CHAPTER 11

Putting Facial Expressions Back in Context

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Imagine yourself walking alone down a dark alley after midnight. Suddenly, you freeze. The man seen in Figure 11.1 is standing straight ahead of you. In a split second, you recognize the anger so strongly evident by the expression on his face and by his tightly clenched fist. Terrified, you turn around, running for your life. Two long minutes later, you are safe in the main street.

Admittedly, this scenario might seem to be taken from yet another rejected Hollywood script, and such an event would certainly prove quite rare in our everyday life. Nevertheless, it captures an essential but seemingly forgotten truth, namely, that facial expressions are typically perceived in a rich context (Russell, 2003; Trope, 1986). In our everyday experiences, angry faces might be accompanied by clenched fists, sad faces are more frequent at funerals than at weddings, and disgusted faces seem to be paired with that unidentified lump of mold growing at the back of our refrigerator. From an evolutionary standpoint, it seems safe to assume that our ancestors had no exposure to isolated facial expres-

FIGURE 11.1. A basic facial expression from Ekman and Friesen (1976). All images of facial expressions in this chapter are reproduced with permission from the Paul Ekman Group.

sions. It is thus implausible that our ability to recognize facial expressions and map them into emotion categories evolved in complete isolation from our ability to recognize the context in which the faces are embedded. It is very surprising, therefore, that while literally hundreds of studies have examined the perception of isolated facial expressions, only a handful have asked how the perception of the expressions on faces might be influenced by their natural surroundings. In fact, with a few exceptions (e.g., Meeren, van Heijnsbergen, & de Gelder, 2005), most contemporary accounts of the perception of facial expressions ignore the role of context altogether.

On the other hand, the neglect of context in studies of face perception might be justified. After all, certain facial configurations tend to be highly reliable (though not infallible) indicators of the internal emotional state, and there is a strong tendency for these configurations to be similar across human cultures (e.g., Ekman, 1993; Keltner, Ekman, Gonzaga, & Beer, 2003). According to this logic, basic emotional facial expressions directly reflect the emotional state of the person expressing them (Buck, 1994). In fact, in some cases (e.g., threat-related expressions) it might even prove advantageous to ignore irrelevant or distracting contextual information and extract the signal directly from the face. According to this line of thought, our ability to recognize prototypical basic facial expressions accurately would surely be maintained regardless of the context in which they appear. Or . . . would it?

Let us revisit the threatening foe depicted in Figure 11.1, undeniably, not the person we would hope to encounter in a dark alley (or probably any other location). Now, take a close look at his face, and try to ignore his waving clenched fist. How would you describe the facial expression? Is it sad? Is it surprised? Perhaps you see the expression as happy, disgusted, or fearful? If you were anything like the participants in our studies, you would have described his facial expression as angry. It might then seem surprising to discover that his facial expression is actually one carefully posed to signal the prototypical and universal muscular movements of disgust (Ekman & Friesen, 1976). Nevertheless, when the expression is viewed in a context suggesting aggression, the disgusted quality of the expression seems to be lost, and the face appears angry.

This fact is particularly surprising given that anger and disgust are actually very different basic emotions at almost every possible level of analysis (Rozin, Haidt, & McCauley, 2000; Panksepp, 1998). Anger has been described as an innate emotional reaction to an actual or perceived threat (Panksepp, 1998). In contrast, disgust is, at its core, a defense against the incorporation of contaminated foods, and as this emotion develops, the revulsion extends as far as to include immoral acts (Haidt, McCauley, & Rozin, 1994; Rozin & Fallon, 1987).

How, then, is it possible that prototypical disgust faces seen in an anger-inducing context (such as the one in Figure 11.1) become nearly indistinguishable from angry faces in an anger context? As we will later show, such effects occur over a wide range of facial expressions placed in a wide range of contexts. Thus, in contrast to the prevailing view of facial expressions, discrete facial configurations do not exhibit a one-to-one mapping with specific emotion categories.

CHAPTER OUTLINE

We start this chapter by briefly reviewing past work on context and facial expressions.[1] As we will see, most studies did not directly address the question of how context might influence the perception of facial expressions themselves.

We next review three diverging views with regard to the most basic, irreducible, emotional information that is assumed to be read-out from the facial configuration in a context-immune manner. We will show that one's stance regarding the atoms of emotion perception bears directly on one's expectations regarding face–context interactions.

Finally, we present a model and empirical studies showing that context changes the perception of facial expressions in a systematic manner. Specifically, dramatic context effects can be predicted from the physical and perceptual similarity that is shared between the configurations of different facial expressions.

RESEARCH ON FACIAL EXPRESSIONS: HISTORICAL NOTES

The eminent naturalist Charles Darwin is frequently cited as the father of current research on facial expressions. Yet, Darwin himself acknowledged that much important work on the topic had been done prior to the publication of his *The Expression of Emotions in Man and Animals* 1965/1872). For example, Bell (1806) described in detail the physiology and anatomy related to facial expressions. Similarly, Duchenne (1862) conducted extensive research on the physiology and classification of facial muscles by electrically stimulating the facial muscles of his models. Both Bell and Duchenne shared a very clear creationist view of the nature of facial expressions. Naturally, they viewed these expressions as a special God-given gift. Consequently, facial expressions were considered at that time uniquely human (Fridlund, 1994).

It was in this context that Darwin's goal in *The Expression of Emotions in Man and Animals* should be understood (Fridlund, 1994). In his treatise, Darwin passionately challenged the notion that facial expressions were uniquely human by demonstrating similarities between expressions in man and animals. In addition, even if his methodology lacked scientific rigor, Darwin was the first to conduct several cross-cultural studies seeking evidence for the universality of human facial expressions (Ekman, 1999).

Darwin concluded that facial expressions are universal, and by doing so he laid the foundations for decades of research to come. The notion of universality implied that emotional facial configurations served as stable, predictable, and accurate signals. After all, a signal that would change its meaning every time it appears would hardly qualify as a universal indicator of any specific emotion (Carroll & Russell, 1996). Interestingly, despite the popularity and importance of Darwin's book, it would take nearly a century for his ideas on facial expressions to influence the scientific community.

EXPRESSIONS IN CONTEXT: EARLY RESEARCH

Between the years 1914 to 1940, many psychologists were preoccupied with the basic question of whether accurate judgments of emotion from facial expressions were at all possible (reviewed by Ekman, Friesen, & Ellsworth, 1972). Experimenting with expressions in context became a popular tool for answering this fundamental question. Notably, although these researchers experimented with facial expressions in context, their motivation was not to understand the complex interactions between these two sources of emotion information. Rather, they attempted to prove or disprove the popular notion that facial expressions were clear emotional signals.

