Children's Recognition of Disgust in Others

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Disgust has been theorized to be a basic emotion with a facial signal that is easily, universally, automatically, and perhaps innately recognized by observers from an early age. This article questions one key part of that theory: the hypothesis that children recognize disgust from its purported facial signal. Over the first 5 years, children experience disgust, produce facial expressions of disgust, develop a concept of disgust, understand and produce the word *disgust* or a synonym, know about disgust's causes and consequences, and infer disgust in others from a situation or a behavior. Yet, only gradually do these children come to "recognize" disgust specifically from the "disgust face" found in standardized sets of the facial expressions of basic emotions. Improvement is gradual, with more than half of children matching the standard disgust face to disgust only at around 9 years of age and with subsequent improvement continuing gradually until the late teens or early adulthood. Up to age 8, a majority of children studied believe that the standard disgust face indicates anger. Rather than relying on an already known signal value, children may be actively learning to interpret the expression.

Keywords: facial expression, disgust, anger, emotion recognition, disgust face

Disgust has been theorized to be important for many reasons: its status as one of only a handful of basic human emotions and hence as a building block of other emotions (Rozin, Haidt, & McCauley, 2008); its role in avoidance of poisons, parasites, disease, and contaminants (Curtis, De Barra, & Aunger, 2011; Hart, 1990; Oaten, Stevenson, & Case, 2009; Schaller & Park, 2011); its role in determining food preferences (Rozin & Fallon, 1987); its relation to psychiatric disorders, especially obsessive-compulsive disorder, phobias, and other anxiety disorders (Olatunji & McKay, 2007; Phillips, Fahy, David, & Senior, 1998); its diagnostic role in neurological disorders such as Huntington's disease (Sprengelmeyer et al., 1996); and, increasingly, its role in reactions to cheating and other social and moral infractions (Haidt, 2003; Prinz, 2007). According to Giner-Sorolla, Bosson, Caswell, and Hettinger (2012), disgust plays "a powerful role in shaping cultural attitudes, policy, and law" (p. 1). Articles, books, and conferences demonstrate a surge of vigorous scientific theorizing and research on disgust. One result of this surge of research is that the idea of disgust as a simple reaction is giving way to a more complex story. As Herz (2012) summarized, "Our age, our personality, our culture, our thoughts and beliefs, our mood, our morals, whom we're with, where we are, and which of our senses is giving us the feeling, all shape whether and how strongly we are able to feel disgusted" (p. 57).

Much of the theorizing and research on disgust to date have been guided, explicitly or implicitly, by a research program centered on the concept of basic emotions—indeed, that research program has provided the standard account of disgust. Theories within this research program (Ekman & Cordaro, 2011; Izard, 1971, 1994; Tomkins, 1962) place facial expressions at the center of emotion. In this article, we question one key part of the standard account of disgust: the hypothesis that, from an early age, a child recognizes disgust in others from their facial expressions. Our review finds evidence that is inconsistent with this hypothesis, and we suggest that the field examine alternative accounts. To place this evidence in a broader context, we also review evidence on closely related topics, such as children's disgust reactions, their acquisition of a word for disgust, their inference of disgust from nonfacial cues, and adults' recognition of disgust from facial expressions.

The Standard Account

The widely assumed standard account of disgust stems from the classic work of Allport (1924) and Tomkins (1962) and those they influenced (Ekman & Cordaro, 2011; Izard, 2011; Levenson, 2011). In this simple, elegant, and plausible account, so-called basic emotions—including disgust—have dedicated neural circuitry, are triggered by specific releasing stimuli, and produce a coordinated response pattern that includes specific autonomic nervous system activation, a behavioral tendency, and a facial expression. Ekman, Friesen, and Ellsworth (1972) described this last aspect of their theory as follows:

> Regardless of the language, of whether the culture is Western or Eastern, industrialized or preliterate, [certain] facial expressions are labeled with the same emotion terms . . . Our neuro-cultural theory postulates a facial affect program, located within the nervous system

of all human beings, linking particular facial muscle movements with particular emotions. (p. 279)

The same view was stated nearly four decades later when Ekman and Cordaro (2011) wrote that basic emotions have "distinctive universal signals" (p. 365) and that the "archetypal expressions for the basic emotions are all universally recognized" (p. 369). Thus, those reacting with disgust are predicted to produce a specific facial expression, and those who witness that expression are predicted to recognize it as indicating disgust specifically—much as a lighthouse signals danger to anyone who happens to see its light.

The Standard Disgust Face

The first step in the basic emotion research program was to identify the signal for each distinct emotion. Drawing on historical work by Duchenne (1862/1990) and Darwin (1872/1965) , Tomkins and McCarter (1964) developed a large set of photographs of actors posing a facial expression for each basic emotion. Subsequent selection among these candidate poses was based principally on the degree of agreement among observers on the emotion conveyed.

The poses so selected were then used to identify those specific facial movements that led to a majority of observers agreeing on the emotion conveyed. In this way, the Maximally Discriminant Facial Movement Coding System (MAX; Izard, 1979), and the Facial Affect Scoring Technique (FAST; Ekman, Friesen, & Tomkins, 1971) were developed. Both MAX and FAST include photographs of parts of the face to be used to specify the emotion conveyed by any facial movement. FAST was soon abandoned, however, to be replaced by a system developed by the anatomist Hjortsjö (1969). Ekman and Friesen (1978) renamed Hjortsjö's system the Facial Action Coding System (FACS). In FACS, specific anatomically based muscle movements are defined by their appearance on the face. Using FACS, Ekman and Friesen (1978) determined that those poses that achieved consensus on disgust were those that contained Action Unit (AU) 9, which wrinkles the upper nose, or AU 10, which raises the upper lip and wrinkles the lower nose, or both. The facial expression of disgust with both AUs is illustrated in Figure 1.

The standard disgust face is a prototype. Ekman, Friesen, and Hager (2002, Table 10.1) listed other AUs that might appear on a "disgust face," but these AUs are neither necessary nor sufficient to identify disgust. Ekman (1993) wrote of expression families and emotion families. Ekman's family metaphor resonates with Russell and Bullock's (1986) account in which categories of emotion, such as anger and disgust, are fuzzy: Members resemble one another rather than share necessary and sufficient features; borders between categories are not clearly defined; and membership in a category is graded. Particular facial expressions vary in their degree of membership in the emotion categories. Thus, not all poses of disgust match the prototype, but the clearest examples do. In other words, the standard account does not provide a single clearly defined facial movement as *the* facial signal of disgust but does provide a prototype that all "disgust faces" are assumed to resemble closely.

Not all studies of facial expressions of disgust have explicitly used the FACS criteria to select faces, and other facial displays for disgust have occasionally been used in research. All the same,
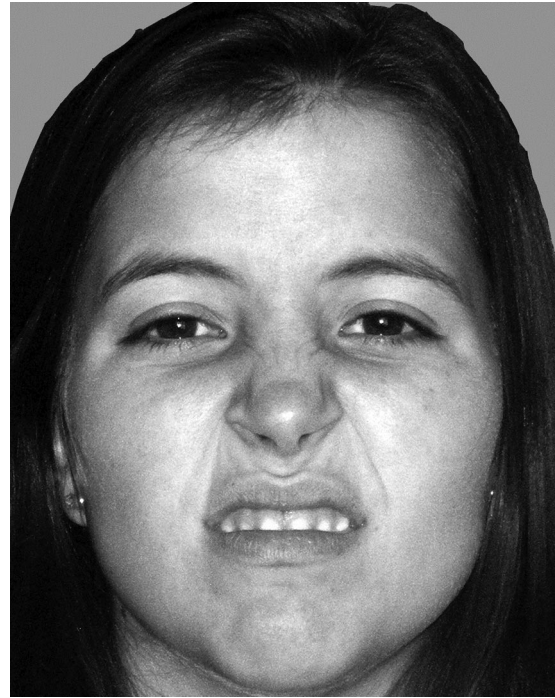

Figure 1. The standard disgust face with both Action Units 9 and 10 (wrinkling of the upper nose and raising of the upper lip, thereby wrinkling the lower nose; Ekman & Friesen, 1978).

most studies have relied directly or indirectly on the Ekman et al. (2002) criteria, all studies selected facial displays on the basis of the amount of agreement by adult observers, and the evidence suggests that in such cases the standard disgust face is the prototype. On the basis of the standard account, the standard disgust face has been included in every set of standard facial expressions that we know of. As shown in Table 1, most published sets of posed facial expressions of emotion relied on the research methods and results of Tomkins and McCarter (1964) and those to whom they provided photographs (Ekman & Friesen, 1971; Izard, 1971).

Recognition of Disgust From the Standard Disgust Face

For decades, scientists and nonscientists have been assured that facial expressions of basic emotions, including disgust, are universally recognized (Ekman & Cordaro, 2011; Ekman & Friesen, 1975). For example, a website founded by a prolific emotion researcher, David Matsumoto, states,

> Research has documented the existence of seven universally expressed and recognized facial expressions of emotion (joy, sadness, fear, surprise, anger, contempt and disgust). The impact of this finding is immense: all people—regardless of race, culture, ethnicity, age, gender or religion—express these emotions in the face in exactly the same ways. (http://www.humintell.com/2012/12/subtle-expressions-did-you-see-that/)

Our focus in this article is on recognition rather than production. Some have theorized that human facial expressions evolved for the purpose of communication (Tomkins & McCarter, 1964)—an idea

Table 1

Facial Expressions Sets Used in Studies of Children's Recognition of Disgust

Facial expression set	Method
Pictures of Facial Affect (Ekman & Friesen, 1976)	Facial expressions were developed in the research tradition of Tomkins (1962) and were later used to specify the standard disgust face by Ekman and Friesen (1978).
Emotion Recognition Facial Expressions (Izard, 1971)	Facial expressions were developed in the research tradition of Tomkins (1962).
Japanese and Caucasian Facial Expressions of Emotion (JACFEE; Matsumoto & Ekman, 1988)	Models were trained to move the muscles for each facial expression as specified by the FACS manual.
Montreal Set of Facial Displays of Emotion (Beaupré & Hess, 2005)	Instructions to move specific muscles were specified by the FACS manual and then coded by FACS coding.
Amsterdam Dynamic Facial Expression Set (van der Schalk, Hawk, Fischer, & Doosje, 2011)	Models were given a manual and practiced the expressions for at least an hour; expressions had to include specific Action Units specified in the FACS manual.
Children's Facial Expressions (Camras, Grow, & Ribordy, 1983)	Instructions to move specific muscles were specified by the FACS manual and then coded by FACS coding.
NimStim set of facial expressions (Tottenham et al., 2009)	Actors were instructed to pose a particular expression (e.g., "Make a happy face") and produce the facial expression as they saw fit. Once one version of the facial expression (e.g., closed mouth) was created and photographed, the other version (e.g., open mouth) was prompted and photographed.

Note. By a "standard disgust face" we mean a "facial expression of disgust" included in one of the sets listed in this table. FACS is the Facial Action Coding System (Ekman & Friesen, 1978).

now often stated by calling a facial expression a *signal*. A signal is defined by Maynard Smith and Harper (2003) as "any act or structure which alters the behavior of other organisms, which evolved because of that effect, and which is effective because the receiver's response has also evolved" (p. 3). Thus, only some facial movements are signals; others may have evolved for other purposes. In modern theories of basic emotions, calling a facial expression of disgust a signal implies recognition of disgust and only disgust from that facial expression. After all, there is no evolutionary advantage in producing unrecognized signals (Fridlund, 1994). If a facial expression is a signal, then recognition of that facial expression had to co-evolve with production of that facial expression if they were to evolve at all. Izard (1971) thus theorized that recognition occurs innately, and Tracy and Robins (2008) theorized that recognition occurs automatically. The standard account also emphasizes that the recognized meaning of each facial signal is *discrete*: The meaning of the standard disgust face is disgust specifically rather than, for example, an undifferentiated unpleasant arousal.

The recognition we focus on is recognition *by children*. The website quoted earlier stated, "all people—regardless of . . . age." In this view, young children are assumed to recognize the sad cry face as sad, the angry scowl face as angry, and the disgust face as disgusted. Although the co-evolution of production and recognition does not require it, even infants have been supposed to recognize emotions from facial signals as early as the first half year of life (e.g., D'Entremont & Muir, 1999; Haviland & Lelwica, 1987; Izard, 1971; Walker-Andrews, 2005). Izard (1994) concluded that "infants discriminate between positive and negative expressions by about 3 months and among negative expressions by 6 or 7 months" (p. 292). Leppänen and Nelson (2006) proposed that "prior to the onset of language, the primary means by which infants can communicate with others in their environment, including caregivers, is by 'reading' faces" (p. 38). "Reading" included recognizing both the identity and the emotions of others. The assumption that recognition is in place from an early age is consistent with the evolutionary argument that recognition emerges when humans are especially vulnerable to ingesting

pathogens, during the immediate postweaning period (at about 3 years of age), and must adapt to their local environment (Dobson & Carper, 1996).

An early onset of the recognition of disgust from its facial expression, in turn, is presupposed in various related theoretical accounts. Harris (1989) theorized that recognition of an emotion from its facial expression is the first step in the child's understanding of that emotion more generally and of the mind of the other. Much of what is disgusting must be learned, and Izard (1994) proposed that young children use caregivers' facial expressions to learn what is disgusting. Thus, specifically, the standard disgust face provides the child with the means to recognize disgust in others. Recognizing disgust in others, in turn, is theorized to be necessary for three processes: (a) direct referencing, (b) vicarious learning, and (c) conceptual learning.

In *direct referencing*, a prelinguistic child confronts an immediate toxin, infectious agent, or other harmful substance. The child can reference the disgust signal of a caregiver, recognize the meaning of that signal, avoid the danger, and, hence, survive. In this way, the child comes to expand the category of disgusting substances and events beyond those innately found disgusting. Studies have shown that 10–12-month-old infants adjust their behavior toward an ambiguous situation on the basis of a caregiver's emotional display (Campos, Thein, & Owen, 2003; Feinman & Lewis, 1983; Klinnert, Emde, Butterfield, & Campos, 1986). By 14 months, infants can use an adult's emotional display (disgust vs. happiness) to decide which objects to avoid and which to approach (Moses, Baldwin, Rosicky, & Tidball, 2001).

