even undiscovered) appraisal criteria. An additional process that has been invoked by both theories is emotion regulation. If the appraisal pattern and/or affect program of anger does not lead to fighting behavior, this may be because the behavior was succesfully suppressed. Moreover, emotion regulation attempts in the lab are often successful because the lab-induced emotions are typically low in intensity for ethical reasons (i.e., another methodological constraint).

A fourth strategy is abstract rephrasing of the cognition-motivation links that form the backbone of basic emotions (e.g., Parkinson, 2017; Scarantino, 2014, in press; Sznycer, Cosmides, & Tooby, 2017). When research reveals that an appraisal of offense not always leads to the tendency to fight, the link gets rephrased as the link between an appraisal of offense and an abstract tendency to defend oneself, of which the tendency to fight is just one concrete manifestation next to the tendency to withdraw (e.g., Eickers, Loaiza, & Prinz, 2017). Likewise, when research reveals that an appraisal of danger does not always produce the tendency to flee, the link gets rephrased as the link between an appraisal of danger and the tendency to seek safety, of which the tendency to flee is just one concrete manifestation next to the tendencies to fight and freeze (Bolles, 1970). Abstract rephrasing allows discrete emotion theories to preserve flexibility on the input side by expanding the set of concrete stimuli that can elicit an emotion, and flexibility on the output side by expanding the set of concrete behaviors that an emotion can be manifested in.

The problem with the fourth strategy is that when the cognition-motivation links are framed at a high level of abstraction they become trivial and empty. The hypothesis that an appraisal of danger leads to the tendency to seek safety comes down to the hypothesis that apppraisal of a stimulus as

incongruent with some goal (in this case, the goal to be safe) leads to the tendency to undo the incongruence. This hypothesis is trivial and leaves us with a lot of explanatory work. If a lack of safety indeed leads to the tendency to regain safety, we still need to work out how this abstract action tendency gets translated in the concrete tendency to either flee, fight, or freeze. This is the point where discrete theories invoke the process of planning. Like emotion regulation, planning is thought to rely on a goal-directed process in which the expected utilities of diffferent action options are weighed and the action option with the highest expected utility is chosen. This mechanism is assumed to be of a different nature than the mechanism responsible for the more abstract, emotional action tendency (but see Moors, 2017a, 2017b; Moors, Boddez, & De Houwer, in press).

Dimensional Appraisal Theories

Dimensional appraisal theories investigate hypotheses about causal relations between specific appraisal values and specific values of the motivational component (Frijda, Kuipers, & ter Schure, 1989), the somatic component (central and peripheral, Scherer, 1993, 2009b; Smith, 1989), and the motor component (facial expressions, Smith & Ellsworth, 1985; Scherer & Ellgring, 2007; vocal expressions, Scherer, 2009b; see review in Moors & Scherer, 2013). For instance, they try to discover the appraisal patterns that cause the tendencies to fight vs. flee without linking these to the discrete emotion subsets of anger vs. fear.

PC Theories

Support for the two-factor hypothesis in PC theories comes from misattribution studies in which bodily feelings were manipulated independently from the source of attribution, and in which both elements were shown to contribute to emotion ratings (Dutton & Aron, 1974). Support for the role of categorization comes from studies in which manipulation of the accessibility of emotion categories (via priming vs. satiation) influenced the emotion ratings of one's own or someone else's state (e.g., Lindquist, Barrett, Bliss-Moreau & Russell, 2006).