In an influential study, Landis (1924) photographed facial expressions while the "actors" were engaged in various emotion-evoking situations (e.g., smelling ammonia, being shocked, looking at pornographic pictures, decapitating a rat, etc). He then presented the images of the evoked expressions to a new group of participants and asked them to describe the photographed person's emotion. Landis's findings were striking: the observers' judgments were not consistently related to the actual emotions supposedly elicited by the emotional situations. He concluded that "it is practically impossible to name accurately the 'emotion' being experienced by a subject when one has only a photograph of the face on which to base the judgment." Face expressions, argued Landis, are amorphous. Take away the information provided by the situational context, and the expressions lose their ability to convey information about an individual's internal emotional state.

Other studies did not yield such extreme conclusions. Nevertheless, they demonstrated an important role for contextual information. Within this research framework, Goodenough and Tinker (1931) developed a technique that would later dominate the field. In their paradigm, a facial expression was presented with a short story serving as context. For example, Goodenough and Tinker presented their participants with a facial expression (e.g., a smiling face) and a short verbal vignette (e.g., just heard his best friend died) and asked observers to judge what emotion was felt by that person. Their results showed that both facial expressions and their context were important in the attribution of emotion to others. In the same vein, Munn (1940) presented participants with candid pictures from magazines such as *Life*. In his study, he presented expressive faces in isolation (e.g., a fearful face) versus expressive faces in a full visual scene (a fearful face displayed by a woman fleeing an attacker). His results confirmed that for many emotions the additional contextual information was crucial in the process of attributing emotion to others. Note that, like Goodenough and Tinker, Munn was interested in emotion attribution, not emotion perception, asking his participants "What emotion is being experienced by this person?," not "What is the facial expression displayed by this person?" These and other studies were reviewed by Bruner and Tagiuiri (1954) and Tagiuri (1969), the former concluding, "All in all, one wonders about the significance of studies of the recognition of 'facial expressions of emotions,' in isolation of context" (1954, p. 638).

For the sake of our discussion, it is important to stress again that the motivation for these studies was based on the more general debate of whether facial expressions are, indeed, universal and accurate signatures of emotion. In addition, these studies focused on the more general phenomenon of emotion attribution and consequently did not explore the possibility that the perception of the facial expression itself could be altered by context. Nevertheless, the consensus from these studies downplayed the importance of faces, independent of context, as cues to an actor's emotional state.

As we describe in the following section, research on processing isolated facial expressions was about to enjoy a renaissance in a series of studies stressing the face as a signal that can stand on its own, independent of context.

FACIAL EXPRESSIONS AS DISCRETE EMOTIONAL CATEGORIES

The pendulum began swinging back with the pioneering works of Sylvan Tomkins (1962–1963), an enthusiast of Darwin's ideas on the value of facial expressions. Tomkins was well aware of the fact that Darwin's "proof" for the universality of facial expressions was based on inadequate methodology. In his attempt to reinvestigate the universality question, Tomkins independently advised Ekman (1972) and Izard (1971) to carry out cross-cultural research and sent them out to gather data from various isolated literate and preliterate cultures. Their results demonstrated a high degree of cross-cultural agreement on the display of certain expressions as indicators of emotions and on the extent to which these same expressions are recognized to be indicators of those emotions (Ekman, 1972; Izard, 1971). Ultimately, the findings led to the formulation of the influential neurocultural theory of emotion (e.g., Ekman, 1972, 1993, 2003; Keltner et al., 2003; Tompkins, 1962–1963). Briefly, this theory argues for the existence of a limited number of basic emotions that are expressed distinctively by the configuration of one's face (among other correlates). These expressions are viewed as genetically determined (Erickson & Schulkin, 2003; Galati, Scherer, & Ricci-Bitti, 1997), universal (Ekman, 1993, 1999), and perceptually discrete (Young et al., 1997). In addition, Ekman and Friesen (1976) helped organize the research in the field by providing other scientists with a standardized, anatomically based, and theory-driven picture set of emotional faces (Ekman & Friesen, 1976; Matsumoto & Ekman, 1988). This tool became the gold standard for most research on facial expressions.

The impact and importance of Ekman's work cannot be overestimated, and his theories still lead mainstream conceptualization in facial expression research. Arguably, the hallmark of his tradition was that specific emotional categories could be directly "read out" in a bottom-up manner from the configuration of the face musculature (e.g., Buck, 1994; Nakamura, Buck, & Kenny, 1990; Tomkins, 1962–1963). According to this view, all of the necessary information for the recognition of basic facial expressions is embedded in their distinctive *physical configurations*.

REVISITING EXPRESSIONS IN CONTEXT: EKMAN'S CRITIQUE

The renaissance of facial expressions as accurate signatures of emotion was on its way, but it was not yet complete. A lingering question was still unanswered: Why did past research demonstrate such a major role for context in the process of emotion attribution? Ekman et al. (1972) addressed this problem in an influential review by meticulously criticizing previous studies for using faces that were vague and ambiguous in comparison to the contexts. If one wished to reach meaningful - conclusions about the relative dominance of the expression of the face versus the emotion induced by the context in which they appear, then both sources would need to be equally strong (Ekman et al., 1972).

Following Ekman et al.'s recommendation, several replications of past experiments were performed. In nearly all of these, variants of the Goodenough and Tinker (1931) paradigm (pairing facial expressions with verbal context) were the methodology of choice (e.g., Watson, 1972; Knudsen & Muzeraki, 1983; Wallbott, 1988; Nakamura et al., 1990). By and large, the results showed that when the face and context were equally clear and strong, the attribution of emotion was determined by the facial expression. However, it is crucial to stress once again that these researchers were not interested in the question of how the context might change the *perception* of the face. Instead, they asked how participants choose from among these different sources of information and reach a decision concerning the emotion of the person they are judging. For this reason, participants in these studies were not asked to categorize the expression of the face itself.

DISCRETE EMOTIONS AS THE "ATOMS" OF EXPRESSION

As previously mentioned, discrete theories contest that specific emotional categories can be directly read out in a bottom-up manner from the configuration of the facial expression (e.g., Buck 1994; Nakamura et al., 1990; Tomkins, 1962–1963). According to this view, the *atoms* in expressive faces are discrete face configurations that represent basic emotions (e.g., anger, fear, disgust). Each basic (expressive) face configuration is a unique facial atom that is immediately recognized by normal, healthy perceivers as belonging to a specific emotion category.

In support of this view, it has been shown that computerized network models can categorically differentiate basic expressions based purely on their structural characteristics (Calder, Burton, Miller, Young, & Akamatsu, 2001; Daily, Cottrell, Padgett, & Adolphs, 2002; Etcoff & Magee, 1992; Smith, Cottrell, Gosselin, & Schyns, 2005; Susskind, Littlewort, Bartlett, Movellan, & Anderson, 2007). For example, Susskind et al. (2007) have shown that a computational model that has no concept of emotion categories can categorize facial expressions based solely on pure data-driven similarity between image pixels. This notion—that all the necessary information for the categorization facial expressions is embedded in the face itself—resonates with McArthur and Baron's (1983) concept of "direct perception" (cf. Gibson, 1950) in social stimuli. According to their theory the raw sensory input (i.e., the configuration of the face) is sufficient for directly perceiving various emotional signals (the atoms) without need for more complex "top-down" processes.