In *vicarious learning*, children do not confront an immediate harmful substance themselves, but they can observe and recognize the disgust reactions of others to a harmful substance. In this way, the child learns which substances are disgusting and, hence, to be avoided. Vicarious learning thus shapes future behavior. In the standard account, what the child vicariously learns from the standard disgust face is not simply undifferentiated negative arousal but is specific to disgust. Izard (1994) asked us to

imagine an adult and juvenile trampling through the savannah when the leading foot of the adult lands adjacent to a stimulus that should be avoided: a foul-smelling, deteriorating carcass. This happens again, but on the second occasion the stimulus is a deadly viper. A display on both occasions that was consistent only with undifferentiated negative arousal would provide the trailing juvenile with little information for learning to discriminate a disgusting encounter from a terrifying and deadly encounter. Surely, the speed and repertoire of behavioral responses in the two situations need to be different to be adaptive. (p. 291)

Similarly, both Rozin, Haidt, and McCauley (2000) and Tomkins (1962) suggested that new disgust elicitors may be acquired via just such a form of parent–child transmission.

In *conceptual learning*, the child acquires the concept of disgust, and by doing so, the child can learn about a harmful object or event even in its absence. The caregiver can simply label something as disgusting, as when the parent says, "Don't go near trolls; they're disgusting." The problem is how conceptual learning gets started in the first place because the child must associate the concept with someone's disgust reaction. Harris (1989) theorized that innate recognition of a facial expression as a signal of another's emotion solves this problem. In short, the standard disgust face is, in certain theories, the bedrock on which understanding of disgust is built.

Consequences of Recognition of Emotion From Facial Expression

Individual differences in the ability of preschoolers to recognize emotions from facial expressions have been related to their subsequent cognitive and linguistic development (e.g., C. Blair, 2002), their health (e.g., Rieffe, Meerum Terwogt, & Jellesma, 2008), and their later school-readiness (Garner & Waajid, 2008; Miller et al., 2006; Raver, Garner, & Smith-Donald, 2007; Trentacosta & Izard, 2007). Acquisition of emotion recognition from faces is considered part of the development of emotional intelligence (Barrett & Salovey, 2002; Zeidner, Matthews, Roberts, & MacCann, 2003). Recognition of disgust from the face has also been central to studies of the link between disgust and the emotional life of those more challenged, such as the hearing disabled (Hosie, Gray, Russell, Scott, & Hunter, 1998). Methods to teach children how to better read facial expressions have also been developed (e.g., Grinspan, Hemphill, & Nowicki, 2003; Ulutaş & Ömeroğlu, 2007).

The standard disgust face has played an especially important role in the study of child psychopathology. In this rapidly growing literature, the standard account is simply presupposed; for example, in a chapter on the assessment and treatment of psychological disorders, Sawchuk (2009) began, "Disgust is one of the basic human emotions with reliable physiological, expressive, and behavioral responses that are universally recognized across cultures" (p. 77). A central hypothesis in this literature is that difficulties in recognizing disgust (and other emotions) are linked to various disorders such as conduct disorder (Fairchild, Van Goozen, Calder, Stollery, & Goodyer, 2009), bipolar disorder (Brotman et al., 2008; Rich et al., 2008), obsessive-compulsive disorder (Allen, Abbott, Rapee, & Coltheart, 2006; Buhlmann, McNally, Etcoff, Tuschen-Caffier, & Wilhelm, 2004; Corcoran, Woody, & Tolin, 2008; Lawrence et al., 2007; Sprengelmeyer, Rausch, Eysel, & Przuntek, 1998), panic disorder (Kessler, Roth, von Wietersheim, Deighton,

& Traue, 2007), phobias (Amir et al., 2005; Sarlo & Munafò, 2010), and social anxiety and shyness (Amir, Najmi, & Bomyea, 2010; Heuer, Lange, Isaac, Rinck, & Becker, 2010; Montagne et al., 2006; Mullins & Duke, 2004; Rossignol, Anselme, Vermeulen, Philippot, & Campanella, 2007; Schofield, Coles, & Gibb, 2007). Indeed, a strong relation has been found between recognition of disgust and anxiety disorders (Cisler, Olatunji, & Lohr, 2009). In all of these studies, a "deficit" in recognizing disgust was operationally defined as failure to label the standard disgust face as disgust. The assumption is that in normal development, the disgust face is recognized as disgust, and thus failure to do so is a problem.

The assumption that people normally recognize disgust from the disgust face plays an important role in other research as well. For example, Giner-Sorolla and Espinosa (2011) tested the hypothesis that one person's disgust reaction to another makes the other feel shame. The disgust reaction was conveyed by showing the standard disgust face. Danovitch and Bloom (2009, Experiment 3) studied whether children found immoral as well as physical events disgusting by asking children whether they associated such events with the standard disgust face. Repacholi (1998; Repacholi & Gopnick, 1997) studied whether toddlers would use an adult's disgust reaction to infer what box contained the more desirable object or what food the adult wanted to eat. The adult's disgust was communicated to the children by a standard disgust face and vocalization. The logic of these studies requires the assumption that people, including toddlers, interpret the disgust face as disgust specifically.

Evidence on the Standard Account From Adults

Perhaps the standard account of disgust is so widely accepted for children because it is often presented as if it is well established for adults. A review of the evidence from adults is beyond the scope of this article, but the proper scientific background for the evidence on children requires noting that evidence from adults for specific claims of the standard account is mixed and that each claim is more controversial than is often acknowledged. Further, the methodological issues that plague the studies of adults recur in the studies of children. Table 2 presents five major claims and cites representative supporting evidence as well as points of contention.

Do adults who experience disgust show the standard disgust face? Controversy arises on the frequency with which, when experiencing disgust, adults show the standard disgust face. Reisenzein (2007) induced disgust by presenting participants with disgusting pictures and objects. Even on trials in which people reported experiencing a high degree of disgust, the standard disgust face occurred in only 29% of trials. Rosenberg and Ekman (1994) induced disgust by showing two short film clips. For one clip, a self-reported emotion (typically disgust) co-occurred to a significant degree with the facial expression of the corresponding emotion, but for the other clip, the co-occurrence of emotion and expression did not differ from chance. Similarly low percentages were found in other studies (Ekman, Friesen, & Ancoli, 1980; Fernández-Dols, Sánchez, Carrera, & Ruiz-Belda, 1997; Vernon & Berenbaum, 2002). On the other hand, Lumley and Melamed (1992) reported that showing video clips from surgery produced a "disgust expression" in 79% of blood-phobic and 67% of nonphobic observers. Unfortunately, in this study, although raising the

Table 2

The Standard Account's Central Claims Regarding Disgust and Controversy Related to Those Claims

Standard account's claim	Controversy
People who experience disgust show the standard disgust face.[a]	The standard disgust face has a low frequency of occurrence in response to disgust elicitors.[b]
Disgust is localized to specific regions of the brain: insula,[c] anterior cingulate cortex.[d]	Meta-analyses show inconsistent results for specific brain area involvement in disgust.[e]
Disgust has a signature pattern in the autonomic nervous system.[f]	Inconsistent results in meta-analyses do not support an autonomic nervous system pattern for disgust.[g]
Disgust is recognized from the standard disgust face by Western observers.[h]	Features of method inflate the degree of recognition: (a) within-subjects design[i]; (b) forced-choice response format[j]; (c) faces presented in isolation from the expresser's context[k]; (d) faces are posed.[l]
Disgust is recognized from the standard disgust face by non-Western observers.[m]	Reviews show significant cultural and language differences in cross-cultural recognition of disgust in the standard disgust face.[n]

[a] Ekman, 1972; Ketelaar, Davis, & Mena, 2011; Lumley & Melamed, 1992; Rosenberg & Ekman, 1984; Schienle, Schäfer, Stark, Walter, & Vaitl, 2005. [b] Ekman et al., 1980; Fernández-Dols et al., 1997; Reisenzein, 2007; Vernon & Berenbaum, 2002; see Reisenzein, Studtmann, & Horstmann, in press, for a review. [c] Calder, Keane, Manes, Antoun, & Young, 2000; Jabbi et al., 2008; Penfield & Faulk, 1955; Sprengelmeyer et al., 1998; Stark et al., 2007; Wicker et al., 2003. [d] Thielscher & Pessoa, 2007; Wicker et al., 2003. [e] Lindquist, Wager, et al., 2012; Murphy, Nimmo-Smith, & Lawrence, 2003; Phan, Wager, Taylor, & Liberzon, 2002; Vytal & Hamann, 2010. [f] Ekman, Levenson, & Friesen, 1983; Levenson, 2011; Ritz, Thons, Fahrenkrug, & Dahme, 2005. [g] Larsen et al., 2008; Zajonc & McIntosh, 1992. [h] Ekman, 2003; Elfenbein & Ambady, 2003; Izard, 1971; Nelson & Russell, in press; Russell, 1994. [i] Russell, 1994; Yik et al., in press. [j] Russell, 1991; Widen, Christy, Hewett, & Russell, 2011. [k] Aviezer et al., 2008; Carroll & Russell, 1997; Marian & Shimamura, 2012; Widen, Acevedo, Gallucci, & Russell, 2011. [l] Naab & Russell, 2007. [m] Ekman, 1972; Ekman, Friesen, & Ellsworth, 1972; Izard, 1971. [n] Elfenbein, 2007; Elfenbein & Ambady, 2002; Fridlund, 1994; Jack et al., 2009; Jack, Caldara, & Schyns, 2011; Nelson & Russell, in press; Parkinson, 2005; Roberson et al., 2010; Russell 1994, 1995; Yuki, Maddux, & Masuda, 2007.

upper lip (AU 10) was scored as a "disgust expression," so too was a brow contraction (AU 4) alone. The brow contraction may be a consequence of any negative reaction (Lang, Greenwald, Bradley, & Hamm, 1993), and it is listed as a component of the facial expressions of fear, anger, and sadness, but not disgust, in the Ekman et al. (2002) summary.

Is there a specific brain circuit for disgust? Of course, all psychological events are produced by the brain. The question is whether the same unique brain locations are associated with disgust in different cases of disgust, in different individuals, induced in different ways, and in different studies. This question is best answered through a meta-analysis of available studies, and such meta-analyses have not found consistent results; see Table 2.

Does disgust have a unique signature in the autonomic nervous system? Again, individual studies cited in Table 2 reported a significant correlation between disgust and an index of autonomic activity, but the question is whether the same unique signature occurs in different individuals, different ways of inducing disgust, and different studies. Meta-analytic studies of emotion and the autonomic nervous system found no unique signature for any emotion consistent across studies (Larsen, Berntson, Poehlmann, Ito, & Cacioppo, 2008). A recent debate between Lench, Flores, and Bench (2011) and Lindquist, Siegel, Quigley, and Barrett (2012) illustrates the controversy in this area. Lench et al. (2011) reported a meta-analysis "to examine the extent to which discrete emotions elicit changes in . . . physiology" (p. 834). They omitted disgust and did not examine whether specific discrete emotions are each associated with a predictable specific pattern of physiological change. Instead, their analysis simply showed that procedures that induce different emotions also reliably induce different (but unspecified) changes in physiology. Lindquist, Siegel, et al. (2012) pointed out that their meta-analysis was also consistent

with a valence-arousal account of emotion induction and, more generally, with a psychological constructionist account.

Do adults from Western cultures recognize disgust from the standard disgust face? As summarized in reviews cited in Table 2, most do so. The controversy is the degree to which this result is shaped by the method of gathering the data. Studies cited in Table 2 show that results vary with three method factors. (a) The design is almost invariably within-subject, but the judgment of one face is influenced by what faces preceded it. (b) The typical response format is forced-choice, in which observers must select one emotion, but when given the option, they choose zero, one, two, or more options. In addition, a consensus can occur for different emotions for the same face depending on the options presented. Finally, this format allows the observer to use a process of elimination to match a face with an emotion label. And (c) the standard facial expressions are posed and devoid of information about the expresser's context. Less agreement is seen on spontaneous expressions, and information about the expresser's context can dramatically change the emotion seen in the face. Each method factor can exert a large effect, but even if the effect were small, that effect would still be important. Russell (1994, 1995) argued that no one method factor need be a fatal flaw in studies of facial expressions. Rather, the challenge to validity is the cumulative impact of various method factors, each exerting pressure in the same direction.

Is recognition of disgust from the standard disgust face universal? As shown in Table 2, although some reviews concluded in favor of universality of basic emotions, others found significant cultural and language differences. Especially important is evidence specifically for disgust and the standard disgust face. When the observers were the Fore of Papua New Guinea, members of an illiterate culture with limited contact with modern Western culture, results were not what would be predicted from the standard account. When the Fore observers were shown a facial

expression and asked to choose one emotion word from a short list repeated to them on each trial, results for the disgust face were weaker than for other emotions: The percentage selecting *disgust* for the disgust face ranged from less than 23% to 44% in three samples (Ekman, Sorenson, & Friesen, 1969). When Fore observers were allowed to choose any word they wanted for the emotion conveyed by the disgust face, the modal response from one sample was *contempt* and from the two other samples was *happiness* (Sorenson, 1976). Sorenson reported that a similar study was done with a different cultural group, the Bahinemo, also of Papua New Guinea, but they showed no consistent association between any facial expression and an emotion word, except for a tendency to see all the faces as angry. Tracy and Robins (2008) studied an African group isolated from modern Western culture. They found 44% selected *disgust* for the disgust face. One method did yield seemingly higher "recognition" of disgust from the disgust face in an isolated society: Observers were asked to select the face that went with a story (Ekman, 1972). For example, when given "smelling a dead pig," between 85% and 91% chose the standard disgust face. Unfortunately, at least three problems exist with this last result. First, the results depend on the set of faces from which observers chose. Choosing the disgust face over another expression (sad cry or surprise startle) for the person smelling a dead pig may simply mean that the other expressions are judged less likely than the disgust face to be seen as resulting from smelling the pig. Second, the method confounds emotion with story, and therefore the results may say more about the association of face with story than of face with emotion. And, third, 48% of observers also chose the disgust face for a story meant to imply anger.