Scientific Definitions

Regarding the intensional definition of emotion (specifying necessary and sufficient conditions), the structural explanations of emotions proposed by emotion theories do not allow for the demarcation of the set of emotions from other sets. Clearly, the mere presence of the listed components is not sufficient for calling an episode emotional. Dropping a pen on the floor may give rise to appraisal of the event as relevant and incongruent with the goal to hold on to the pen and easy to control, the tendency to pick up the pen, physiological and behavioral responses that prepare the body for picking up the pen, and traces of all of these components integrated in conscious feelings. Yet few theorists will classify this episode as an emotional episode, at least not a strong one. Additional criteria have been offered in the form of the theories' causal-mechanistic explanantia. Traditional affect program theories propose that emotions are affect programs and modern affect program theories propose that emotions are episodes in which an affect program is active. Few network theories have explicitly addressed the demarcation problem, but if we follow their logic,

emotions are episodes in which an emotion network is active. Appraisal theories propose that emotions are episodes in which a stimulus is appraised as being highly goal relevant, in the sense that it has a high impact on a goal of high importance (Frijda, 1986; Lazarus, 1991; Moors, 2007; Oatley & Johnson-Laird, 1987). In the pen example, the goal to hold on to the pen may be of only minor importance. High goal relevance, moreover, is manifested in an action tendency with control precedence (i.e., that calls for priority in determining behavior; Frijda, 1986, 2007), and/or in a high degree of synchronicity among all components (Scherer, 2000). It must be noted that these three related criteria are gradual in nature, thereby allowing only relative statements about the emotional nature of episodes.

All PC theories have emphasized that emotion episodes are characterized by the attribution or categorisation of bodily feelings or core affect. Barrett (2006) takes this process to be uniquely present in emotional episodes. Russell (2003), on the other hand, thinks this process is often but not always present in episodes that people call emotional[4]. Both Barrett (2015, 2017) and Russell (2003) have emphasized that unlike affect programs in affect program theories, the categorization process in PC theories is a general-purpose mechanism. This is certainly true when the categorization process is described in terms of the *operations* involved. However, if the categorization process is described in terms of the *content* of the representations involved, that is, as the transition from a representation of bodily responses to a representation of an emotion, it no longer qualifies as general-purpose. Moreover, the fact that Barrett (2006, 2012) takes the representation resulting from this categorisation process to be a real emotion, ironically turns this process into a mechanism that is again dedicated to emotions. Russell (2003), on the other hand, considers the representation resulting from this categorisation process to be a mere self-ascription of an emotion, which is not the same thing as an emotion. It is not because a person ascribes an emotion to herself, that she is actually having an emotion, or that emotions even exist. Compare it to supernatural powers. It is not because a person ascribes supernatural powers to herself, that she actually has these powers, or that they even exist (Moors, 2017b).

The mechanisms proposed by emotion theories also serve as the basis for their divisio definitions (i.e., the organisation of the total set of emotions into subsets). In affect program theories, each basic emotion is caused by its own affect program. In network theories, each emotion is caused by its own network, and in appraisal theories, each emotion is caused by its own appraisal pattern. In discrete network theories and appraisal theories, the number of networks and appraisal patterns are limited in number. In their dimensional counterparts, there is no limit, and the set of emotions is best internally structured by placing them in a multidimensional space. In dimensional appraisal theories, dimensions correspond to appraisal criteria. In Russell's (2012) version of PC theory, the variety within the descriptive set of emotions can be organised according to the dimensions of valence and

[4] Episodes that external observers call emotional may not contain such an attribution or categorisation process.

arousal, but also according to dimensions that describe any of the other components. In Barrett's (2006) version of PC theory, the variety in the scientific set of emotions can be organised according to the dimensions of valence and arousal, but also according to the emotion categories picked out by the individual.