Although the discrete view of facial expressions proved to be very productive in enhancing our understanding of isolated expression perception, it came with an unfortunate price. Specifically, the role of context in the processing of facial expressions was minimized, if not completely forgotten (Calder & Young, 2005; Ekman & O'Sullivan, 1988; Smith et al., 2005).

As we describe next, the notion of facial expressions as discrete entities that signal specific emotions has its opponents in the dimensional theories of emotion. As we shall see, these theories emphasize the more basic underlying affective dimensions of valence and arousal that are read out from the face in a context-immune manner.

DIMENSIONAL–CONTEXTUAL MODELS OF EMOTION PERCEPTION

The view that basic facial expressions of emotion are distinct and context-resilient entities has not gone unchallenged. According to the circumplex model of emotion (Russell, 1980, 2003), all of the emotions can be characterized by a conjunction of values along two underlying factors that consist of bipolar dimensions. As can be seen in Figure 11.2, these bipolar dimensions include valence (pleasant vs. unpleasant face) and arousal (activated or deactivated face). Importantly, these broad dimensional values, but not specific emotion categories, are considered to be expressed in the face.

Based on research pioneered by Woodworth and Schlosberg (1954), the circumplex model considers emotional facial expressions to be systematically related to one another by their degree of arousal and valence. Thus, expressions can be located next to or distant from one another in a two dimensional circular arrangement. Some expressions that share similar degrees of arousal and valence will be located adjacently (e.g., anger and disgust), while other faces (e.g., those expressing sadness and fear) that encompass different levels of valence or arousal will be positioned in nonadjacent locations on the circumplex (Russell, 2003; Russell & Bullock, 1985; Woodworth & Schlosberg, 1954).

Direct evidence for the psychological perceptual reality of this model was obtained by Russell and Bullock (1985). In their study, a group of preschoolers and adults was asked to group together facial expressions of people who appear to feel alike. When the results were analyzed, a clear bipolar representation, with the factors of valence and

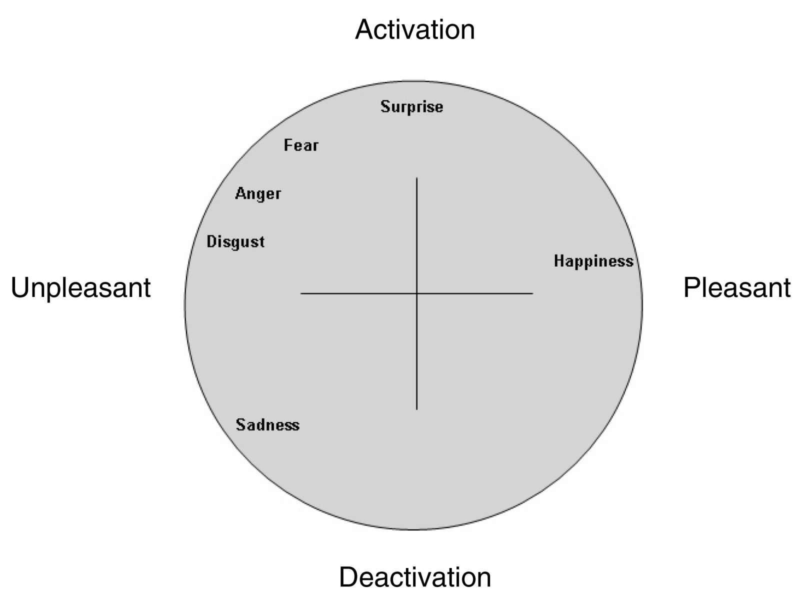

FIGURE 11.2. A schematic representation of the location of basic emotions on the circumplex model. Every basic emotion has been placed roughly in its appropriate location as predicted by dimensional theories (e.g., see Russell, 1997). The location of each emotion reflects the combination of the two bipolar dimensions of arousal (activation) and valence (pleasantness).

arousal, emerged for both groups. Importantly, the fact that preschoolers are not conceptually and linguistically proficient with specific emotion categories (such as anger, fear, disgust, etc.) did not affect the overall representational structure that they ascribed to the faces.

EMOTIONAL DIMENSIONS AS THE "ATOMS" OF EXPRESSION

According to the dimensional account of facial expressions, the "atoms" of facial expression perception consist of valence and arousal.[2] As atoms, the values of the dimensions are considered to be read out directly from the face and thus to be immune to contextual influence. For example, faces with negative valence should be perceived as negative regardless of the context in which they appear.

Based on the circumplex model, Russell and Bullock (1985) and Russell (1997) have tentatively suggested a two-stage model for recognizing emotional facial expressions. At the first stage, the basic dimensions of valence and arousal are directly "read out" from the face rapidly and effortlessly. This stage is assumed to be immune to contextual influence (Russell, 1997). However, the end product perceived in this first stage (e.g. high arousal, negative valence) is considered to be highly amorphous with regard to the specific emotional category that can be inferred from the configuration of the face. Referring back to Figure 11.2, a face conveying high levels of displeasure and high levels of arousal should be compatible with a range of specific emotions (e.g., anger, fear, disgust) occupying the quadrant from about "9–12 o'clock" in the circumplex (Russell, 1997, p. 311).

How, then, do people perceive specific emotion categories in their mundane experience? This matter is resolved at the second stage of the model, in which a specific emotion category is attributed to the face in a more laborious and effortful top-down process. In contrast to the first stage, this second "disambiguation stage" is assumed to depend heavily on contextual information and "top-down" processing (Larsen & Diener, 1992; Russell, 1997, 2003). Thus, dimensional models recognize the role that context has on mapping facial expressions into emotion categories, albeit not in the perception of valence and arousal from the face (Carroll & Russell, 1996; Posner, Russell, & Peterson, 2005; Russell, 1980, 1997, 2003; Russell & Bullock, 1985, 1986; Barrett, 2006).

The latter assumption was tested by Carroll and Russell (1996) in yet another study utilizing the Goodenough–Tinker paradigm (i.e., pairing facial expressions with short contextual stories). In their study, they paired emotional faces with emotionally incongruent contexts that nevertheless shared similar emotional dimensions (i.e., similar degrees of arousal and valence). For example, a fearful face was paired with an anger-inducing context (but not a happiness-inducing context). After seeing the facial expression and hearing its paired contextual vignette, participants were asked to decide which emotion the person might be feeling. As the researchers predicted, the majority of participants chose the emotion suggested by the context.