Children's Disgust Reactions

The standard account of disgust assumes that a disgust reaction to harmful substances provided an evolutionary advantage and, in this way, became part of human nature. By "disgust reaction" is meant a package of components consisting of physiological, subjective, and behavioral changes. Unfortunately, surprisingly few studies have examined whether young children respond to harmful substances with this package of responses—perhaps in part because the package has not been consensually and clearly defined.

One study might be cited as support for the standard account: 2- and 3-year-olds agreed with adults on whether strong odors (such as cheese, vomit, and spoiled milk) smelled good or bad (Schmidt & Beauchamp, 1988), but the response measure was simple valence rather than disgust specifically. Other studies, however, found less support even for valence: Preschoolers (3–5 years) did not judge smells (rapeseed oil, butyric acid—a rancid smell) as negatively as did adults in paired comparisons with neutral (diethyl phthalate) and pleasant odors (neroli oil-orange, safrole-licorice; Engen & Corbit, 1970; Stein, Ottenberg, & Roulet, 1958).

Behavioral evidence might bring us closer to disgust specifically. Infants reject bitter tastes (Cowart, 1981). Yet, given the opportunity, some toddlers (16–29 months) are willing to put some disgusting items such as (imitation) feces in their mouths (Rozin, Hammer, Oster, Horowitz, & Marmora, 1986). This pattern of results led to a speculation opposite to that of the standard account: Up to 2.5 years, children are *attracted* to many things that adults find disgusting. Older children (3½–5 years) showed a more adult-like behavioral response to disgusting objects and did not accept

them when offered. By the age of 5–6 years, children actively rejected such things (Rozin et al., 1986).

The late age at which rejection occurs led Bloom (2004) to suggest that children must be taught which objects are disgusting. From this learning perspective, disgust reactions are mediated by knowledge of what is disgusting. Large cultural differences in what is disgusting are therefore consistent with this hypothesis (Herz, 2012). One finding supportive of the same hypothesis—with adults—is that disgust was elicited by a smell labeled "vomit" but not by the same smell labeled "parmesan cheese" (Herz & von Clef, 2001). In Rozin, Haidt, and McCauley's (1993) account, disgust begins in the innate rejection of bitter tastes (distaste), and further disgust elicitors are acquired by their association with distaste. In this account, by 5 years of age, children link distaste to food and eating, body products, hygiene, body envelope violations, and certain animals. Other researchers suggest that this linkage occurs earlier (e.g., Siegal, 1988; Stevenson, Oaten, Case, Repacholi, & Wagland, 2010).

The standard disgust face has been observed in infants when solutions are placed in their mouths. Neonates showed a standard disgust face to all four primary tastes (sweet, salty, sour, bitter) but especially to sour or bitter solutions (Rosenstein & Oster, 1988). Another study further underscored the question of whether the standard disgust face is specific to disgust: The facial behavior of 4-month-old infants was observed while they were subjected to six different types of stimulation, each predicted to elicit a different basic emotion (Bennett, Bendersky, & Lewis, 2002). For example, the disgust face was predicted to be specific to having lemon juice placed in the infant's mouth. Instead, "no evidence of predicted specificity was found for anger, disgust, fear, and sadness expressions" (Bennett et al., 2002, p. 97).

The standard disgust face has also been observed in infants subjected to strong odors. Soussignan, Schaal, Marlier, and Jiang (1997) found standard disgust faces in neonates subjected to the smell of butyric acid (vomit): The percentage of neonates scrunching their noses varied from 16% to 30%, depending on the concentration of butyric acid. Similarly, Stevenson et al. (2010) found the standard disgust face in response to the odor of feces or urine. In a study of older children, up to 37% of children between 5 and 12 years of age produced a standard disgust face when smelling fecal and fishy odors (Soussignan & Schaal, 1996).

Few studies have examined whether children produce the standard disgust face in response to events other than tastes and smells. Stevenson et al. (2010) observed that theirs was the first study to do so for children younger than 5. They presented children 2.5 to 14.5 years of age with eight disgust elicitors. Overall, smiles were the most frequent facial reaction to the disgust elicitors, but some standard disgust faces (coded to meet criteria established by Ekman et al., 2002) were observed: The median was 22% of children across the eight disgust elicitors, but 88% of children showed at least one standard disgust face during the presentation of the eight elicitors. The number of standard disgust faces the youngest age group ($M = 2.5$ years, $SD = 0.5$) made when presented with socio-moral elicitors, animal elicitors (maggots), or even some core disgust elicitors (food and hygiene), did not differ significantly from zero, but the children did make standard disgust faces when presented with the odor of feces or urine.

One mechanism through which the set of disgust elicitors is broadened is the rule of contamination: An object becomes dis-

gusting when it is in contact with an already disgusting object. Initial studies on contamination had found that children do not acquire this rule of contamination until they are 3–5 years old (Raman & Gelman, 2008; Siegel, 1988; Siegal & Share, 1990; Toyama, 1999) and sometimes do not follow it until they are 7–8 years old (Fallon, Rozin, & Pliner, 1984; Rozin, Fallon, & Augustoni-Ziskind, 1985). For example, participants witnessed a (sterilized) cockroach being dipped into a glass of juice and removed again. Adults refused to drink the contaminated juice even though there were no visible parts of the cockroach left in the juice: The juice was contaminated by prior contact with the cockroach. Before the age of 7, children, on the other hand, happily drank the juice, presumably because they did not understand that the appearance of the juice—that there were no visible cockroach parts in it—could be different from its reality (Rosen & Rozin, 1993; Rozin et al., 1985). And yet more recent studies suggest an implicit understanding of contamination even in toddlers. Toddlers and preschoolers were invited to eat a preferred food when it was touching a disliked food (Brown & Harris, 2012; Brown, Harris, Bell, & Lines, 2012). They treated the preferred food as if it was contaminated and would not eat it while it was still on the same plate with the disliked food, but they would eat it when it was moved to a new plate.

What explains the difference between toddlers who treated a preferred food as contaminated by contact with a disliked food and 5-year-olds who drank juice after a bug had been removed? One key variable may be visibility. In the recent studies of toddlers, the disliked food remained visible, whereas in the earlier studies of older children, the disgusting object had been removed. Brown and Harris (2012) suggested that the disgusting qualities of the disliked food must also be perceived (seen or smelled) and are often the result of personal taste or neophobia (especially in young children; Toyama, 1999). In contrast, the insects, dirty comb, and other stimuli used in earlier studies (e.g., Fallon et al., 1984; Rozin et al., 1985; Siegal & Share, 1990; Toyama, 1999) are disgusting due to our knowledge of the nature and origin of the objects. The disgusting nature of these later items must be explicitly taught (Bloom, 2004). Parents' attitudes about disgust and food contamination have a large influence on what their children find disgusting (Rozin, Fallon, & Mandell, 1984). Thus, for toddlers and young children, the "disgusting property" can be transferred to otherwise nondisgusting objects by contact. At this early stage, the contact must be salient and visible. Later, after explicit teaching by parents and others, this transfer can be less salient and even invisible.

Children are also taught moral disgust. Although children know moral rules by the age of 4 years (Nunner-Winkler & Sodian, 1988; Smetana et al., 2012; Turiel, 1983), they do not respond with disgust or say that another feels disgust when a moral rule is broken. For example, children (4 to 9 years) were told stories about physical disgust (putting your hand in slime) and moral violations (making up mean lies about a good friend; Danovitch & Bloom, 2009). For each one they were asked if the event in the story was disgusting. For the physical disgust stories, children agreed that the stories were disgusting, but less than 30% of 4–7-year-olds did so for the moral violation stories. A similar pattern was found when children were asked if a standard disgust face went with each story. In another study, when children (4–12 years) were given a choice between a standard disgust face and an angry scowl, they again chose the standard disgust face for the physical disgust stories but chose the angry scowl for the moral disgust stories (Pochedly & Zeman, 2012). Thus, young children associate anger with moral violations when that option is available and only later learn to associate disgust with them.

In summary, research has found specific components of the disgust reaction—negative subjective feelings, avoidance or rejection, and the standard disgust facial expression—in very young children, although not in the proportions one might expect from the standard account. There is, however, to our knowledge, only indirect evidence for the assumption that these three components cohere as a package. Studies of adults have found a significant correlation between disgust sensitivity and avoidance behavior (Björklund & Hursti, 2004; Rozin, Haidt, McCauley, Dunlop, & Ashmore, 1999). If we assume that those with greater disgust sensitivity experience more intense subjective feelings of disgust, then this evidence shows a correlation between two of the components. Still, other studies found a weak correlation between subjective experience and facial behavior (Reisenzein, Studtmann, & Horstmann, in press), but this type of study has not been replicated with children. We know of only one study of children on the correlation between subjective feeling and avoidance. Children (9–13 years) who were told that a novel animal was disgusting rated the animal as disgusting and were reluctant to approach the animal (Muris et al., 2009). These same children also rated the animal as scary, and so the exact subjective feeling leading to their avoidance is unclear. None of these studies measured or reported the participants' facial responses to the disgust elicitors. More developmental studies that investigate the relationship among these assumed components of disgust are required. Thus, it remains a matter of assumption rather than an empirically established finding that all three channels are highly intercorrelated manifestations of the same reaction and, hence, that the facial channel is validly called disgust.

Prerequisite Linguistic and Cognitive Development

Most children start using words around 13 months and emotion words around 20 months. Studies of children's spontaneous conversations show that, before their 3rd birthdays, some children are already using a word related to disgust. (Here and throughout this article we ignore syntactic form—e.g., *disgust*, *disgusted*, and *disgusting* were treated as the same—when assessing a child's lexicon.) The proportion of children under 3 years of age uttering *disgust* or a synonym varied with what was counted as its synonym: When only *disgust* was counted, 6% used the word (Dunn, Bretherton, & Munn, 1987; Ridgeway, Waters, & Kuczaj, 1985); when *disgust* or *yuck* were counted, 33% did (Bretherton & Beeghly, 1982); and when *disgust*, *yuck, ick*, and other unspecified synonyms were counted, 40% did (Bretherton, McNew, & Beeghly-Smith, 1981). Longitudinal data from five children (1.5–5 years) from the CHILDES database (MacWhinney, 2000) showed that four of the five children used *disgust* or a synonym (*yuck, gross*) in spontaneous conversation when they were 3 years of age (Widen, 2005).

There is a developmental progression in children's use of emotion labels in spontaneous conversation (Smiley & Huttenlocher, 1989). Beginning around 20 months of age, children use emotion labels to talk about their own emotions. Around 24 months, they

do so for the emotions of others. By analyzing spontaneous utterances with emotion words embedded in sentences and in a broader context, Wellman, Harris, Banerjee, and Sinclair (1995) concluded that, by 3 years, children understand that emotions are internal feelings, distinct from the causes that elicit them and from the behaviors and expressions that result from them. Thus, young children have a sophisticated concept of emotion. Because Wellman et al. did not analyze emotions individually, it is not known whether children's concept of disgust is equally sophisticated, but their analysis does indicate that children are capable of forming sophisticated emotion concepts.

Although close to half of 2- and 3-year-olds use some word for disgust in spontaneous conversation, they do so infrequently. In the CHILDES database (MacWhinney, 2000), the frequency of using a disgust-related word was lower (a total of 22 out of 179 emotion utterances) than the frequency of using words for fear, anger, happiness, or sadness (Widen, 2005). Perhaps the concept of disgust is only weakly accessible, or perhaps in these children's lives, a context for using *disgust* was infrequent. Two studies used a procedure that we call *active priming* to explore whether a greater percentage of preschoolers produce words for disgust when a relevant context is created (Widen & Russell, 2003, Study 3, 2008a). In active priming, the experimenter seeks to have the child spontaneously name several targeted emotions. The experimenter first asks the child to name emotions and then engages the child in a conversation about any targeted emotions the child did not name. The child and experimenter work together to find a situation from the child's life for each such emotion, and then the child is asked to name that emotion. As a result, 96% of the children (2–5 years) spontaneously produced the word *disgust* (or *yucky* or *gross*) in this conversation—a percentage similar to that for *happy, sad, angry, scared,* and *surprised*. Thus, by 3 years, and likely earlier, almost all preschoolers have some word for disgust in their vocabulary and can, given repeated prompts and questions, associate that word with an event in their own lives.

Not surprisingly, a smaller percentage of 3–4-year-olds associated disgust with a relevant disgust elicitor when given the word *disgust* and asked to imagine a cause for someone feeling that way. In two studies, 34% (Russell & Widen, 2002b) and 50% (Widen & Russell, 2004) of the causes children generated were recognized (by adult judges blind to the target emotion) as producing disgust. An additional 41% and 20%, respectively, of the causes were judged as stemming from a different negative emotion, whereas only 5% and 8% were judged as stemming from a positive emotion. In other words, in 75% and 70%, respectively, of cases, young preschoolers generated a negative antecedent situation when asked what made someone feel disgusted.

The evidence reviewed so far goes some way toward showing that *disgust* is associated with negative causal situations, albeit ones unique to each child. Some evidence is available on preschoolers' association of the label *disgust* with more general or stereotypical causes and consequences. Of course, fewer children can be expected to have this more general knowledge. In two studies, preschoolers (3–5 years) were told a brief story describing a typical cause and consequence of disgust in a fictional character. Asked to label the emotion of the protagonist, only 15% (Widen & Russell, 2010b, Study 2) and 20% (Widen & Russell, 2010a) said *disgust* (or a synonym). An additional 57% of labels in each study were other negative emotions (e.g., *sad, angry, scared*). Thus,

these studies provide further evidence that young children understand disgust as negative but do not readily map *disgust* onto even a prototypical disgust situation. This finding contrasts with the results of active priming in which nearly all children labeled an event from their own lives as disgusting given enough prompts and questions. The reconciliation of these disparate findings may lie in the overlap in meaning of emotion words for preschoolers. That is, it appears that the same antecedent events are associated with multiple negative emotion words.