Conclusion

Application of the four steps of the scientific cycle to emotion theories yields the following axes for the comparison of emotion theories: A first axis divides theories into those with an optimist, pessimist, and intermediate outlook on the succesful completion of the scientific cycle and the hope of finding a scientific intensional definition of emotion. A second axis divides theories into those that expect to find a scientific basis for organising the set of emotions according to the discrete emotion subsets found in natural language, those that expect an infinite variety that is best captured by several dimensions, and those that occupy an intermediate position. A third axis organises theories according to the number and nature of the components that they include in the emotion. A fourth axis divides theories into action-oriented and feeling-oriented ones. The fifth and final axis refers to the causal-mechanisms proposed by the various theories: affect programs in affect program theories, networks in network theories, appraisals with a specific output in appraisal theories, and categorisation with a specific output in Barrett's (2006) PC theory. These mechanisms were later used as the basis for the intensional as well as the divisio definitions of these theories. Russell (2003) argued that there is no difference between mechanisms operating in so-called emotional vs. non-emotional episodes, leaving him no mechanistic ground to distinguish between both types of episodes, and leading to the conclusion that emotion remains a descriptive set or folk concept.

Let me close by pointing at a recent theory (Moors, 2017a, 2017n, Moors et al., in press), grown out of an attempt to integrate elements from Russell's (2012) PC theory with elements from dimensional appraisal theory. The theory, called the goal-directed theory, stretches appraisal to information processing in the broadest sense, so that in addition to the fixed cognition-motivation links proposed in appraisal theories, there is now also room and even a leading role[5] for goal-directed processes as those described in the literatures on operant learning, decision making, and expectancy-value theories of motivation. This squares well with Russell's (2012) recommendation to hand over explanation of the various components (in this case the behavior-related components) to already existing specialized research areas in psychology, and with his view that the mechanisms in so-called emotional episodes do not differ from those in non-emotional ones.

[5] Recall that in the theories discussed above, the role of goal-directed processes is confined to planning and emotion regulation.

References

Barrett, L. F. (2006). Solving the emotion paradox: Categorization and the experience of emotion. *Personality and Social Psychology Review, 10*, 20-46.

Barrett, L. F. (2011). Was Darwin wrong about emotional expressions?. *Current Directions in Psychological Science, 20*(6), 400-406.

Barrett, L. F. (2012). Emotions are real. *Emotion*, *12*(3), 413-429.

Barrett, L. F. (2014). The conceptual act theory: A précis. *Emotion Review, 6*(4), 292-297

Barrett, L. F. (2015). Ten common misconceptions about the psychological construction of emotion. Chapter in L. F. Barrett and J. A. Russell (Eds.), *The psychological construction of emotion* (p. 45-79). NY: Guilford.

Barrett, L. F. (2017). Categories and their role in the science of emotion. *Psychological Inquiry, 28*(1), 20-26.

Bechtel, W. (2008). *Mental mechanisms: Philosophical perspectives on cognitive neuroscience*. London, UK: Routledge.

Beckers, T., Krypotos, A. M., Boddez, Y., Effting, M., & Kindt, M. (2013). What's wrong with fear conditioning?. *Biological psychology*, *92*(1), 90-96.

Bolles, R. C. (1970). Species-specific defense reactions and avoidance learning. *Psychological review*, *77*(1), 32-48.

Bower, G. H. (1981). Mood and memory. *American Psychologist, 36*, 129-148.

Bossuyt, E., Moors, A., & De Houwer, J. (2014a). Exploring the relations between regret, self-agency, and the tendency to repair using experimental methods and structural equation modeling. *Psychological Record*, 64, 841-857.

Cacioppo, J. T., Berntson, G. G., Larsen, J. T., Poehlmann, K. M., & Ito, T. A. (2000). The psychophysiology of emotion. *Handbook of emotions*, *2*, 173-191.

Carnap, R. (1950). *Logical Foundations of Probability*. Chicago: University of Chicago Press.

Clark, A. (2013). Whatever next? Predictive brains, situated agents and the future of cognitive science. *Behavioral and Brain Sciences, 36*, 181-253.

Clore, G. L., & Ortony, A. (2000). Cognition in emotion: Always, sometimes, or never? In R. D. Lane & L. Nadel (Eds.), *Cognitive neuroscience of emotion* (pp. 24-61). NY: Oxford University Press.