All the same, these data say little about contextual influence on the *perception* of facial expression. As previously noted, the traditional use of the Goodenough and Tinker paradigm implicated emotion *attribution*, not emotion *perception*. Similarly, in Carroll and Russell's (1996) study, participants were asked, "What emotion is the person feeling?," not "What is the facial expression displayed by this person?" As such, these studies focused on the more general phenomenon of emotion attribution but not on the specific process of perceiving the expression of the face. Therefore, it is unclear if the perception of the facial expressions in that study were at all influenced by context.

A TWO-STAGE MODEL OF ATTRIBUTION

It is interesting that a formal model describing the relation between the perception of facial expression and context was not put forward initially by emotion theorists or psychologists focused on face perception, but by social psychologists studying attributions. Researchers studying attributions have pondered over the process by which ordinary people figure out the causes of other people's behavior (Gilbert, 1998). Early attribution theorists (e.g., Kelley, 1967, 1972; Jones & Davis, 1965) have shown that people view behaviors as the combined result of situational context and enduring predispositions. According to these classical accounts, if someone's behavior would be sufficiently explained by the situation, people would have no logical reason to infer anything about the enduring character of that person.

For example, if John is just about to plunge to his first bungee jump, we might not attribute his fearful face to an enduring fearful disposition but to the situation. If, however, John displays the same face while sitting at home on his couch, we might just consider him a very anxious fellow. Hence, according to Kelley (1972), the attribution of a personal disposition is inversely related to the strength of the situational context. Other researchers have noticed, however, that people have a surprising tendency to downplay situational demands and evaluate the behavior of others in terms of enduring character despite logical expectations (Ichheiser, 1949; Jones & Harris, 1967; Ross, 1977). This tendency to downplay situational context has been termed the "*fundamental attribution bias*" (Ross, 1977).

The common theme to these theories was that they all dealt extensively with the rather late stages of attribution, occurring after the behavior (i.e., the fearful face) was already identified. In contrast, they completely ignored the initial stages in which the behavior itself was perceptually processed. It was in this context that Trope (1986) asked: How is the face recognized as fearful in the first place?

AMBIGUITY AND EXPRESSION PERCEPTION

In order to answer this question, Trope (1986) suggested a model in which the attribution process was broken down into two stages. The first stage (on which we will focus here) consisted of identification, and the second consisted of dispositional inferences. At the initial identification stage, situational cues (e.g., upcoming bungee jump), behavioral cues (e.g., fearful face), and cues concerning prior knowledge about the perceived person (e.g., that person is usually scared of his own shadow) all have the potential of interacting to influence our attribution of emotion. Consequently, Trope argued, in order to predict the outcomes of the identification process, we must take into consideration the ambiguity of both the context and the behavior. According to this line of thought, ambiguous facial expressions are equally and highly associated with more than one emotion category[3] (e.g., a facial expression that has an equal chance of being categorized as happy or angry). Unambiguous facial expressions, in contrast, are strongly associated with only one category (e.g., a face that is only categorized as angry). Of course, just as a facial expression can be ambiguous or unambiguous, so can the context in which it appears. For example, the death of a friend after years of suffering from cancer might equally be considered as relieving as well as saddening.

Importantly, Trope (1986) posited that the effect of context on behavior identification should increase with the ambiguity of the facial expression and decrease with the ambiguity of the context. For example, imagine that we see an ambiguous facial expression that equally signals anger and fear. Now, if we were to know that a bungee jump was the context in which that face appeared, the contextual expectation of fear would affect the categorization of the ambiguous face, and it would be identified as fearful. Thus, the model allows for behavioral cues, such as facial expressions, to be directly influenced by various contextual cues.

In this model, context has the potential power of drastically shifting the classification of ambiguous cues from one category to the other. However, basic prototypical universal expressions, which are fairly unambiguous, should prove to be contextually immune.

The two-stage model was experimentally tested by pairing faces with contextual verbal descriptions. Yet, in contrast to previous studies, Trope (1986) had his participants categorize the *facial expression itself*. Critically, some of the expressions were ambiguous, and some were unambiguous. All faces were paired with a short situational description. For example, an ambiguous happy-angry face was paired with an angry situation and with a happy situation. Similarly, unambiguous angry and happy faces were paired with both angry and happy contexts. As hypothesized, dramatic contextual effects were found only when the facial expressions were ambiguous.

WHEN ARE CONTEXTUAL EFFECTS EXPECTED? A SUMMARY

Theorists that consider facial expressions as discrete categories have usually ignored the role of context in expression perception (e.g., Ekman et al., 1972; Ekman & O'Sullivan, 1988). Prototypical basic facial expressions were viewed as signals that conveyed unambiguous emotional meanings. As such, the role of context in that process was minimized. Thus, theories of discrete expressions predict that specific emotional categories (e.g. anger, fear, disgust) should be directly read out from the face configuration regardless of the context in which it appears (Ekman & O'Sullivan, 1988).

In contrast, dimensional models permit contextual effects, albeit to a limited degree. Context might strongly shift the categorization of expressions *within* given values of valence and arousal, for example, within a given quadrant of the circumplex. However, contextual information would not be expected to shift the values of the fundamental dimensions that are perceived in the face (Carroll & Russell, 1996; Russell, 1997). Hence, contextual information would not be expected to cause shifts between facial expressions that are positioned in different quadrants of the circumplex.

Finally, Trope's (1986) model predicts contextual effects as a function of empirical ambiguity, with no *a priori* differentiation between any kind of facial expression or dimension. Furthermore, the model assumes that the lowest degree of ambiguity matches those facial expressions identified as "basic" by Ekman and Friesen (1976). Hence, it clearly follows that those basic facial expressions will be least prone to context effects.

REVISING THE TWO-STAGE MODEL: CONTEXT EFFECTS AND PHYSICAL SIMILARITY

Past research has usually presented faces and contexts from different modalities (e.g., Carroll & Russell, 1996). However, this practice has its limits. Most notably, it has been demonstrated that emotions are more accessible from pictures of faces than from verbal descriptions of situations (Fernandez-Dols & Carroll, 1997). We intended to embark on a program of research that can bypass this inequality. Our initial concern involved finding a reliable tool in which various prototypical facial expressions could be presented while embedded in different naturalistic contexts. Specifically, we aimed for the face and context both to be visual and to be experienced together as an integrated and unitary scene. To this end, we decided to investigate visual context effects by utilizing the fact that body behavior, gestures, and scenes might serve as natural and rich contexts in which to interpret the emotion cues conveyed by the face (e.g., Wallbott, 1998; Meeren et al., 2005; Van den Stock, Righart, & deGelder, 2007; for a review see de Gelder et al., 2006).