Taken together, available evidence suggests that, at least by 3 years of age, almost all preschoolers have the word *disgust* or its synonym in their vocabulary. Although children use the word *disgust* from time to time, it is difficult to know precisely what they mean by that word. We know that 70% to 75% of these children associate *disgust* with some negative antecedent situation, but only 15% to 20% associate it with a prototypical disgust cause specified by the experimenter. Almost all of the children associate it with *some* cause from their own experience. The word *disgust* thus might begin by meaning "feels bad" and very gradually narrow to a more adult-like meaning. The word may not be highly accessible, and a context for its use may arise infrequently, but given the right circumstances, almost all preschoolers can produce the word *disgust* or a synonym and know approximately what it means.

The linguistic evidence just reviewed on the word *disgust* and on other emotion words suggests that the cognitive prerequisites are in place for children to understand different aspects of emotion by 3 years of age. Complementary evidence stems from studies showing that children who are 3 years of age and older can associate the cause of various emotions other than disgust with an appropriate label (Balconi & Carrera, 2007; Reichenbach & Masters, 1983; Russell & Widen, 2002a, 2002b; Widen & Russell, 2002, 2004, 2010a, 2010b). They can also label facial expressions of smiles, pouts, and scowls as *happy*, *sad*, and *angry,* respectively (Camras & Allison, 1985; Denham & Couchoud, 1990; Harrigan, 1984; Widen & Russell, 2003, 2008a). Thus, by 3 years of age, the linguistic and cognitive prerequisites are in place for children to associate the standard disgust face with disgust. (See Blankson et al., 2012, Porges, 2003, and Posner & Rothbart, 2007, for different perspectives on the links between cognitive development and emotion understanding.)

Children's Understanding of Disgust in Others

Children's Recognition of Disgust From the Standard Disgust Face Isolated From Context

In the standard account, the optimal circumstance for using the word *disgust* would be the child seeing someone showing the facial signal of disgust, the standard disgust face. Here we examine evidence on this prediction. A corollary of the standard account is that the standard disgust face alone, isolated from context, suffices to convey disgust. That is where we begin.

Free labeling by English-speaking children. In the earliest studies of children's understanding of faces (Gates, 1923; Kellogg & Eagleson, 1931), the experimenter simply showed the child a still photograph of a face and asked, "What is this person feeling?" These two early studies did not include disgust, but later studies did. We know of 17 studies on how English-speaking children

answered that question when shown still photographs of the standard disgust face. By combining data sets from our own lab, we examined seven data sets: six from other labs (Harrigan, 1984; Izard, 1971; Markham & Adams, 1992; Markham & Wang, 1996; Michalson & Lewis, 1985; Vicari, Reilly, Pasqualetti, Vizzotto, & Caltagirone, 2000) and the seventh from our lab, composed of data from 11 studies (Ma, Pochedly, & Widen, 2012; Widen & Russell, 2002, 2003, Study 2, Study 3, 2008a, 2008b, 2010a, 2010b, Study 1, Study 2, 2010c, 2012b) so that we could examine age in a fine-grained manner. Izard (1971) reported results averaged across emotions, and so his results for disgust specifically are not available; his results are informative nonetheless.

These seven data sets yielded four important conclusions. The first is detailed in Table 3. Children (2–12 years) are generally *less* likely to use the predicted label for the standard disgust face than for any other facial expression. This pattern was strong: The mean percentage "correct" for the standard disgust face, 21%, was lower than for other expressions, which ranged from 45% to 92%. With

one exception (Harrigan, 1984), every study found that "correct" labels for the disgust face were the lowest or tied for the lowest.

The second conclusion is that improvement in labeling the standard disgust face is gradual. The gradualness of improvement was found in all of the studies, and it is illustrated in Figure 2 with Widen and Russell's cumulative data set because it had the largest *N,* had the most fine-grained treatment of age, and was the only one that reported "incorrect" responses. Figure 2 shows that for children between the ages of 2 and 8 years, the percentage "correct" gradually increased from 3% to 33%. At 9 years of age, 51% of children labeled the standard disgust face as *disgust,* and 45% labeled it as *anger* (the remaining 4% labeled it as *embarrassed*).

The third conclusion is that children's "accuracy" in free labeling faces varied with the experiences children had during the experiment prior to the free labeling task. In one study, children received no task prior to free labeling, and no child labeled the standard disgust face "correctly" (Michalson & Lewis, 1985). In the Widen–Russell cumulative data set, the prior task was passive

Table 3

Percentages of Children Who "Correctly" Free Labeled Each of Six Facial Expressions in Six Data Sets

Study	Source of facial expressions	Ages in years (N)	Facial expression					
			Smile as *happy*	Cry as *sad*	Scowl as *angry*	Gasp as *scared*	Startle as *surprised*	Standard disgust face as *disgusted*
Harrigan (1984)	Own set, rated by adult sample; photographs that did not receive 80% agreement were omitted	3–12 (96)	94	83	78	59	39	46
Markham & Adams (1992)	Pictures of Facial Affect[c, d]	4–8 (72)	97	77	78	82	67	47
Markham & Wang (1996)[a]	Pictures of Facial Affect[c, d] and own set, rated by adult sample; photographs that did not receive 70% agreement were omitted	4 (24)	85	50	58	58	46	47
		6 (24)	100	83	66	84	73	53
		8 (24)	100	80	77	90	93	66
Vicari et al. (2000)	Pictures of Facial Affect[c, d]	5–6 (42)	100	81	75	58	42	27
		7–8 (39)	96	89	74	71	75	46
		9–10 (39)	100	88	84	86	89	75
Michalson & Lewis (1985)	Own set of posed expressions, coded with the Max facial coding system (Izard, 1979)[e]	2 (10)	10	10	0	0	0	0
		3 (11)	36	45	18	0	9	0
		4 (9)	55	77	66	11	33	0
Widen & Russell[b]	Multiple sets[f]	2 (94)	46	36	32	9	5	3
		3 (229)	93	64	79	22	34	9
		4 (299)	97	83	89	37	52	12
		5 (209)	98	79	90	45	72	12
		6 (74)	99	95	87	57	78	16
		7 (66)	95	88	89	41	88	27
		8 (61)	96	89	96	48	90	33
		9 (33)	100	70	78	67	96	52
Weighted *M*			92	77	78	45	56	21
Weighted *M* omitting Widen & Russell			92	81	76	64	58	36

Note. The task given the children was free labeling.
[a] Australian sample. [b] Widen & Russell is a database of 11 free labeling studies from our lab: Ma et al., 2012; Widen & Russell, 2002, 2003, Study 2, Study 3, 2008a, 2008b, 2010a, 2010b, Study1, Study 2, 2010c, 2012b. [c] Disgust expression in this set includes standard disgust face. [d] Ekman & Friesen, 1976. [e] The Max facial coding system was developed in the research tradition of Tomkins (1962). [f] Pictures of Facial Affect (Ekman & Friesen, 1976), children's facial expressions (Camras et al., 1983), Amsterdam Dynamic Facial Expression Set (van der Schalk et al., 2011), set with basic and social emotion facial expressions (Haidt & Keltner, 1999), or portrait-like drawings of children (Tremblay et al., 1987). All sets included the standard disgust face.
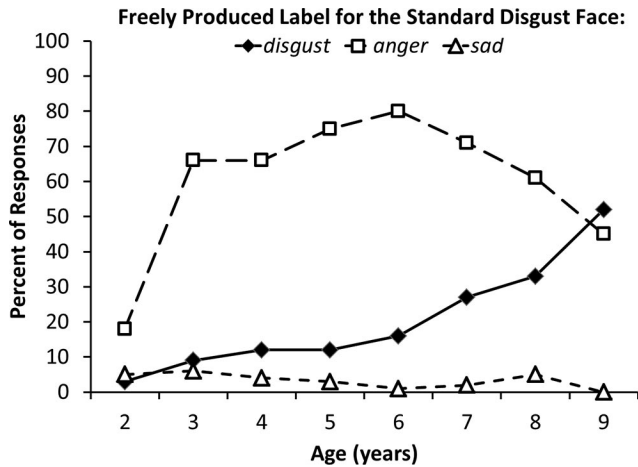
Figure 2. Percentages of children labeling a still photograph of the standard disgust face as *disgust*, *anger*, or *sadness* in 11 studies (Ma et al., 2012; Widen & Russell, 2002, 2003, Study 2, Study 3, 2008a, 2008b, 2010a, 2010b, Study1, Study 2, 2010c, 2012b). The *N*s for each age group were as follows: 2 years, *N* = 94; 3 years, *N* = 229; 4 years, *N* = 299; 5 years, *N* = 209; 6 years, *N* = 74; 7 years, *N* = 66; 8 years, *N* = 61; and 9 years, *N* = 33.

priming: In passive priming, the experimenter introduces each of the target emotion labels in a brief conversation prior to the free-labeling procedure. Passive priming makes the label more accessible in the child's memory, without teaching the meaning of the label or associating it with a face in any way. In a study on the effects of passive priming, primed children (2–5 years) were more likely to label the standard disgust face as *disgusted* (17%) than were children who had no priming (4%; Widen & Russell, 2008a). A small but reliable improvement due to passive priming can also be seen by a comparison of the total cumulative data set with results from Michalson and Lewis's (1985) study (Table 3). Finally, in the remaining five studies, the prior task involved making some association between face and label. Children received at least one such task in addition to free labeling, with task order rotated. And in these studies, children's "accuracy" for the standard disgust face was higher still.

Of course, cross-study comparisons are hazardous, but within-study comparisons led to the same conclusion. Izard (1971) presented two tasks and found that, for all facial expressions, preschoolers were rarely "accurate" in free labeling any facial expression other than the happy smile when the free labeling task was first. Noticeable improvement resulted when free labeling was presented after another task, such as choosing from a small array of facial expressions the face that matched an emotion label (e.g., "Find the sad person"). Harrigan (1984), Markham and Adams (1992), Markham and Wang (1996), and Vicari et al. (2000) confirmed that free-labeling "accuracy" improved when a prior task was given.

There are several possible explanations for why a prior task improved the "accuracy" of free labeling. Perhaps, through this prior task, children learned some associations between the label and face. Or, perhaps even if they did not learn specific associations, children learned what emotion categories were of interest to the experimenter, and this knowledge increased the likelihood that they would use the target labels (both "correctly" and "incorrectly"). Still another alter-

native is that these prior tasks had more than one effect. Perhaps the child realized that the experiment concerned certain emotions (whose names were primed or used in prior questions), and then a process of elimination helped them associate the unknown face with the unknown label (Nelson & Russell, 2012). This possibility was supported by a study of 5–14-year-olds who were asked to select a label for the standard disgust face (Pochedly, Widen, & Russell, 2012): When the set of preceding faces lacked an angry scowl, only 25% selected *disgusted* and 75% selected *angry* for the standard disgust face. When the preceding set included an angry scowl, however, 60% selected *disgusted*. One interpretation is that the prior use of *angry* for the angry scowl led some children to eliminate *angry* as an option for the disgust face, resulting in a greater likelihood of selecting *disgusted*.

The fourth conclusion from the data sets in Table 3 was that the results depended on what the experimenters took to be "correct" for the standard disgust face. Vicari et al. (2000) did not report what they considered correct. Michalson and Lewis (1985) accepted only *disgusted*, and no child was correct. In the Widen and Russell cumulative data set, only synonyms for disgust (*disgusted*, *ick, yucky* and *gross*; syntax or being embedded in a phrase were ignored) were accepted, and results for the standard disgust face were low. In contrast, Harrigan (1984) accepted *disgusted*, *ick, yucky* and *gross* plus *distaste, dislike, nauseated, smells bad, tastes bad, something stinks,* and *sickened* as "correct" (p. 161, Table 1). Markham and Adams (1992) and Markham and Wang (1996) had similar lists. Their lists show that children interpreted the standard disgust face in a variety of ways: feelings, tastes, and smells as well as the very general word *dislike*. These results indicate that some children interpret the standard disgust face as conveying a general aversion (especially to something that tastes or smells bad), rather than the specific emotion of disgust. Comparing across these studies, we conclude that "accuracy" is minimal when the correct response is limited to words close to *disgust* and that the appearance of higher accuracy depends on counting a broad range of interpretations as correct.

Three studies investigated how adolescents free labeled the emotion they saw in the standard disgust face (see Table 4; Herba et al., 2008; Jones et al., 2011; Ma et al., 2012). The adolescents' percentage "correct" for disgust was not much above the 51% for 9-year-olds (see Figure 2). Only one of these studies (Ma et al., 2012) compared different age groups: 33% of 12–14-year-olds labeled the standard disgust face as disgust; 72% of 15–17-year-olds did so. Thus, children's association of disgust with the standard disgust face continues to develop through adolescence.