Crivelli, C., Jarillo, S., & Fridlund, A. J. (2016). A Multidisciplinary approach to research in small-scale societies: Studying emotions and facial expressions in the field. *Frontiers in Psychology*, *7*, 1073.

Darwin, C. (1965). The expression of emotions in man and animals. Chicago: University of Chicago Press. (Original work published 1872)

Dickinson, A., & Balleine, B. (1994). Motivational control of goal-directed action. *Animal Learning & Behavior*, *22*(1), 1-18.

Durán, J., Reisenzein, R., & Fernández-Dols, J.M. (2017). Coherence between emotions and facial expressions. In J. M. Fernández-Dols & J. A. Russell (Eds.), *The science of facial expression* (pp.107-129). Oxford, UK: Oxford University Press.

Dutton, D. G., & Aron, A. P. (1974). Some evidence for heightened sexual attraction under conditions of high anxiety. *Journal of personality and social psychology*, *30*(4), 510.

Eickers, G., Loaiza, J. R., & Prinz, J. (2017). Embodiment, context-sensitivity, and discrete emotions: A response to Moors. *Psychological Inquiry*, *28*(1), 31-38.

Ekman, P. (1992). An argument for basic emotions. *Cognition and Emotion*, *6*(3-4), 169-200.

Ekman, P. (1999). Facial Expressions. In T. Dalgleish & M. Power (Eds.), Handbook of cognition and emotion (pp. 301-320). Sussex, UK: Wiley.

Ekman, P., Levenson, R. W., & Friesen, W. V. (1983). Autonomic nervous system activity distinguishes among emotions. *Science*, *221*(4616), 1208-1210.

Ekman, P., Sorenson, E. R., & Friesen, W. V. (1969). Pan-cultural elements in facial displays of emotion. *Science*, *164*(3875), 86-88.

Ellsworth, P. C. (2013). Appraisal theory: Old and new questions. *Emotion Review*, *5*, 119-124.

Elfenbein, H. A., & Ambady, N. (2002) On the universality and cultural specificity of emotion regulation: A meta-analysis. *Psychological Bulletin*, *128*(2), 203-235.

Fernández-Dols, J. M., & Crivelli, C. (2013). Emotion and expression: Naturalistic studies. *Emotion Review*, *5*(1), 24-29.

Fridlund, A. J. (1994). *Human facial expression: An evolutionary view*. San Diego, CA: Academic Press.

Fridlund, A. J. (2017). The behavioral ecology view of facial displays, 25 years later. In J. M. Fernández-Dols & J. A. Russell (Eds.), *The science of facial expression* (pp. 77-92). Oxford, UK: Oxford University Press.

Frijda, N. H. (1986). *The emotions*. NY: Cambridge University Press.

Frijda, N. H. (2007). *The laws of emotion.* Mahwah, NJ: Erlbaum.

Frijda, N. H., Kuipers, P., & ter Schure, L. (1989). Relations between emotion, appraisal and emotional action readiness. *Journal of Personality and Social Psychology*, *57*, 212-228.

Frijda, N. H., & Zeelenberg, M. (2001). What is the dependent? In K. R. Scherer, A. Schorr, & T. Johnstone (Eds.), *Appraisal processes in emotion: Theory, methods, research* (pp. 141-155). NY: Oxford University Press.

Galati, D., Scherer, K. R., & Ricci-Bitti, P. E. (1997). Voluntary facial expression of emotion: Comparing congenitally blind with normally sighted encoders. *Journal of Personality and Social Psychology* 73 (6), 1363-1379.

Gendron, M., Roberson, D., van der Vyver, J. M., & Barrett, L. F. (2014). Perceptions of emotion from facial expressions are not culturally universal: evidence from a remote culture. *Emotion*, *14*(2), 251-262.

Green, O. H. (1992). *The emotions: A philosophical theory*. Dordrecht: Kluwer.