In the preparation of the stimuli (e.g., Figure 11.1), we carefully merged pictures of models engaged in various emotion-evoking situations (e.g., holding dirty diapers, waving angry fists, etc.) with images of facial expressions (for similar methodology see Meeren et al., 2005). For the faces we used "gold standard" facial expressions from the standardized sets of Ekman and Friesen (1976) and Matsumoto and Ekman (1988), thus ensuring that the expressions conveyed by the isolated faces were clear and unambiguous. Indeed, our pilot studies with Israeli and Canadian populations of undergraduate students confirmed that the expressions of the isolated faces are recognized with a satisfactory degree of accuracy, replicating the data of Ekman and Friesen (1976).

In an initial pilot study, we presented basic expressions with a range of affective contexts. For example, we "planted" an anger face on an athlete running a hurdle race (Figure 11.3), a disgust face on a person who was waving an angry fist (Figure 11.1) and a disgust face on a person displaying confusion by shrugging his shoulders (Figure 11.4). Participants were shown the images with no time limit and were instructed to choose the option that best described the facial expression in the picture. In addition to the options describing the basic emotions, we also included options that corresponded to the contexts.

Remarkably, in all of our face–context combinations the recognition of the "original" basic expression was practically lost. Instead, facial expressions were categorized in accordance with the context in which they appeared. Consider the hurdle-race runner in Figure 11.3.

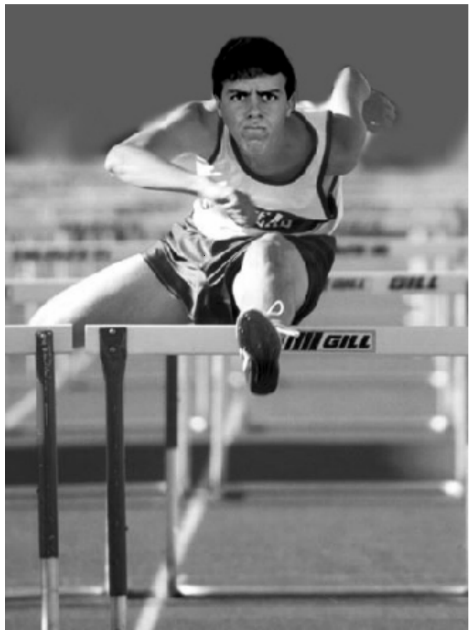

FIGURE 11.3. A basic facial expression of anger in the context of determination (facial expression from Matsumoto & Ekman, 1988). Reproduced with permission from the Paul Ekman Group.

When his facial expression is presented in isolation, it serves as a highly unambiguous signature of anger (categorized by 91% as anger in the published norms by Matsumoto & Ekman, 1988). Yet, when the face was presented in a context suggesting "determination," not even one of our 24 participants chose anger as the emotion portrayed by the face, and the dominant response was "determination." Figure 11.4 presents yet another example of the powerful effect context may exert on unambiguous facial expressions. Although the face in isolation was recognized as disgust by nearly 90% of the viewers (Matsumoto & Ekman, 1988), that recognition level was reduced to 0% when the face was presented in a context suggesting confusion.

These examples make it clear that context can induce a radical shift in the categorization of unambiguous expressions portrayed by faces. Critically, and in contrast to most previous studies, our participants were specifically attempting to categorize the *facial expression* rather than to attribute an emotion to the target. Our next step was to look for the rules that govern these contextual effects. Specifically, we wished to un-

FIGURE 11.4. Basic expression of disgust in the context of confusion (facial expression from Matsumoto & Ekman, 1988). Reproduced with permission from the Paul Ekman Group.

derstand when contextual effects would prevail and when they would diminish.

PHYSICAL SIMILARITY AND "EMOTION SEEDS"

One way of understanding the effects of context on expression perception is by considering the inherent but only latent physical similarity that resides within basic facial expressions. Each expression includes physical features (i.e., face muscular movements) that are associated, to varying degrees, with faces that express different emotions. For example, whereas certain features in disgust faces might be relatively unique to disgust, such as the wrinkled nose, other features, such as the furrowed brows, are shared with other expressions (Smith & Scott, 1997). As a result, a given facial expression *X* may share many features with emotion *Y* but few features with emotion *Z*. Each facial expression, then, is confounded to varying degrees with other facial expressions with which it shares physical information.

To the above end, we introduce the term "emotion seeds" to describe this shared physical information. This term underscores the fact that, when viewed in isolation, the *shared* physical input has very little impact, and the seeds remain inert. However, when faces are perceived in context, these seeds may become highly relevant and "grow" significantly, influencing the perception of the facial expression. We next elaborate on these concepts and describe how emotion seeds are defined as well as how they might alter the perception of the facial expressions.

Emotion seeds in faces are at least partly a function of similarity between expressions, and hence they can be assessed using computational models that calculate this similarity (Dailey et al., 2002; Susskind et al., 2007). For example, Susskind et al. (2007) used an algorithm that was designed to make seven-way forced-choice categorizations of basic expressions. The process was purely data-driven from the similarities in the pixels of the expression images, and the model does not have any *a priori* concept of emotion. The results showed that different facial expressions could be assigned to distinct groups based purely on their physical properties. Critically, good agreement was found between the model and the judgments of human participants who rated the faces with respect to to six basic emotions (anger, happiness, surprise, sadness, fear, and disgust) on a scale from 1 to 7 (1 = not at all; 7 = very much). Hence, it seems likely that the patterns of human emotion categorization could be driven by the low-level physical similarities among expressions.

Figure 11.5 illustrates the network classifications for the six basic facial expressions. Each cluster represents a different facial expression

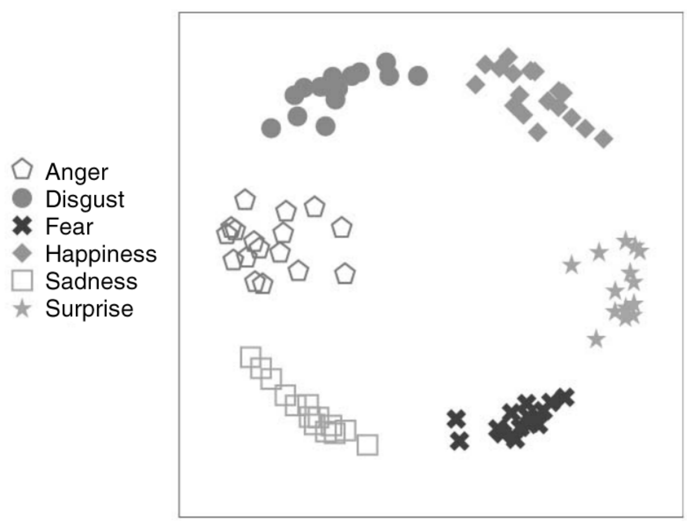

FIGURE 11.5. Computer-based categorization of facial expressions based on the physical similarity between the different facial configurations. Emotion categories placed next to each other are more physically similar. Adapted from Susskind, Littlewort, Bartlett, Movellan, and Anderson (2007).

category, and the location of each cluster represents the relative physical similarity between the different expressions. For example, the expressions of disgust were classified as most similar to those of anger, less similar to sad faces, and even less similar to fear faces. Thus, one can think of disgust expressions as sharing many emotion seeds with anger faces, some emotion seeds with sad faces, and very few emotion seeds with fear faces.