To summarize the review so far: Free-labeling studies carried out in different laboratories, using different sets of facial expressions and different methods, begin to provide a portrait of the developmental path of the understanding of the standard disgust face. Few of the younger children (3–8 years) spontaneously used the label *disgust* or its synonyms for the emotion conveyed by the standard disgust face without some help from the experimenter. Priming the word *disgust* provided some help, but arguably only enough to aid their memory search for an appropriate word. A prior task that included not only mention of the word *disgust* but its association in some way with faces provided more help. With or without help, when asked how the person with the standard disgust face was feeling, children produced a variety of labels: A minority before the age of 9 used *disgust* or a synonym, others used another negative term, and some mentioned smells, tastes, or

Table 4

Percentage of Adolescents Who Labeled the Standard Disgust Face "Correctly" in 14 Studies

Study	Stimuli	Ages (N)	Disgust
Free labeling			
Ma et al. (2012)	Still photographs; Amsterdam Dynamic Facial Expression Set[a]; UC Davis set of Emotion Expressions[b]	12–17 (36)	53
Jones et al. (2011)	Still photographs; Pictures of Facial Affect[c]	M_{age} = 15.6 (57)	54
Herba et al. (2008)	Morphs (neutral to 100% disgust); Pictures of Facial Affect[c]	4–15 (153)	59
Weighted M			57
Facial expression matching			
Herba et al. (2006)	Still photos; Pictures of Facial Affect[c]	10–15 (50)	83
Forced choice			
Simonian et al. (2001)	Still photographs; Pictures of Facial Affect[c]	9–15 (14)	87
Jarros et al. (2012)	Still photographs; Pictures of Facial Affect[c]	10–17 (27)	63
Sato et al. (2009)	Still photographs; Pictures of Facial Affect[c] and JACFEE[d]	M_{age} = 17.4 (24)	54
Williams et al. (2008)	Still photographs; 3D Facial Emotional Stimuli[e]	10–19 (163)	43
D. W. Walker & Leister (1994)	Still photographs; Pictures of Facial Affect[c]	13–18 (273)	73
E. Walker et al. (1980)	Still photographs; study-made	13–19 (16)	56
Law Smith et al. (2010)	Still photographs (80%–100% disgust); source unspecified	12–18 (16)	82
Montirosso et al. (2010)	Morphs (neutral to 35%–100% disgust); Pictures of Facial Affect[c]	10–18 (144)	62
R. J. R. Blair & Coles (2000)	Photographs of blended facial expressions (disgust-sad, disgust-anger); Pictures of Facial Affect[c]	11–14 (55)	41
Fairchild et al. (2009)	Morphs between disgust-sad and disgust-anger; Pictures of Facial Affect[c]	14–18 (40)	73
Weighted M			61

[a] van der Schalk et al., 2011.   [b] Tracy, Robins, & Schriber, 2009.   [c] Ekman & Friesen, 1976.   [d] JACFEE = Japanese and Caucasian Facial Expressions of Emotion; Matsumoto & Ekman, 1988.   [e] Gur et al., 2002.

a general dislike. The proportion seeing disgust in the standard face rose very gradually from early childhood through adolescence to adulthood.

A skeptical reader might raise various objections to the conclusions we draw from the free-labeling data shown in Tables 3 and 4 and Figure 2. The most common objection has been that the label *disgust* is not in children's vocabulary—but this objection is ruled out by studies already reviewed showing that the word *disgust* or a synonym is in children's vocabulary by the preschool years. Two further objections can be raised. Perhaps the free-labeling task is too difficult for young children. Perhaps the task of freely labeling the face should be replaced with the task of simply matching the face to the label. We consider each in turn.

Task difficulty. Is a free-labeling task per se too difficult for young children? One way of addressing this question is to ask whether the same children are willing and able to label things other than the standard disgust face. To answer this question, Table 5 shows results combined from three studies (N = 269, 2–4 years, not equally distributed by age) from our lab (Widen & Russell, 2003, Study 3, 2008a, 2010b, Study 2). These children labeled animals (e.g., cat, dog, rabbit) at high to ceiling levels. They also labeled one facial expression—the happy smile—at high to ceiling

levels. And they labeled other facial expressions (sad cry, angry scowl, scared gasp, surprised startle) at moderate to high levels. These same children showed the typical pattern of labeling the standard disgust face at low to floor levels. Thus, children can, and do, produce labels on demand. Per se, the task of producing a label is not the problem.

Alternative response formats. Perhaps discouraged by the early results obtained with free labeling, subsequent researchers often turned to response formats that seemed to show greater recognition. In one task, children were shown a target face and asked to select the matching face from an array of 2 to 4 faces (Tables 4 and 6). A large majority of children and adolescents shown the standard disgust face matched it with another disgust face: 73% of 4–10-year-olds (Herba, Landau, Russell, Ecker, & Phillips, 2006), 90% of 4–8-year-olds (Markham & Adams, 1992), 92% of 5–10-year-olds (Vicari et al., 2000), and 83% of adolescents (Herba et al., 2006). Although such results are sometimes termed "recognition," a child can solve this problem simply by perceptual matching. The child need not understand the meaning of the standard disgust face to see that one standard disgust face looks like another.

Table 5
Percentages of Children Who Labeled Animals and Facial Expressions "Correctly"

Age in years	Stimulus						
	Animals	Happy smile	Sad cry	Angry scowl	Scared gasp	Surprised startle	Standard disgust face
2 (*n* = 24)	99	83	50	38	13	6	4
3 (*n* = 112)	99	96	64	82	38	39	13
4 (*n* = 133)	100	100	84	95	36	57	14
M	99	93	66	72	29	34	10

Note. Results were derived by combining data from three studies (Widen & Russell, 2003, Study 3, 2008a, 2010b, Study 2). Stimulus was a within-subject condition. "Correctly" indicates conformity to prediction. Animals were common farm animals (horse, cow) and house pets (cat, dog). For the smile and other expressions, children were asked, "How does he(she) feel?" Acceptable responses included only emotion labels (e.g., *happy*) and did not include descriptions of the facial expression (e.g., *smile*).

Other tasks do require the child to attach meaning to the facial expression. In the choice-from-array task, children are asked to select from an array of facial expressions the person who is disgusted. With this task, results varied with the size of the array (see Table 6): When the array was small (2 or 3 faces), 84% of 2–5-year-olds (Bullock & Russell, 1985) and 91% of 3–12-year-olds (Harrigan, 1984) were correct. When the array was larger (4 to 6 faces), 64% of 2–5-year-olds (Michalson & Lewis, 1985) and 42% of 3–7-year-olds (Widen & Russell, 2008b) did so. And, when the array was larger still (10 faces), 24% of 3–5-year-olds (Bullock & Russell, 1984) and 43% of 3–4-year-olds (Widen & Naab, 2012) did so. (Choice-from-array has not been used with adolescents.) Because random selection would yield a percentage correct that varies with array size, this pattern is not surprising. The smaller the array size, the more the observed percentage correct is inflated by random guesses; the larger the display, the less guessing inflates the score. The child's choice depends not only on how many faces, but more importantly on *which* faces are the distractors in the display: Choosing the standard disgust face over a smile is one thing, over an angry scowl is another. Thus, comparing actual results to random choice is likely to be an overly liberal method. Unfortunately, the reported results have not analyzed how choice of the standard disgust face varies with the distractors.

A further interesting result from the choice-from-array task is that the standard disgust face is not the only face in which children see disgust: Children in two studies (3–7 years, *N* = 204; Widen & Naab, 2012; Widen & Russell, 2008b) were asked to find everyone who felt *disgusted*. Of their 368 selections, they were most likely to select the standard disgust face (33%) followed by the angry scowl (23%), the scared gasp (19%), the sad cry (12%), the surprised startle (7%), and the happy smile (6%).

The choice-from-array task raises not only the statistical concerns mentioned but also substantive and methodological concerns. In responding to a choice-from-array task, the child begins with the concept of disgust and then searches for a face that fits. Thus, on the substantive side, results from the choice-from-array task do not allow us to conclude that children who successfully find the standard disgust face on the disgust trial would spontaneously interpret the standard disgust face as disgust. The nonlaboratory counterpart would be the unusual event of a child searching for disgusted persons. The question left unanswered—and the more important question—is whether children recognize disgust when they see it.

On the methodological side, results from the choice-from-array task indicate that when children are asked to find someone who is disgusted, they often choose the standard disgust face *over the alternatives*, that is, over the stereotypical expressions of happiness, sadness, anger, fear, and surprise—all expressions that most children spontaneously label "correctly" by the age of 5 years. One possibility is that they can often eliminate expressions for which they already know the label and that this process of elimination leaves a reduced number of options and sometimes leaves only the standard disgust face. For instance, if the child can readily label the happy, sad, and angry faces but no others, then, when shown six faces (happy smile, sad cry, angry scowl, scared gasp, surprised startle, and standard disgust face), the child can eliminate happy, sad, and angry faces; the choice is effectively among three rather than six. (The free-labeling format might be subject to a similar methodological criticism, especially with some additional prior task that specifies which emotion words are of interest. Still, even eliminating *happy*, *sad*, and *angry* as possible labels, the child is choosing from an extremely large number of possible labels.) Another (not incompatible) possibility is that children at these ages use what they know of disgust (that disgust is associated with smelling or tasting something foul) to figure out a solution on the spot. Among the faces available, a standard disgust face might come closest to looking like what happens when smelling something foul. If disgust is associated with odors, and if the standard disgust face draws attention to the nose, the child might choose it for that reason alone.

Finally, a forced-choice response format has been used: Observers are asked to select from a short list of emotion labels the one that matches the standard disgust face. This format is the one most commonly used in studies of adult recognition of facial expressions and produces the highest recognition scores (Russell, 1994). The forced-choice format has been used less frequently with children. We know of only two studies with English-speaking children with this response format, and each found that a high percentage of children selected *disgust* for the standard disgust face (see Table 6): 54% of 4–9-year-olds (Montirosso, Peverelli, Frigerio, Crespi, & Borgatti, 2010) and 87% of 4–8-year-olds (Markham & Adams, 1992). This apparent high level of recognition achieved with the forced-choice format in these two studies must be viewed with caution. The results suffer from methodological problems inherent in the forced-choice format that we described for adults but also from problems similar to those described for the free-labeling format. In Markham and Adams's

Table 6

Percentage of Children Who Associated Each of Six Facial Expressions With the Target Facial Expression or Emotion Label Using Three Alternative Response Formats

Study	Array	Stimuli	Age (N)	Facial expression					
				Happiness	Sadness	Anger	Fear	Surprise	Disgust
			Matching facial expressions						
Herba et al. (2006)	2 faces	Pictures of Facial Affect[a]	4–7 (51)	79	58	57	72		66
			7–10 (51)	83	66	59	86		79
Markham & Adams (1992)	3 faces	Pictures of Facial Affect[a]	4–8 (72)	97	87	78	85	87	90
Vicari et al. (2000)	4 faces	Pictures of Facial Affect[a]	5–6 (42)	95	74	61	61	89	90
			7–8 (39)	96	84	85	78	93	95
			9–10 (39)	97	95	96	82	95	91
Weighted M				91	77	72	78	90	85
			Choice from array						
Bullock & Russell (1985)	2 faces	Pictures of Facial Affect[a] and study-made photos	2 (60)	64	73	78	79	66	76
			3 (60)	89	88	93	91	71	78
			4 (60)	95	97	91	94	77	88
			5 (60)	95	95	97	97	86	92
Harrigan (1984)	3 faces	Study-made photos	3–12 (96)	86	88	82	83	64	91
Michalson & Lewis (1985)	4 faces	Study-made photos	2 (10)	80	80	40	10	60	20
			3 (11)	60	70	80	10	55	20
			4 (9)	90	90	100	45	60	50
			5 (5)	100	100	80	80	80	55
Widen & Russell (2008b)	6 faces	Children's facial expressions[b]	3 (48)	98		81			43
			5 (48)	96		87			38
			7 (48)	100		83			45
Bullock & Russell (1984)	10 faces	Pictures of Facial Affect[a] and study-made photos	3 (38)	76	45	46	28	13	21
			4 (38)	79	82	45	45	11	28
			5 (38)	86	79	52	36	21	23
Widen & Naab (2012)	10 faces	Pictures of Facial Affect[a]	3–4 (60)	87	72	55	56		43
Weighted M				89	83	78	71	59	61
			Forced choice						
Markham & Adams (1992)	3 labels	Pictures of Facial Affect[a]	4–8 (72)	97	78	88	83	85	87
Montirosso et al., 2010	5 labels	Pictures of Facial Affect[a]	4–6 (20)	78	45	42	46		50
			7–9 (20)	89	53	53	62		58
Weighted M				92	68	74	73	85	75

[a] Ekman & Friesen, 1976.   [b] Camras et al., 1983.

study, children had four emotion tasks, all with the same facial expressions. Thus, although some children had the forced-choice task first, most had one, two, or three other tasks before it. In Montirosso et al.'s study, children had a training task in which they labeled the experimenter's facial expressions and then produced their own facial expressions for each of the target emotions.

Results from a forced-choice format also depend on what options are offered. Although the pitfalls of the forced-choice format have long been noted (Ekman et al., 1971; Frank & Stennett, 2001; Russell, 1993), it remains the common practice to require adult observers to select only one emotion from a short list of options. Because the forced-choice response format forces the observer to choose an option, it has been shown to produce high recognition scores for qualitatively different emo-

tion labels for the same facial expression (Russell, 1993). Frank and Stennett (2001) replicated this format's power to produce artifacts but also showed that when a "none of the above" option was added, the artifactual effects were greatly reduced. In the two developmental studies in Table 6, "none of the above" or "two of the above" were never options.

The forced-choice response format was the one most frequently used with adolescents (Table 4). Only one study reported developmental results, and it did not find changes with age. Montirosso et al. reported that 64% of 13–15-year-olds selected disgust for the standard disgust face; 60% of 16–18-year-olds did so. The results of this method showed high variability across studies, ranging from 41% to 87%. Five studies reported adolescents' "errors" when labeling the stan-

dard disgust face (Fairchild et al., 2009; Jarros et al., 2012; Jones et al., 2011; Ma et al., 2012; Sato, Uono, Matsuura, & Toichi, 2009). Whereas children's modal response to the standard disgust face was anger (Figure 2), for adolescents, the modal response to the standard disgust face was disgust (see Table 7). The most frequent "incorrect" response was anger—and by a wide margin for all but one study (Fairchild et al., 2009). As with the adults' and children's forced-choice studies, the results of these studies may have been affected by procedural factors.

Summary. During the first 8 years of their lives, only a few children spontaneously label the standard disgust face isolated from context as expressing disgust specifically. Even among 9-year-olds, only about half of them do so, and from 10 to 19 years, the percentage who do so continues to increase only gradually. This robust finding is not a method artifact or a vocabulary problem. At a young age, the same children label other things, such as animals and some facial expressions "correctly." Other response formats have been used with varying results. Those formats that provide more help and that limit children's response options the most are more likely to show that children match the standard disgust face with *disgust*. The data clearly rule out two ends of a continuum: Contrary to the standard account, very few children spontaneously recognize disgust specifically from the standard disgust face. On the other hand, by 3 years, children are not random in interpreting that face. Priming and other tasks help them come to an interpretation closer to disgust, but most revealing is the list of words counted as correct by several researchers: a range of interpretations including disgust, reaction to aversive smells and tastes, and general dislike.