Griffiths, P. E. (2004). Is emotion a natural kind? In R. C. Solomon (Ed.), *Thinking about feeling: Contemporary philosophers on emotions* (pp. 233–249). Oxford, UK: Oxford University Press.

Hollenstein, T., & Lanteigne, D. (2014). Models and methods of emotional concordance. *Biological psychology*, *98*, 1-5.

James, W. (1890). *The principles of psychology*. NY: Dover.

Johansen, J. P., Cain, C. K., Ostroff, L. E., & LeDoux, J. E. (2011). Molecular mechanisms of fear learning and memory. *Cell, 147*(3), 509–524.

Keltner, D., Tracy, J., Sauter, D. A., Cordaro, D. C., & McNeil G. (2016). Expression of emotion. In L. F. Barrett, M. Lewis, & J. M. Haviland-Jones (Eds.), *Handbook of emotions* (pp. 467-482). NY: Guilford Press.

Kreibig, S. D. (2010). Autonomic nervous system activity in emotion: A review. *Biological psychology*,*84*(3), 394-421.

Kuppens, P., Van Mechelen, I., Smits, D. J. M., De Boeck, P., & Ceulemans, E. (2007). Individual differences in patterns of appraisal and anger experience. *Cognition and Emotion, 21*, 689-713.

Lang, P. J. (1994). The motivational organization of emotion: Affect-reflex connections. In S. H. M. Van Goozen, N. E. Van de Poll, & J. A. Sergeant (Eds.), *Emotions: Essays on emotion theory* (pp. 61-92). Hillsdale, NJ: Erlbaum.

Larsen, J. T., Berntson, G. G., Poehlmann, K. M., Ito, T. A., & Cacioppo, J. T. (2008). The psychophysiology of emotion. *Handbook of emotions*, *3*, 180-195.

Lazarus, R. S. (1991). *Emotion and adaptation*. NY: Oxford University Press.

Levenson, R. W. (2014). The autonomic nervous system and emotion. *Emotion Review, 6*, 100-112.

Levenson, R. W., Ekman, P., Heider, K., & Friesen, W. V. (1992). Emotion and autonomic nervous system activity in the Minangkabau of West Sumatra. *Journal of personality and social psychology*, *62*(6), 972.

Leventhal, H. (1984). A perceptual-motor theory of emotion. In L. Berkowitz (Ed.), *Advances in experimental social psychology* (Vol. 17, pp. 117-182). NY: Academic Press.

Leventhal, H., & Scherer, K. R. (1987). The relationship of emotion to cognition: A functional approach to a semantic controversy. *Cognition and Emotion*, *1*, 3–28.

Lewis, M. D. (2005). Bridging emotion theory and neurobiology through dynamic system modeling. *Behavioral and Brain Sciences, 28*, 169-194.

Lindquist, K. A., Barrett, L. F., Bliss-Moreau, E., & Russell, J. A. (2006). Language and the perception of emotion. *Emotion*, *6*(1), 125-138.

Lindquist, K. A., & Gendron, M. (2013). What's in a word? Language constructs emotion perception. *Emotion Review*, *5*(1), 66-71.

Matsumoto, D., Keltner, D., Shiota, M. N., Frank, M. G., & O'Sullivan, M. (2008). What's in a face? Facial expressions as signals of discrete emotions. In M. Lewis, J. M. Haviland, & L. Feldman Barrett (Eds.), *Handbook of emotions* (pp. 211–234). NY: Guilford Press.

Matsumoto, D., & Willingham, B. (2009). Spontaneous facial expressions of emotion of congenitally and noncongenitally blind individuals. *Journal of personality and social psychology, 96*(1), 1-10.

Moors, A. (2007). Can cognitive methods be used to study the unique aspect of emotion: An appraisal theorist's answer. *Cognition and Emotion, 21*, 1238-1269.