Corroborating evidence comes from analyzing the errors of facial expression categorizations in the norms provided by Ekman and Friesen (1976). For example, as we noted, the computational model shows that disgust faces hold declining degrees of emotion seeds with the expressions of anger, sadness, and fear, respectively. This finding is mirrored in the Ekman and Friesen (1976) error analysis, as evident in the declining average confusability between the expressions of disgust and anger (6%), disgust and sadness (3%), and disgust and fear (1%).

In short, both the computerized analysis of physical similarity between facial expressions and human errors strongly suggest that facial expressions are ambiguous to varying degrees with other facial expressions with which they share physical features. Under the typical experimental design in which faces are shown devoid of any context, the emotion seeds remain latent. Indeed, the average rate of confusability between isolated facial expressions is negligible. Yet, it seems that these seeds grow and exert powerful effects when the faces are placed in context. When is it, then, that the emotion seeds sprout?

CONTEXTUAL EFFECTS AND "EMOTION SEEDS"

How do the physical similarities among various expressions relate to contextual effects? As we have previously claimed, each facial expression is ambiguous to varying degrees with others, depending on the amount of shared physical features. Independently, contexts differ in the extent to which they can activate one or more emotions. Context effects on faces depend, we argue, on the emotion seeds shared by the target expression (i.e., the actual face being judged) and by the facial expression that would typically be associated with the emotional context.

This notion of ambiguity differs from previous accounts that emphasized the ambiguity of facial expressions as a property of the expression (Trope, 1986). In contrast, the current conceptualization argues that facial expressions should not be thought of as simply ambiguous *or* as unambiguous. For instance, due to the physical similarity between the two facial configurations, sad faces encompass seeds of disgust. Yet, the disgust concealed in sad faces will not be evident unless activated by the appropriate context. This ambiguity would probably remain latent if the sad face were presented in the context of a person celebrating his birthday party with his close friends. This is the case because surprise birthday parties do not strongly activate the notion of disgust, and, consequently, the seed remains dormant. In contrast, consider the same sad face appearing in the context of a person holding a soiled pair of underwear. Since this context can strongly activate the emotion seed of disgust, it would result in the sad face being perceived as disgusted.

Thus, a given facial expression may be *highly ambiguous* with respect to some physically similar expressions yet *highly unambiguous* with respect to other physically dissimilar expressions. The specific combination of facial expression and context, we argue, would ultimately determine the occurrence and magnitude of context effects.

“EMOTION SEEDS” IN CONTEXT: ILLUSTRATIVE RESEARCH

In our first study, we examined the relationship between the magnitude of context effect and the physical similarity between the actual facial expression and the expression typically associated with the context. Specifically we assumed that the magnitude of the context effect would positively correlate with the degree of similarity (and, ex hypothesis, the amount of shared seeds; Aviezer et al., in press).

To achieve this goal we presented faces that expressed disgust in the contexts of bodies gesturing disgust, anger, sadness, and fear. Crucially, the facial expressions associated with these contexts were less and less similar (and hence shared fewer emotion seeds) with the original disgust expression (see Susskind et al., 2007). In other words, each of these contexts suggests a facial expression that is physically more distant from disgust, as determined by the computational model (Figure 11.5). Consequently, disgust expressions were predicted to be highly influenced by the anger context, moderately influenced by the sad context, and only slightly influenced by the fear context.

Our design could also tackle a nagging concern from our pilot results, namely, that participants might have simply been ignoring the faces in the presented images. Although our instructions were explicit, participants might have rather relied on the perhaps more salient context than on the face. If participants were merely ignoring the face, then contextual effects in the current design should manifest equally regardless of the unique face–context combination. If our results would show differential context effects, however, then we could safely conclude that the faces are not being ignored.

We used the same experimental procedure as described in the pilot study. Ten prototypical facial expressions of disgust from the database, each from a different model (5 female, 5 male), were used to ensure a wide representation of the facial expression (Ekman & Friesen, 1976). Participants were required to categorize the expressions of the faces with no time limit, and the face in each trial remained in full view until a response was made. In a control condition, participants were also required to categorize the same facial expressions in isolation and the contextual scenes with the faces blanked out.

CROSS-CATEGORY CONTEXT EFFECTS

We defined accurate responses as those in which the face was categorized as belonging to the anatomically-based category of disgust (Ekman & Friesen, 1976). The average accuracy for the isolated disgust faces was 65.6% (chance level = 16.7%). Although somewhat lower than expected from the average published norms, such performance is within the range of normal performance (Young et al., 2002). The faceless context images were recognized with a much higher agreement, ranging from 92% to 96%, with *no significant differences between the various* contexts (Aviezer et al., 2007). Hence, any differences in the perception of the disgust faces placed in context could not be readily attributed only to differences in context strength.

The average recognition accuracy of the disgust faces was measured in each context in which they were embedded. Our results showed the dramatic effect of context. The mean accuracy for the disgust faces was 91% when placed in a disgust context, 59% when placed in the fear context, 35% when placed in the sadness context, and 11% when placed in the anger context. Critically, the categorization accuracy of the facial expressions declined linearly as a function of the physical similarity between the actual face and the facial expressions suggested by the context. Consistent with our theorizing, then, the anger context yielded the most powerful context effect. We believe it did so because the disgust and anger faces are physically similar and hence share a great deal of emotion seeds. Consequently, participants were at chance level at their recognition of the disgusted faces when presented in an anger context. In contrast, the fear context exerted a relatively modest influence on the recognition of the facial expression. We believe that the influence of this context was modest because disgust faces and fear faces share little physical similarity; hence, few seeds of "fear" are present in the "disgust" expression.

We next examined if the facial expressions of disgust were categorized, indeed, as belonging to the context categories or, alternatively, if the perception of disgust was hampered by incongruent context with no systematic bias toward the context. A bias toward the context could corroborate our view that the degree of these categorizations depended on seed ambiguity induced by the physical similarity between the expressions. Remarkably, the probability of categorizing disgust faces in a disgust context as disgusted (91%) did not differ significantly from the probability of categorizing the same disgust faces as expressing anger when placed in an anger context (87%). Furthermore, disgust faces in a sad context were nearly equally likely to be placed into the sad (29%) or disgust (35%) categories (Aviezer et al., in press). However, when the disgust faces were presented in the fear context, participants were far less likely to categorize the face as fear (13%) than they were to categorize it as disgust (59%).