Children's Recognition of Disgust From the Standard Disgust Face in Context

In the nonlaboratory world, children encounter disgust in a moving person reacting to something in a context. It is possible that children do recognize disgust in such cases, even if they do not recognize disgust from the standard disgust face presented in a still photograph and isolated from context. Two studies that used dynamic presentations of disgust in context support this possibility. In one study, 51% of 4-year-olds freely labeled a dynamic presentation of disgust as *disgusted* (Lariviere, 2005). In another, 50% of 4-year-olds, 63% of 6-year-olds, and 81% of 8-year-olds freely labeled a dynamic display as *disgusted* (Wiggers & van Lieshout, 1985). With a forced-choice response format, the results were even higher: 63%, 69%, and 88%, respectively. Importantly, neither study restricted the emotional display to the standard disgust face. In Lariviere's presentation, an actress focused on a bowl and said "Keep away!" as she backed away from the bowl and displayed a facial expression consisting of a wrinkled nose, down-turned mouth, and slightly protruding tongue. Wiggers and van Lieshout did not describe the specific expression and context they used for disgust, but the video presented a child interacting with two parents acting out an entire scenario. These two studies indicate that with context and a full emotional display, disgust can be conveyed to a majority of preschool children and almost all school-age children. The question remains, however, which single cue or combination of cues within these rich stimulus presentations resulted in the recognition of disgust. What, if any, contribution is

Table 7
Percentage of Adolescents Who Used Each Label for the Standard Disgust Face

Study	Stimuli	Age (N)	Disgust	Anger	Sadness	Surprise	Fear	Happiness
					Labels used for standard disgust face			
		Free labeling						
Ma et al. (2012)	Amsterdam Dynamic Facial Expression Set[a] and University of California, Davis, set of Emotion Expressions[b]	12–17 (36)	53	37	6	3	0	0
Jones et al. (2011)	Pictures of Facial Affect[c]	4–26 (57)	54	39	3	1	4	4
		Forced choice						
Jarros et al. (2012)	Pictures of Facial Affect[c]	10–17 (27)	63	32	0	0	1	0
Sato et al. (2009)	Pictures of Facial Affect[c] and JACFEE[d]	10–24 (24)	46	43	1	3	1	3
Fairchild et al. (2009)	Pictures of Facial Affect[c] and JACFEE[d]	14–18 (40)	74	13	12	1	0	0
Weighted M			58	5	2	2	2	

[a] van der Schalk et al., 2011.   [b] Tracy, Robins, & Schriber, 2009.   [c] Ekman & Friesen, 1976.   [d] JACFEE = Japanese and Caucasian Facial Expressions of Emotion; Matsumoto & Ekman, 1988.

made by the standard disgust face? Future research would do well to pursue these leads.

Does a dynamic presentation of the standard disgust face, even when isolated from the surrounding external situation, improve accuracy over that achieved with a still photograph? Children (3–5 years) freely labeled a photograph of the standard disgust face and, separately, a video that showed a dynamic standard disgust face embedded in the context of a bodily expression and vocalization of disgust (Nelson, Hudspeth, & Russell, 2012). Younger preschoolers (3–4 years) were unlikely to label either the video (8%) or the photograph (12%) as *disgusted*. Older preschoolers (5-year-olds), however, were more likely to label the video (39%) than the photograph (11%) as *disgusted*. In another study, adolescents were shown dynamic videos of disgust displays, but no still photographs were used for comparison (Herba et al., 2008); nonetheless, the proportion freely labeling the disgust display as *disgust* was not noticeably greater than the proportion other studies had found with adolescents shown still photographs. Thus, a dynamic display of disgust may provide an advantage over a still photograph at some ages but not others. The question also remains as to which aspects of the full display (dynamic version of the standard disgust expression, other aspects of face and head, voice, bodily expression) produce this advantage, but it is reasonable to assume that, at least for older preschoolers, the dynamism of the standard disgust expression played a part, albeit small.

To summarize, evidence on the child's labeling of the standard disgust face when more information is provided is consistent with conclusions drawn earlier. At a young age, children (3–4 years) have a word for disgust and a concept of disgust that includes causes and consequences. Thus, many children recognize disgust when given more information than simply a still photograph of the standard disgust face. Recognition probably increases somewhat, at least for older preschoolers, when the child is presented with a dynamically moving full-body expression of disgust. Recognition increases considerably when the child sees a person moving and interacting in a context, but then the role of the standard disgust face is unclear in such studies. This evidence on the effects of context complements evidence reviewed earlier that a prior task influences labeling of the disgust face in that both types of evidence suggest that the child is actively interpreting the standard disgust face rather than simply responding in an automatic manner to a preinterpreted signal. Seeing someone scrunch the nose raises the question of why they are doing so, and the child uses what information is available in an attempt to answer that question.

Other Interpretations of the Standard Disgust Face

Interpretation as unhappy. Although the majority of children under 9 years of age do not spontaneously interpret the standard disgust face as disgust specifically, neither do they stare at it in bewilderment. In the Widen–Russell cumulative data set (Figure 2), 86% of children ($N = 1,065$, 2–9 years) freely provided some emotion label. Only 14% offered a response that was not codable as an emotion (e.g., silence), and even some of the nonemotion responses were interpretations: "He's squinting because the sun is too bright." Of the 911 children who provided some emotion label, 97% offered a negative emotion (*disgust*, *sad*, *angry*); 2%, a positive emotion (*happy*); and 1%, a neutral emotion (*surprised*). This strong negative interpretation was evident even in

the labels offered by 2-year-olds: Of the 31 responses given by 2-year-olds that referred to an emotion, 81% were negative emotions, 16% were positive, and 3% were neutral (*surprised*).

There is other evidence that younger preschoolers interpret the standard disgust face as negative. In a multidimensional scaling study, 2-year-olds were found to judge the similarity between feelings conveyed by facial expressions in terms of two dimensions: pleasure–displeasure and degree of arousal (Bullock & Russell, 1985). The standard disgust face was among the negative emotions, neutral in arousal. Repacholi and Gopnik (1997) provided behavioral evidence for the same conclusion. They showed that 18-month-olds use an adult's standard disgust face to determine which food the adult dislikes. Although Repacholi and Gopnik interpreted this evidence as showing that 18-month-olds interpret the standard disgust face as disgust specifically, their evidence is also consistent with the hypothesis that the 18-month-olds interpreted the standard disgust face as negative.

Interpretation as anger. Of the emotion labels produced by children in the Widen–Russell cumulative data set in Figure 2, even the youngest children used *angry* more than any other label for the standard disgust face. For 2-year-olds ($n = 94$), the frequency of *anger* (18%) was greater than that for *sadness* (5%) or *disgust* (3%). The overwhelming majority of children at each age between 3 and 8 labeled the standard disgust face as *anger*, with a peak around age 6. At age 9, *disgust* and *anger* did not differ reliably.

We hesitate, however, to take the modal label of *anger* for the standard disgust face at face value, because it is not known exactly what these preschoolers mean by the label *anger*. In another task, 2-year-olds were shown a box and told that it was only for people who feel angry (Russell & Widen, 2002a, Study 1). In other words, the box was a physical representation of the anger category. Few included happy faces in the box (11%), but the majority included the standard disgust face (60%), the angry scowl (64%), the sad cry (60%), and the scared gasp (55%) faces in the box; there was no reliable difference in proportion included among these negative faces. Thus, these young children did not differentiate among negative facial expressions when asked to find people who feel angry. To a 2-year-old, *anger* likely means unhappy.

As children get older, the label *anger* can more confidently be thought of as implying a specific emotion similar to that implied by adults. As age increases, children's concept of anger and correspondingly their use of the label gradually narrows as they home in on the adult meaning. For example, children ($N = 120$) were asked to label the emotion of the protagonist in brief stories describing a stereotypical cause and consequence of an emotion (Widen & Russell, 2010a). For 4-year-olds, the modal response was *anger* for four stories: anger, contempt, disgust, and shame. For 6-year-olds, three stories: anger, contempt, disgust. For 8-year-olds, two stories: anger and contempt.

Other methods also indicate that children interpret the standard disgust face as anger. In a particularly revealing study, children (5–10 years) heard a brief emotion story that included the emotion label and were asked to select from an array of six faces the one that matched the story (Gosselin & Laroque, 2000). For the angry story (e.g., "He is angry and about to fight"), 43% of children selected the angry scowl and 45% selected the standard disgust face. Our lab pursued this finding. More than 80% of children (2–7 years) included the standard disgust face in the anger category

defined by three different methods: 84% included the standard disgust face in the box into which only angry people could go (Russell & Widen, 2002a; Widen & Russell, 2008a, 2008b); 84% agreed that the standard disgust face was angry (Widen & Russell, 2008b); and 82% selected the disgust face(s) when asked to select the angry faces from an array (Widen & Naab, 2012; Widen & Russell, 2008b). When children (4–9 years) were asked to generate a possible cause of someone showing the standard disgust face, 48% described a cause that (adult judges agreed) would elicit anger, whereas less than 1% generated a cause that would elicit disgust (Widen & Russell, 2010c). When children (3–5 years) were shown an array of 9 faces and asked to find the angry persons, their first two choices were the angry scowl and the standard disgust face (Bullock & Russell, 1984).

Interpretation as both anger and disgust. With free labeling, only one label is requested for each face. The previously discussed choice-from-array task, on the other hand, is less restrictive in this regard, allowing children to categorize the same face in multiple ways. In two studies (Widen & Naab, 2012; Widen & Russell, 2008b), children (combined $N = 204$, 3–7 years) selected all the faces that were angry on one trial and all the faces that were disgusted on another. Children indeed categorized the standard disgust face as *both* anger and disgust: 48% did so. The next most common response was to include the disgust face in only the anger category: 34% did so; relatively few children included it in only the disgust category: 11%. (And only 7% included it in neither category.) That is, relatively few children fit the prediction of the standard account.

The trend with age in seeing both anger and disgust in the disgust face has not been well charted (perhaps because of the standard practice of simply scoring responses as correct or incorrect). No data are available for adolescents, but some adults may see both anger and disgust in the standard disgust face. For example, when the standard disgust face is presented with a mismatched body (clenched fist), 87% of participants labeled the pair as *angry* (Aviezer et al., 2008). Similarly, when adults were asked to choose angry persons from an array of nine different expressions, they reliably chose the angry scowl first and the standard disgust face second (Bullock & Russell, 1984). When adults were asked whether each of eight facial expressions was angry or not, all of them said *yes* to the angry scowl and 75% said *yes* to the standard disgust face (Widen & Russell, 2008b).

Culture and the Standard Disgust Face

We turn now to the question of whether the patterns seen so far replicate in studies of children from other cultures and who speak other languages. The results summarized in Tables 3 and 6 for English-speaking children appear to replicate well. Studies of French-speaking Canadian children (Table 8) found results consistent with the general findings from English speakers. For example, French-speaking Canadian children were as unlikely to label the standard disgust face as *disgust* (Massarani, Gosselin, Montembeault, Gagnon, & Suurland, 2011) as were the English speakers with the most similar method (i.e., no prior tasks; cf. Table 3), and they were most likely to label it as *angry*. In two studies, French-speaking Canadian children (5–10 years) were asked to select from an array of six faces the one that matched a short emotion story. For the disgust story, 67% (Tremblay, Kirouac, & Dore, 1987) and 43% (Gosselin & Laroque, 2000) of

Table 8

Percentage of Non-English-Speaking Children Who Associated the Standard Disgust Face With Disgust

Study	Stimuli	Language	Array	Age (n)	Disgust
		Free labeling			
Massarani et al. (2011)	Children's facial expressions[a]	French	—	5–6 (39)	3
				7–8 (36)	6
				9–10 (41)	6
Weighted M					5
		Choice from array			
Tremblay et al. (1987)	Pictures of Facial Affect[b]	French	6 faces	5 (20)	46
				7 (20)	73
				9 (20)	81
Gosselin & Laroque (2000)	JACFEE[c]	French	6 faces	5–6 (20)	36
				7–8 (20)	33
				9–10 (20)	68
Weighted M					56
		Forced choice			
Gosselin et al. (1995)	FACS coded facial expressions[d]	French	4 labels	5–6 (30)	67
				7–8 (30)	97
				9–10 (30)	97
Weighted M					87

[a] Camras et al. (1983). [b] Ekman & Friesen (1976). [c] JACFEE = Japanese and Caucasian Facial Expressions of Emotion; Matsumoto & Ekman (1988). [d] FACS = Facial Action Coding System; Bégin, Kirouac, & Doré (1984) as cited in Gosselin et al. (1995).

children selected the standard disgust face. Gosselin and Laroque found that French-speaking children selected the standard disgust face for the anger stories (42%) about as frequently as they did for the disgust story (43%). In another study, French-speaking Canadian children were asked to select a label from a short list to match the standard disgust face (5–10 years; Gosselin, Roberge, & Lavalée, 1995): 64% selected *disgust* (cf. Table 6).

Having more than one culture in the same study provides more precise comparisons. As illustrated by Table 9, cross-cultural comparisons show that children's association of the standard disgust face with disgust seems to follow the same path, but at a different pace in different cultures. Between 2 and 9 years, both French and American children showed increased "accuracy," but French children were more likely than American children to select the standard disgust face as *disgust* (Izard, 1971). More Palestinian children associated the standard disgust face with sadness and fear in a categorization (box) task than did American children, but Americans were more likely to associate it with anger than were Palestinians (Kayyal, Widen, & Russell, 2012a, Study 1, Study 2, 2012b). Another study compared Australian and Chinese children (4–8 years) on two tasks (Markham & Wang, 1996). In one task, children were asked to select from an array of three faces the one that matched a short emotion story. In the other, they were asked to free label facial expressions. For both groups, disgust was the least likely of the six emotions to be matched or labeled "correctly." Chinese children were more likely than were Australian children to match the standard disgust face to the disgust story and to label the standard disgust face as *disgust.* In short, culture seems to influence the pace of change: French children may narrow their disgust category to the standard disgust face earlier than American children, who do so earlier than Palestinian children, and Chinese children may do so earlier than do Australian children.