Moors, A. (2012). Comparison of affect program theories, appraisal theories, and psychological construction theories. In P. Zachar & R. D. Ellis (Eds.), *Categorical versus dimensional models of affect: A seminar on the theories of Panksepp and Russell* (pp. 257–278). Amsterdam, The Netherlands: John Benjamins.

Moors, A. (2014). Flavors of appraisal theories of emotion. *Emotion Review, 4,* 303-307.

Moors, A. (2017a). Integration of Two Skeptical Emotion Theories: Dimensional Appraisal Theory and Russell's Psychological Construction Theory. *Psychological Inquiry, 28*(1), 1-19.

Moors, A. (2017b). The integrated theory of emotional behavior follows a radically goal-directed approach. *Psychological Inquiry*, *28*(1), 68-75.

Moors, A., Boddez, Y., & De Houwer, J. (in press). The power of goal-directed processes in the causation of emotional and other actions. *Emotion Review*.

Moors, A., & Scherer, K. R. (2013). The role of appraisal in emotion. In M. Robinson, E. Watkins, & E. Harmon-Jones (Eds.), *Handbook of cognition and emotion* (pp. 135-155). NY: Guilford Press.

Murphy, F. C., Nimmo-Smith, I. A. N., & Lawrence, A. D. (2003). Functional neuroanatomy of emotions: a meta-analysis. *Cognitive, Affective, & Behavioral Neuroscience*, *3*(3), 207-233.

Nelson, N. L., & Russell, J. A. (2013). Universality revisited. *Emotion Review*,*5*(1), 8-15.

Neumann, R. (2000). The Causal influences of attributions on emotions: A procedural priming approach. *Psychological Science, 11*, 179-182

Oatley, K., & Johnson-Laird, P. N. (1987). Towards a cognitive theory of emotions. *Cognition and Emotion, 1*, 29-50.

Öhman, A., & Mineka, S. (2001). Fears, phobias, and preparedness: Toward an evolved module of fear and fear learning. *Psychological Review, 108*, 483–522.

Ortony, A., & Turner, T. J. (1990). What's basic about basic emotions? *Psychological Review, 97,* 315-331.

Parkinson, B. (1997). Untangling the appraisal-emotion connection. *Personality and Social Psychology Review, 1*, 62-79.

Parkinson, B. (2013). Contextualizing facial activity. *Emotion Review, 5*(1), 97-103.

Parkinson, B. (2017). Emotion components and social relations. *Psychological Inquiry, 28*(1), 45-49.

Parrott, G. W. (2007). Components and the definition of emotion. *Social Science Information, 46*, 419-423.

Phan, K. L., Wager, T., Taylor, S. F., & Liberzon, I. (2002). Functional neuroanatomy of emotion: a meta-analysis of emotion activation studies in PET and fMRI. *Neuroimage, 16*(2), 331-348.

Quigley, K. S., & Barrett, L. F. (2014). Is there consistency and specificity of autonomic changes during emotional episodes? Guidance from the conceptual act theory and psychophysiology. *Biological psychology, 98*, 82-94.

Reisenzein, R., Studtmann, M., & Horstmann, G. (2013). Coherence between emotion and facial expression: Evidence from laboratory experiments. *Emotion Review*, *5*(1), 16-23.

Roseman, I. J. (2013). Appraisal in the emotion system: Coherence in strategies for coping. *Emotion Review, 5*, 141-149.

Roseman, I. J., & Evdokas, A. (2004). Appraisals cause experienced emotions: Experimental evidence. *Cognition and Emotion, 18*, 1-28.

Rosenberg, E. L., & Ekman, P. (1994). Coherence between expressive and experiential systems in emotion. *Cognition & Emotion*, *8*(3), 201-229.

Russell, J. A. (1994). Is there universal recognition of emotion from facial expression: A review of the cross-cultural studies. *Psychological Bulletin, 115*, 102-141.

Russell, J. A. (2003). Core affect and the psychological construction of emotion. *Psychological Review, 110*, 145-172.