Together, these results confirm that the participants were not ignoring the face and choosing the label suggested by context nor was their categorization merely interfered with by an incongruent context (cf. Meeren et al., 2005). On the contrary, it seems that the respondents were paying close attention to the context as well as to the face (which, indeed, was their task). Most importantly, the emotional information provided by the context and the expression of the face seemed to *interact* in a highly predictable manner. Further experimentation in our lab has confirmed that these effects apply to a wide range of facial expressions, including fear, anger, and sadness, as well as disgust. In addition, we have shown that the results are not an artifact of the response format available to participants. For example, we allowed participants to choose more than one correct answer as well as to choose none of the options by selecting a "none of the above" response. These variations in the experimental task did not result in any significant changes to the results.

It is interesting to compare our results with those obtained by Meeren et al. (2005), who conducted a conceptually similar study that examined the influence of body language (expressing fear and anger) on the rapid categorization of facial expressions (fear and anger). In their study, faces and contexts were presented in both congruent (e.g., fear on fear) and incongruent (e.g., fear on anger) combinations. Their results indicated Stroop-like interference effects (e.g., lower accuracy and higher RTs for incongruent pairs) but *no contextually induced categorical shifts* (Meeren et al., 2005). Hence, notwithstanding the interference, the majority of facial expression categorizations corresponded to the original expression conveyed by the faces, regardless of whether they appeared with congruent or incongruent body language. In light of our theory and results, the lack of cross-categorical context effects in the Meeren et al. (2005) study might be explained by the fact that they limited their investigation to facial expressions of fear and anger that are in fact quite dissimilar at the physical level (Susskind et al., 2007). Consequently, anger and fear share few emotion seeds, and context effects do not prevail.

CROSS-DIMENSIONAL CONTEXT EFFECTS

As we argued earlier, dimensional models, such as the circumplex, consider the dimensions of arousal and valence to be the basic atoms of affect perception (Russell, 1997; Russell & Bullock, 1986). These values are considered contextually invariable since they can be unequivocally "read out" from the facial configuration. For example, a consistent finding in dimensional models (e.g. Russell & Bullock, 1985; Russell, 1997) is that facial expressions of sadness and fear are very distant from each other, occupying separate quadrants of the circumplex (see Figure 11.2). This stems from the obvious fact that the two expressions differ greatly in their degree of arousal. Interestingly however, when the physical similarity between sadness and fear is examined, it becomes apparent that the two share substantial degrees of physical similarity (Susskind et al., 2007; see Figure 11.5). Thus, diverging predictions can be made with regard to the viability of achieving context effects that aim at crossing the border of dimensional arousal.

On the one hand, the circumplex model views this as highly unlikely due to the very different levels of arousal and valence accompanying the emotions of sadness and fear. Because, ex hypothesis, these dimensions are directly and unambiguously read out from the facial configuration, they should not be altered by context. Therefore, dimensional models would predict that, regardless of the context, low-arousal sad expressions should not be perceived as conveying high arousal. On the other hand, the emotion seed approach does not restrict contextual effects to cases that share dimensional values but to cases that share physically based similarity. Thus, we do not consider the values of the facial dimensions of arousal and valence as contextually immune. For example, given their physical similarity, sadness and fear might indeed be potential candidates for contextual cross-category shifts.

In an attempt to examine if the perception of arousal might shift due to context, we presented different faces expressing sadness in a highly arousing fear context (see the example in Figure 11.6) or in a congruent low-arousal sad context (Aviezer et al., in press). Participants were required to rate the valence and arousal of the faces without referring to a specific emotional category. We used a computerized version of the 9 × 9 "affect grid," which represents valence and arousal in its bipolar axes (Russell, Weiss, & Mendelsohn, 1989). Using this tool, emo-

FIGURE 11.6. Example of a basic facial expression of sadness (low arousal) in fear context (high arousal). Facial expression from Ekman and Friesen (1976). Reproduced with permission from the Paul Ekman Group.

tional stimuli can be simultaneously rated for arousal and valence on a 1–9 scale. Importantly, both the arousal and valence scales are bipolar (positive to negative, high-arousal to low-arousal), with a neutral midpoint assigned the value of 5, represented by a central gray square in the grid.

As predicted by the "emotion seeds" approach, the results showed that the fearful context resulted in a categorical shift in the perception of arousal. Whereas sad faces in a sad context were rated as portraying low arousal (4.4 out of 9), sad faces in a fear context were rated as portraying high arousal (6.7 out of 9). It seems, then, that at least under certain conditions the perception of arousal may not be immune to contextual influence. In a subsequent stage, participants also categorized the specific emotions of the same facial expressions.[4] Replicating previous results, the context also induced a complete categorical shift in the categorization of the faces (Aviezer et al., in press). For example, the face in Figure 11.6 was categorized as fearful by nearly 60% of the participants, whereas only 17% categorized it as sad (which is in fact the intended emotion). In conclusion, it appears that physically based emotion seeds can be used as a useful conceptualization of when context effects on dimension and emotion perception will occur.

Although the notion of emotion seeds brings us closer to understanding the rules and constraints of context effects on processing facial expressions, it is clearly not enough. The fact that certain physically based "seeds" of emotion lay latent in each facial expression is in itself insufficient in explaining the *mechanism* by which the seed can grow. In the following section we sketch a tentative model in which we describe how trace levels of emotion seeds might be contextually magnified, resulting in striking effects on facial expression perception. The model suggests an attentional mechanism that may explain the changes that facial expressions undergo when placed in different contexts.

AN ATTENTIONAL BIAS MODEL

The basic premise of the attentional bias model is that context can influence the perception of facial expressions by guiding the viewer's attention to various facial regions that correspond to the emotion suggested by the context (e.g., Bar, 2004). This attentional bias can result in a perceptual change, depending on the face's emotion seeds and the emotional category associated with the context. If attention is diverted by the context to the facial feature of the emotion seeds, then, metaphorically speaking, the seed is watered by attention, a process that allows it to exert its influence of emotion perception.

Facial expressions include features that convey both unambiguous and ambiguous information (Smith & Scott, 1997; Smith et al., 2005). For example, certain features in disgust faces might be relatively unique to disgust (e.g., the wrinkled nose), while other features are shared with other expressions (e.g., the furrowed eyebrows). Facial expression recognition takes place by viewers extracting as much information as possible from specific areas of the face (Smith et al., 2005). Indeed, ample evidence from behavioral studies and eye-movement recording shows that when we categorize different expressions we focus visual attention on different regions of the face (Calder, Young, Keane, & Dean, 2000; Smith et al., 2005, Sullivan & Kirkpatrick, 1996; Wong, Cronin-Golomb, & Neargarder, 2005).

When facial expressions are perceived in context, the contextual cues invoke an associated category, which then serves as a source of expectations concerning the categorization of the facial expressions (Bar, 2004; Trope, 1986). Under these conditions, we hypothesize that attention is diverted *away* from the components that are diagnostic of the original expression and *toward* the emotion seeds. Consequently, very small degrees of emotion seeds that would otherwise be ignored become disproportionably magnified by attention.