At a given age, cultural differences in the categorization of facial expressions have been found for both children (Izard, 1971; Kayyal et al., 2012a, Study 1, Study 2, 2012b; Markham & Wang, 1996) and adults (e.g., Biehl et al., 1997; Jack, Blais, Scheepers, Schyns, & Caldara, 2009; Moriguchi et al., 2005). One explanation for these differences between cultures is that the beliefs and ideologies of each culture exert top-down influences on a variety of perceptual phenomena, including the categorization of facial expressions (Jack, Caldara, & Schyns, 2012). For example, more individualistic Western cultures may focus more on specific local features of facial expressions, whereas more collectivistic Asian cultures may focus more on the global configuration of the same expressions. Another explanation that may play a role is the language that is spoken in each culture. Although researchers often treat emotion labels as if they have direct translations between languages, often translations are only best approximations and the subtle variations and nuances of meaning do not translate at all (Wierzbicka, 1992, 1994). Recently, the possibility that language influences perception and other psychological processes has begun to get more attention (Gelman, 2003; Gentner & Goldin-Meadow, 2003; Lindquist, Barrett, Bliss-Moreau, & Russell, 2006).

How Powerful Is the Standard Disgust Face as a Cue to Disgust?

The standard account, with its emphasis on an early understanding of the meaning of facial signals, implies that the standard

disgust face is the most powerful cue to identifying disgust in others. Indeed, the notion of a signal implies that a facial expression is preeminent over any other indication of an emotion. If, for example, two emotion indicators conflict, then the signal would be predicted to take precedence for an observer. Even if, as evidence reviewed so far suggests, children infrequently infer disgust from the standard disgust face, it would still be the most powerful of cues. (Critiques of the evidence on faces that explain that infrequency in terms of vocabulary or cognitive prerequisites would similarly imply poor performance with other disgust indicators.) In studies that compare children's understanding of the standard disgust face to another cue to disgust, however, the consistent finding is just the opposite, a *face inferiority effect*: Children are less likely to associate disgust with the standard disgust face than with other cues tested. A study comparing three cues found that the standard disgust face was not the strongest, at least for adolescents: Participants (mean age: 15.6 years) free labeled facial expressions, tones of voice (e.g., *386* said in a disgusted tone of voice), and nonverbal vocalization (e.g., *ugh*; Jones et al., 2011). Adolescents were as likely to label the standard disgust face as disgust (54%) as the tone of voice (52%) but much more likely to do so for the nonverbal vocalization (88%). In studies with younger children, the cues compared to the standard disgust face so far are story and label.

Story superiority effect. Children are more likely to identify disgust from a story of a disgust elicitor (e.g., "He has bitten into his apple and found a smelly, squashed dead worm"; Camras & Allison, 1985) than from a standard disgust face. In a forced-choice response task, children were more likely to select the label *disgusted* for the disgust story than for the standard disgust face (Camras & Allison, 1985; Gosselin et al., 1995). Free-labeling studies have consistently shown that at around the age of 3 years children start to spontaneously label the protagonist in a disgust story as *disgusted*, even though at this age few children label someone scrunching the nose as *disgusted*. Data from 11 face-labeling studies (Ma et al., 2012; Widen & Russell, 2002, 2003, Study 2, Study 3, 2008a, 2008b, 2010a, 2010b, Study1, Study 2, 2010c, 2012b) and five story-labeling studies (Ma et al., 2012; Widen & Russell, 2002, 2010a, 2010b, Study 1, Study 2) showed that children's association of the disgust stories with disgust increased from 17% at 3 years to 69% at 9 years compared to 9% to 52% for the standard disgust face. The advantage of story over face was significant for every age group except 6-year-olds, independent samples t tests, $t > 2.14$, $p < .04$ (2-year-olds were at floor level for both modes). One study also included adolescents (12–17 years) who were asked to free label facial expressions and, separately, brief stories describing the cause and consequence of emotions (Ma et al., 2012). Adolescents were also more likely to label the disgust story as *disgust* (81%) than the standard disgust face (58%). We have labeled this difference between story and face the *story superiority effect*. The story superiority effect was also found when the task was turned around and children were asked to generate a cause from a standard disgust face or from a story describing the behavioral consequence of disgust (wanting to wash; Widen & Russell, 2004). Children's (3–4 years) causes were better recognized as disgust from the story (48%) than from the standard disgust face (15%).

Label superiority effect. Children understand the label *disgust* before they understand the standard disgust face as a sign

Table 9

Cross-Cultural Comparisons of Children's Categorization of the Standard Disgust Face

Study	Source of facial expressions	Task	Array	Age	\%	(*n*)	\%	(*n*)
							Cultures	
Izard (1971)	Emotion Recognition Facial Expressions[a]	Choice from array	3 faces		French		American	
				2	41	(7)	49	(4)
				3	57	(28)	55	(17)
				4	5	(26)	52	(25)
				5	67	(24)	55	(34)
				6	63	(20)	59	(35)
				7	73	(14)	68	(55)
				8	86	(11)	75	(41)
				9	72	(10)	81	(53)
Weighted *M*					54		66	
Kayyal et al. (2012a), Study 1	Pictures of Facial Affect[b]	Box task			Palestinian		American	
		Included standard disgust face in fear box		2–5	89	(10)	6	(10)
				5–8	55	(10)	10	(10)
Weighted *M*					72		8	
Kayyal et al. (2012a), Study 2	Pictures of Facial Affect[b]	Box task			Palestinian		American	
		Included standard disgust face in fear box		4–6	15	(26)	15	(26)
				6–8	12	(26)	0	(26)
		Included standard disgust face in sad box		4–6	23	(26)	8	(26)
				6–8	31	(26)	0	(26)
		Included standard disgust face in angry box		4–6	58	(26)	81	(26)
				6–8	65	(26)	85	(26)
Weighted *M*					34		32	
Kayyal et al. (2012b)	Pictures of Facial Affect[b]	Box task			Palestinian		American	
		Included standard disgust face in fear box		2–4	48	(30)	23	(30)
				4–7	48	(30)	13	(30)
		Included standard disgust face in sad box		2–4	62	(30)	23	(30)
				4–7	58	(30)	13	(30)
		Included standard disgust face in angry box		2–4	62	(30)	83	(30)
				4–7	74	(30)	87	(30)
Weighted *M*					59		40	
Markham & Wang (1996)	Pictures of Facial Affect[b] and own set, rated by adult sample; photographs that did not receive 70% agreement were omitted				Chinese		Australian	
		Choice from array	3 faces	4	70	(24)	47	(24)
				6	83	(24)	53	(24)
				8	87	(24)	66	(24)
Weighted *M*					80		55	
		Free labeling		4	40	(24)	47	(24)
				6	43	(24)	53	(24)
				8	60	(24)	66	(24)
Weighted *M*					48		55	

[a] Izard, 1971.   [b] Ekman & Friesen, 1976.

of disgust. Evidence for this point comes from the label superiority effect. The label superiority effect was seen when children engaged in a storytelling game. They were asked to tell a story about what caused various emotions. The emotion was conveyed to the child either by its label (specifically, *disgusted*) or by its facial expression (i.e., the standard disgust face). Children's (3–4 years) stories for disgust were better recognized (by adult judges blind to the emotion the child was given) when the child had been given the label (34%, Russell & Widen, 2002b; 50%, Widen & Russell, 2004) than when given the face (8% and 15%, respectively). An even greater label superiority effect might be found if labels such as *yuck* and *ick* were used (Widen & Russell, 2012a). Interestingly, causal stories produced for the standard disgust face differed from those produced for the label *disgust*. Causal stories for the standard disgust face were more likely to describe smelling something foul (feces, vomit; 55%) than were causal stories for the label *disgusted* (20%; Widen & Russell, 2008b). This result is another hint that children initially associate the standard disgust face with smells.

Discussion and Conclusion

Much research and theorizing—and applied work as well—presupposes the standard account of emotions. Concerning that account, Barrett (2011) observed,

> This compelling narrative is the received view in the scientific study of emotion: Many scientific papers casually state that expressions are innate and universally recognized. Research findings are interpreted in support of this view without much consideration of alternative explanations. The view has been absorbed, without reflection, into other fields. (p. 400)

According to the standard account of disgust, the standard disgust face is its prewired signal shaped during the course of evolution—a signal that, from an early age, is automatically produced when disgust is elicited and automatically recognized by anyone who happens to see it. Recognition, in turn, mediates such further processes as the child's disgust concept and learning of culture-specific disgust elicitors. Our review of the evidence calls aspects of this account into question and underscores the need for alternative accounts.

During their first 8 years, children scrunch their noses (Stevenson et al., 2010), experience disgust (Rozin et al., 1986), develop a concept of disgust (Widen & Russell, 2010a), acquire a word for disgust (Bretherton et al., 1981), and are able to infer disgust in another from the situation the other encounters or how that person reacts to that situation (Widen & Russell, 2011). Children are also able to infer disgust from the standard disgust face provided that it is embedded in a rich context (Wiggers & van Lieshout, 1985). Yet few of these children spontaneously interpret the standard disgust face *alone* as a signal of disgust (Widen & Russell, 2008b). Instead, most interpret it as a sign of anger. The limited data we have from other cultures (French-speaking Canadians, Gosselin, et al., 1995; French-speaking French, Izard, 1971; Chinese-speaking Chinese, Markham & Wang, 1996; and Arabic-speaking Palestinians, Kayyal et al., 2012a) paint a similar picture. Cumulatively, the evidence questioning children's interpretation of the standard

disgust face as disgust provides a poor prognosis for this part of the standard account of disgust as it stands today.

Our conclusion—that children only gradually come to recognize disgust specifically from the standard disgust face alone, with only about half doing so at age 9 and the number gradually increasing through the teen years—is at odds with the standard account. The standard account provides a set of related predictions: that adults recognize the standard disgust face as a signal of disgust (Ekman et al., 1980); that such recognition is universal (Ekman & Cordaro, 2011); that, when disgusted, persons of all cultures and speaking all languages produce the standard disgust face (Ekman, 1994); and so on. If these related predictions were unequivocally verified by evidence, then our conclusion regarding children might be seen as a curiosity best left in abeyance until more definitive evidence is available. But each of these other predictions has produced, on the more sympathetic interpretation, equivocal empirical results or, on a less sympathetic interpretation, negative results. These related parts of the standard account are thus incapable of bolstering the standard account of children's recognition of disgust from the standard disgust face. Enough evidence on disgust and the standard disgust face has accumulated that the entire standard account of disgust should now be subjected to more scrutiny. Reviewing new evidence that verbal processing is required to categorize a facial expression, Roberson, Damjanovic, and Kikutani (2010) came to a conclusion similar to ours:

> Given the evidence that systems of categorization for facial expressions of emotion are slow to develop, vary with culture (and language) and, even when fully established, can be disrupted if verbal processing is prevented . . . it seems unlikely that a complex system of emotional expression categories could be an entirely closed-loop system, predetermined at birth by evolutionary factors. (p. 4)

Of course, proponents of the standard account can cite evidence consistent with their theory. For example, when the standard disgust face is embedded in an appropriate context (such as a video clip of people interacting; Wiggers & van Lieshout, 1985), children typically recognize disgust. From a scientific point of view, however, this type of stimulus confounds two sources of information. It may be the context or it may be the standard disgust face that prompts recognition. When context and face are separated, the evidence points to context as the source of recognition (Widen & Russell, 2004). Generally, the more information provided about the context, the higher the percentage of children who "accurately" recognize disgust from context-plus-face. Indeed, context alone (presented as a story) suffices to convey disgust to children. Therefore, children's ability to recognize disgust from face-in-context does not speak to the question of whether the standard disgust face signals disgust to the child. Indeed, that young children perceive disgust from contextual information alone shows that they are fully capable of perceiving disgust, and therefore this evidence provides a telling methodological contrast to the evidence on how poorly similarly aged children do when given the standard disgust face alone.

Proponents of the standard account might take comfort from the evidence claiming to show that teenagers (D. W. Walker & Leister, 1994) and adults (Ekman & Cordaro, 2011) recognize disgust from the standard disgust face alone. Such comfort might be precarious, however, for two reasons. First, the greatest percentage of observers recognizing disgust from the standard disgust face is seen in

more educated observers from Western cultures (Nelson & Russell, in press; Wolfgang & Cohen, 1988); decrements due to education, culture, and language are statistically significant. Second, the "recognition" seen in these studies appears to depend on certain features of the experimental method, such as a within-subject design, forced-choice response format, and posed faces devoid of context (Russell, 1994). Other evidence shows that when these methodological features are changed, consensus on the standard disgust face as conveying disgust specifically is greatly attenuated (Aviezer et al., 2008; Naab & Russell, 2007; Pochedly et al., 2012; Yik, Widen, & Russell, in press).

Proponents of the standard account might, alternatively, hold out hope that a new response measure will show that young children do, indeed, recognize disgust specifically from the standard disgust face alone. The measures of "recognition" used in prior research can perhaps be faulted, as can any measure. Perhaps new behavioral, psychophysiological, or neurological measures might provide new evidence. Without data, such a possibility cannot be evaluated today, except to note that the concept of "recognition of disgust" cannot currently be measured in these ways. Theorists have not pointed to a behavioral or physiological reaction that is specific to recognizing another's disgust rather than a general reaction of dislike. Toddlers likely associate the standard disgust face with avoidance broadly defined (Moses et al., 2001; Repacholi, 1998; Widen, in press; Widen & Russell, 2008c), but this hypothesis is an alternative to rather than a prediction of the standard account, for avoidance is not specific to disgust but is associated with various negative emotions.