Russell, J. A. (2012). From a psychological constructionist perspective. In P. Zachar, & R. D. Ellis (Eds.), *Categorical versus dimensional models of affect: A seminar on the theories of Panksepp and Russell* (pp. 79-118). Amsterdam: John Benjamins.

Russell, J. A., Bachorowski, J. A., & Fernández-Dols, J. M. (2003). Facial and vocal expressions of emotion. *Annual review of psychology*, *54*(1), 329-349.

Scarantino, A. (2012). How to define emotions scientifically. *Emotion review*, *4*(4), 358-368.

Scarantino, A. (2014). The motivational theory of emotions. In D. Jacobson & J. D'Arms (Eds.), *Moral psychology and human agency* (pp. 156-185). Cambridge, UK: Cambridge University Press.

Scarantino, A. (in press). Do emotions cause actions, and if so how? *Emotion Review.*

Schachter, S. (1964). The interaction of cognitive and physiological determinants of emotional state. *Advances in Experiment Social Psychology, 1*, 49-80.

Scherer, K. R. (2000). Emotions as episodes of subsystem synchronization driven by nonlinear appraisal processes. In M. D. Lewis & I. Granic (Eds.) *Emotion, development, and self-organization: Dynamic systems approaches to emotional development* (pp. 70-99). Cambridge, UK: Cambridge University Press.

Scherer, K. R. (2009a). Emotions are emergent processes: They require a dynamic computational architecture. *Philosophical Transactions of the Royal Society: B, 364*, 3459–3474.

Scherer, K. R. (2009b). The dynamic architecture of emotion: Evidence for the component process model. Cognition and Emotion, 23, 1307-1351.

Scherer, K. R., & Ellgring, H. (2007). Are facial expressions of emotion produced by categorical affect programs or dynamically driven by appraisal? *Emotion, 7*, 113–130.

Smith, C. A. (1989). Dimensions of appraisal and physiological response in emotion. *Journal of Personality and Social Psychology, 56*, 339-353.

Smith, C. A., & Ellsworth, P. C. (1985). Patterns of cognitive appraisal in emotion. *Journal of Personality and Social Psychology, 48*, 813-838.

Strack, F., Martin, L. L., & Stepper, S. (1988). Inhibiting and facilitating conditions of the human smile: a nonobtrusive test of the facial feedback hypothesis. *Journal of Personality and Social Psychology, 54*, 768-777.

Sznycer, D., Cosmides, L., & Tooby, J. (2017). Adaptationism carves emotions at their functional joints. *Psychological Inquiry*, *28*(1), 56-62.

Swartz, N. (2010): Definitions, dictionnaries, and meanings. Retrieved from http://www.sfu.ca/~swartz/definitions.htm

Teasdale, J. D. (1999). Multi-level theories of cognition-emotion relations. In T. Dalgleish & M. Power (Eds.), *Handbook of cognition and emotion* (pp. 665-682). Chichester: Wiley.

Tomkins, S. S. (1962). *Affect, imagery, and consciousness*. NY: Springer.

Tracy, J. L. (2014). An evolutionary approach to understanding distinct emotions. *Emotion Review*, *6*(4), 308-312.

Tracy, J. L., Shariff, A. F., Zhao, W., & Henrich, J. (2013). Cross-cultural evidence that the nonverbal expression of pride is an automatic status signal. *Journal of Experimental Psychology: General*, *142*(1), 163–180.

Vytal, K., & Hamann, S. (2010). Neuroimaging support for discrete neural correlates of basic emotions: A voxel-based meta-analysis. *Journal of Cognitive Neuroscience*, *22*, 2864–2885.

Wagenmakers, E. J., Beek, T., Dijkhoff, L., & Gronau, Q. F. (2016). Registered Replication Report: Strack, Martin, & Stepper (1988). *Perspectives on Psychological Science*, *11*(6), 917-928.