In sum, context effects will depend on both the emotion seeds of the target facial expression and the extent to which the context activates one of the latent seeds that resides in the face. One interesting prediction that may be deduced from the attentional bias model is that the attentional processing of facial expressions will differ depending on the contexts in which the faces appear. We next describe some preliminary evidence for this hypothesis from eye-movement tracking.

EYE SCANNING AND ATTENTIONAL BIAS

The attentional model posits that facial expression recognition takes place by viewers extracting as much information as possible from the diagnostic areas of the face (Smith et al., 2005). Indeed, converging evidence has accumulated demonstrating that different regions of the face are crucial for the accurate recognition of specific facial expressions. For example, Calder et al. (2000) had viewers categorize facial expressions while being presented with only the top half or bottom half segments of the face. Their result indicated that some expressions (e.g. anger) were more recognizable from the top half whereas others (e.g. disgust) were better recognized from the bottom half.

Similar results were obtained by studies that examined the critical regions for expression recognition with *bubbles* (Gosselin & Schyns, 2001). In that technique, participants are presented with various bubbles that consist of windows to the facial expression, each composed from different spatial frequency bandwidths and Gaussian filters. By examining the bubbles that are crucial for correct categorization, the diagnostic regions for the recognition of each expression can be determined. The results from that study have shown that distinct locations in the face are utilized when decoding different facial expressions (Smith et al., 2005). Specifically, the regions critical for disgust perception included the lower mouth region; however, the eye region was critical for anger recognition. This finding has also been replicated in eye tracking studies. For example, Wong et al. (2005) had participants passively view facial expressions without any categorization task. Their results have shown that, while viewing anger faces, scanning (the number and duration of fixations) was much more pronounced on the eye region than on the mouth region. In contrast, when viewing disgust faces, a more symmetrical scanning pattern existed between the eyes and mouth (Wong et al., 2005).

Given the well-established segregation between the eye region and mouth region for the recognition of disgust and anger expressions, we were motivated to examine if context would induce changes in the characteristic scanning of these facial expressions. According to the attentional bias model, we conjectured that the scanning of the face should be influenced by the context rather than by the configuration of the face alone. We hypothesized that the number and duration of fixations to the different facial features will differ as a function of the context in which faces appears. Therefore, disgust expressions in the context of anger were expected to be scanned as congruent anger expressions, with more scanning to the upper eye regions. Conversely, anger expressions in the context of disgust were expected to be scanned as congruent disgust expressions, with a more symmetrical scanning pattern between the mouth and eye regions.

We compared the scanning of anger and disgust facial expressions, each occurring in a congruent (e.g., anger face–anger context) or incongruent (e.g. anger face–disgust context) condition (Aviezer et al., in press). Ten different prototypical expression exemplars appeared in each condition. Eye path scanning was measured with EyeLink II, a 500 Hz infrared pupil-centered eye tracker. All stimuli were randomly presented while participants viewed and categorized the faces.

The results indicated that visual scanning of expressive faces changed systematically as a function of the context in which the faces appeared. When anger faces appeared in a congruent anger context, more fixations were made to the eye (5.1) than to the mouth (3) regions. However, when the same faces appeared in a disgust context, a symmetrical pattern of fixations was observed between the eyes and mouth (3.4, and 3.3, respectively). Conversely, when disgust faces appeared in a disgust context, the number of fixations to the mouth (3.4) and eye (3.2) regions was symmetrical. Yet, when the same faces appeared in an anger context, more fixations were made to the eye regions (5) than to the mouth region (3.6). Interestingly, this striking influence of context was evident from the very first gaze to the face, suggesting that the attentional bias reflects a rapid initial stage rather than a late influence of semantic processing (Aviezer et al., in press).

Thus, facial expressions of disgust and anger are distinctly scanned when placed in neutral context. However, when incongruent combinations are formed between anger and disgust faces and contexts, the categorization and characteristic eye-scanning patterns are reversed, reflecting the expression context. This pattern of eye scanning is consistent with the attentional bias model. However, more research is necessary to determine the causal relationship between the behavioral context effect and the eye-scanning pattern.

SUMMARY AND CONCLUSION

In this chapter, we challenged the two major views of facial expression perception. Discrete theories contest the view that facial expressions convey specific emotional categories (e.g., Buck, 1994; Nakamura et al., 1990; Tompkins, 1962–1963). In contrast, dimensional theories hold that emotional faces convey the broad affective dimensions of valence and arousal (Russell, 1997; Russell & Bullock, 1986). Both accounts assume that the perception of the basic atoms of facial expressions (discrete categories for the former, affective dimensions for the latter) is immune to contextual influences, since they can be directly and unambiguously read out from the face.

In contrast, we present data that demonstrate that the perception of both types of emotional atoms is highly influenced by context. Furthermore, we suggest that contextual influence on the perception of facial expressions can best be understood by examining the physical properties of the facial expressions. We highlighted the fact that each facial expression includes physical features that are associated, to varying degrees, with faces that express other emotions. We then introduced the notion of *emotion seeds*, reflecting the shared physical and perceptual similarity that resides between different expressions. As we have demonstrated, these seeds may alter the perception of the face when they are activated by context.

According to our conceptualization, a given facial expression may be *highly ambiguous* with respect to some physically similar expressions and yet *highly unambiguous* with respect to other expressions that are more physically dissimilar. The specific combination between facial expression and context would ultimately determine the occurrence and magnitude of context effects.

We then proposed an attentional bias model as a means of understanding the mechanisms that underlie contextual effects. The basic premise of this model is that context can influence the perception of facial expressions by guiding the viewer's attention to features in the face that correspond to the emotion suggested by the context. This attentional bias can result in a perceptual change, depending on the face's emotion seeds and the emotional category suggested by the context. We closed the chapter by presenting eye-scanning data that are consistent with the model's predictions, showing that the scanning of an emotional face may follow the pattern of fixations typical of the emotion suggested by the context rather than by the configuration of the face.

Current models of facial expression perception generally ignore the role of context and consider each facial expression as an isolated entity that is perceived in a void. We suggest that this view should be revised and that there is an important role for context in emotion perception. However, the framework proposed in this chapter does not stop at this general level. Rather, it begins to characterize the very rules and mechanisms that govern face and context interactions.

NOTES

1. Note that although the theories we address in this chapter are essentially theories of *emotion*, we strictly limit ourselves to the aspect of *facial expression* and its *perception*.
2. Note that Russell (1997) also considers "quasi-physical" facial information, such as nose wrinkling, crying, etc., to be directly *read out* from the face. However, we focus on the more central dimensions that are represented in the circumplex.
3. Note that ambiguous stimuli are not vague, as the latter are not strongly associated with any category.
4. This block appeared always second, to prevent contamination from the specific semantic category assigned to the face to the valence or arousal ratings.

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