To accommodate the negative evidence summarized here, the standard account might be salvaged by dropping the assumption that the signal of disgust is the *standard disgust face*. We focused on the standard disgust face because of the common assumption that it is *the* facial signal for disgust, because it was specified by Ekman et al. (2002, Table 10-1), and because of the widespread use of photographs of the standard disgust face in current research both basic and applied. Conceivably, prior research identified the wrong signal. Put differently, one limitation of current evidence, and hence of our review of that evidence, is its focus on the standard disgust face. Focus on the standard disgust face, in turn, was guided by the research program based on Tomkins's theorizing and his description of the various facial expressions (Tomkins & McCarter, 1964). That program relied on actors' attempts to portray disgust and on consensus among observers found with the standard method. Most studies of the facial expression of disgust relied directly on Tomkins's photographs or ones derived from them or in a similar manner. Thus, the few sets that did not directly use the standard disgust face—such as the NimStim (Tottenham et al., 2009) set—nonetheless relied on actors' attempts to portray disgust. We found no evidence that any of these "disgust faces" are more easily recognized by children than the standard disgust face or, indeed, that a different set of conclusions would follow from the study of these various "disgust faces." We speculate that the facial movements used by actors to mime disgust are a poor starting place for the study of disgust. Rodin could convey thinking by showing a man with his chin resting on his fist, but thinking occurs in natural settings with the chin elsewhere.

An alternative research strategy focused on those facial movements that actually occur during disgust reactions might reveal a signal other than the standard disgust face. Surprisingly, in the entire body of research carried out by advocates of the standard account, actual disgust reactions have rarely been studied, actual facial movements during disgust rarely recorded. (Notable exceptions include research from Davidson, Ekman, Saron, Senulis, & Friesen, 1990; Ekman, 1972; Ekman et al., 1980; Reisenzein, 2007; and Rozin et al., 2008.) Hints of a possible alternative signal come from studies in which children recognized disgust from videotapes of dynamic presentations (Lariviere, 2005; Wiggers & van Lieshout, 1985). At a minimum, dynamic presentation of actual disgust reactions should be explored more. Rozin, Lowery, and Ebert (1994) explored four different facial displays of disgust and found that they conveyed slightly different meanings to adults. Von dem Hagen et al. (2009) found different brain activations in persons shown the standard disgust face than in those shown an expression they called "distaste" (mouth gape and tongue protrusion).

Another possible way to salvage the standard account would be to drop the assumption that disgust has any *signal*. (McDougall, 1908/1960, and Panksepp, 2004, offered basic emotion theories without facial signals.) The standard disgust face might simply be an instrumental response instead. For example, scrunching the nose might alter one's ability to smell. If so, one could continue to assume that disgust produces the standard disgust face but abandon the assumption that human beings innately or easily or automatically recognize disgust from the standard disgust face. The standard disgust face would be a *sign* rather than a signal of disgust. In that case, some people learn to infer disgust when they observe a standard disgust face and learn to mime it when they want to convey disgust to others, but some might not. A problem with this tack is the evidence reviewed earlier that disgust does not typically result in the standard disgust face in either children or adults. Perhaps the theoretical alteration would need to go further and drop the association of the standard disgust face with disgust altogether and hypothesize that one scrunches the nose as part of smelling intense or novel odors. Clearer evidence on what conditions do and do not produce the standard disgust face or the various disgust faces identified by Rozin et al. (1994) is much needed.

While some theorizing can be aimed at modifying the standard account, a more promising theoretical tack can be aimed at questioning others of its assumptions. The list of basic emotions varies with theorist, and even with the same theorist at different times. Ekman (1992) proposed that to be a basic emotion, the emotion must have a facial signal (although see Ekman & Cordaro, 2011), but perhaps that proposal should be questioned for all the emotions. For example, the evidence reviewed here on children's recognition of disgust from the face also raises the question of how children of various ages interpret other facial expressions alleged to signal other emotions (Widen & Russell, 2003, 2008a).

Evidence reviewed here underscores the need to reexamine studies that used the standard disgust face to convey disgust. For example, Repacholi (1998; Repacholi & Gopnick, 1997) found that toddlers (14–18 months) used an adult's standard disgust face (vs. a smile) to infer which box contained the more desirable object or which food an adult would want to eat. Repacholi interpreted this result in terms of disgust, but whether this result is unique to the standard disgust face or occurs with any negative expression remains to be seen. But-

telmann, Call, and Tomasello (2009) offered a similar critique of Repacholi's interpretation when reporting a study with great apes that replicated Repacholi's result. Similarly, Danovitch and Bloom (2009) concluded that children find immoral events to be as disgusting as physically disgusting events. Specifically, they showed children the standard disgust face and asked whether or not it went with a story. Faced with this choice, almost all children (6–10 years) agreed that the standard disgust face went with stories about physically disgusting events (smelling a bottle of rotten milk), and about half did so for stories about morally disgusting events (stealing money from a little kid to buy candy). Alternatively, the Danovitch and Bloom result might mean simply that both the story and the standard disgust face were seen as negative or as angry. Indeed, Pochedly and Zeman (2012) found that, given a choice between an angry scowl and a standard disgust face, three quarters of children (aged 4–12 years) selected an angry scowl over the standard disgust face for the stories about moral offenses.

The standard account—especially the hypotheses that recognition is hard-wired and automatic—is not the only possible account of how children come to recognize disgust from the standard disgust face. One of several alternatives is that children develop a *concept* of disgust, much as they develop concepts of various events in their lives from a birthday party to a visit to the doctor. For an adult, the concept of disgust consists of its prototypical components as they unfold in a temporal and causal order (Fehr & Russell, 1984). The components are subevents, such as the antecedent cause, appraisal of that cause, a subjective experience, facial and vocal expressions, bodily changes, and behavioral consequences. The prototypical causal event may be something rotten, the prototypical subjective feeling may be nausea, the prototypical behavioral consequence ridding oneself of the offending object, and so on. Each component listed above for the concept was called "prototypical" to indicate that a range of events can serve in that role. Thus, "ridding oneself of a disgusting object" may take many forms, such as washing one's hands, vomiting, looking away, and so on.

Evidence suggests that children do not begin with the full-blown concept for any emotion, nor do they acquire the entire concept whole (Russell & Paris, 1994; Widen & Russell, 2004, 2011). Rather, the adult's concept is an end product of a developmental process. The usual perceptual-cognitive processes involved in concept formation can be invoked for the perception of individual components and for forming associations between them. Concept development is built upon such processes. Concepts therefore change over the course of development as new components (including facial expressions) are added one at a time. This assumption leads to two hypotheses about using the concept to categorize an emotional episode. First, before it is added to the emotion concept, a component has no power as a cue to that emotion. Second, the earlier a component is added to the concept, the more powerful it is as a cue in leading the child to identify the emotion. These hypotheses provide the researcher with tools for charting the development of the concept of disgust: The power of a cue is an indication of when it entered the concept.

According to one set of theories, the full set of emotion concepts is built up slowly through a process of differentiation (e.g., Bennett et al., 2002; Bridges, 1930; Fischer, 1980; Widen & Russell, 2003, 2008a, 2008b). By "differentiation," we mean that the child initially conceptualizes emotions in terms of very broad categories and then subdivides each category until eventually the full adult taxonomy is reached. The broad categories contain few components, and differentiation involves adding new ones. Specifically, infants initially divide emotions into pleasant versus unpleasant. The child then gradually subdivides within the pleasant set and, separately, within the unpleasant set. Next, the child differentiates within each of the resulting categories, and so forth.

These hypotheses allow a tentative hypothesis on the order in which children add components to the disgust concept. Evidence so far suggests that the disgust concept—like other negative emotion concepts (Russell & Paris, 1994)—consists initially of feeling unhappy (Widen & Russell, 2010b). That feeling is next coupled with a cause (something that tastes or smells bad; Widen & Russell, 2008b, Study 1). Later, a label (*disgust* or *yucky* or *gross*) is added, followed by the behavioral consequence (rejecting the cause), and finally the facial expression (standard disgust face; Widen & Russell, 2004). Thus, the concept of disgust is well developed before it includes the standard facial expression.

The hypothesized order just described raises but does not answer the question of why the facial expression enters the concept relatively late. Possible answers include the frequency and salience of a disgust face during disgust episodes, especially in the lives of the children examined in the research reviewed here. It is not known what induces the child to see, eventually, an association between the standard disgust face and disgust specifically, but one possibility is that children observe that people scrunch their noses when tasting rotten food or smelling foul odors. Or, children might notice that they themselves scrunch their noses when tasting or smelling something aversive. For example, when children were asked what made them feel disgusted (Widen & Russell, 2003, Study 3, 2008a), 72% of their answers referred to tastes or smells (e.g., food or feces). Another possible influence may be the surrounding language community. Exciting theoretical and empirical work has begun to chart the influence of language on other psychological processes (Gelman, 2003; Roberson, Kikutani, Döge, Whitaker, & Majid, 2012).

One possible account of the development of recognition of disgust from the standard disgust face begins in infancy. Infants can perceive the standard disgust face as a physical movement (Nelson & Dolgin, 1985), but it remains unknown what, if any, meaning they attribute to it. By 2 years, toddlers might read it as a sign that the person whose nose is scrunched is unhappy or, alternatively, they might simply associate it with the command to avoid something (Widen & Russell, 2008c). That is, the standard disgust face is initially attached to the broad "unhappy" emotion category. More generally, until about 2.5 years children might interpret all facial expressions in terms of the dimension of valence. When the child divides the unhappy category in two, the standard disgust face goes with the "anger broadly defined" category and is labeled *anger*. When a parent is scrunching the nose and looking directly at them, children may infer that the parent is unhappy *at* them. In other words, children may interpret the standard disgust face as a sign of disapproval, something to which they are highly sensitive, and hence label it as *anger*. Children who have been abused interpret a broad range of facial expressions as anger (Pollak, Cicchetti, Hornung, & Reed, 2000; Pollak & Sinha, 2002). We

know of no evidence on the consequences of this interpretation, but we can speculate that interpreting a disgust face as anger would lead to inappropriate learning. That is, the child learns, not that a certain event is disgusting (and hence better avoided for health reasons) but that it evokes anger (and hence avoided in order to escape parental anger). For the first 8 years, the majority of children studied label the standard disgust face as *angry*, but gradually the meaning of the word *angry* narrows toward its adult meaning as it comes to be limited to certain causal antecedents, behavioral consequences, and social norms.

Later, when anger is distinguished from disgust, it appears that the standard disgust face stays with anger or, more accurately, with the broader anger-disgust category. Most children (and adults) label the standard disgust face as both anger *and* disgust (Widen & Russell, 2008b). Thus, there is no one-to-one correspondence between the meaning seen in the standard disgust face and a single one of the so-called basic discrete emotions typically postulated in psychology. Only later and in a fraction of cases does the standard disgust face come to be interpreted as disgust only. Indeed, in a study that included American and Palestinian adults responding to spontaneous facial expressions of emotion identified by Ekman (1980), observers selected on average four emotions per expression (Kayyal & Russell, 2012).

Of course, many questions remain. Anecdotally, the standard disgust face is seen in a variety of circumstances, including positive ones (some individuals wrinkle their nose and raise their upper lip when smiling). Do children interpret such expressions as happy or unhappy? Although seeing disgust in the standard disgust face alone is rare even at 8 years of age, some 3-year-olds do so. How are we to understand this individual difference? If the perception of disgust from the standard disgust face is not automatic, and if disgusted persons infrequently scrunch their noses, how do people eventually come to see disgust in the standard disgust face? In what circumstances do children witness standard disgust faces?

Better research, better applications, and better insight into children's understanding of disgust require better theoretical accounts. With the standard account taken for granted, theoretical gears have been idling in neutral. The evidence reviewed in this article presents mounting problems for the standard account for children and invites proposals for new ones.

References

Allen, J., Abbott, M. J., Rapee, R. M., & Coltheart, M. (2006). Ew gross! Recognition of expressions of disgust by children with obsessive-compulsive disorder. *Behaviour Change, 23,* 239–249. doi:10.1375/bech.23.4.239

Allport, F. H. (1924). *Social psychology.* Boston, MA: Houghton Mifflin.

Amir, N., Klumpp, H., Elias, J., Bedwell, J., Yanasak, N., & Miller, L. S. (2005). Increased activation of the anterior cingulate cortex during processing of disgust faces in individuals with social phobia. *Biological Psychiatry, 57,* 975–981. doi:10.1016/j.biopsych.2005.01.044

Amir, N., Najmi, S., & Bomyea, J. (2010). Disgust and anger in social anxiety. *International Journal of Cognitive Therapy, 3,* 3–10. doi:10.1521/ijct.2010.3.1.3

Aviezer, H., Hassin, R. R., Ryan, J., Grady, C., Susskind, J., Anderson, A., . . . Bentin, S. (2008). Angry, disgusted, or afraid? Studies on the malleability of emotion perception. *Psychological Science, 19,* 724–732. doi:10.1111/j.1467-9280.2008.02148.x

Balconi, M., & Carrera, A. (2007). Emotional representation in facial expression and script: A comparison between normal and autistic children. *Research in Developmental Disabilities, 28,* 409–422. doi:10.1016/j.ridd.2006.05.001

Barrett, L. F. (2011). Was Darwin wrong about emotional expressions? *Current Directions in Psychological Science, 20,* 400–406. doi:10.1177/0963721411429125

Barrett, L. F., & Salovey, P. (2002). *The wisdom in feeling: Psychological processes in emotional intelligence.* New York, NY: Guilford Press.

Beaupré, M., & Hess, U. (2005). Cross-cultural emotion recognition among Canadian ethnic groups. *Journal of Cross-Cultural Psychology, 36,* 355–370. doi:10.1177/0022022104273656

Bennett, D. S., Bendersky, M., & Lewis, M. (2002). Facial expressivity at 4 months: A context by expression analysis. *Infancy, 3,* 97–113. doi:10.1207/S15327078IN0301_5

Biehl, M., Matsumoto, D., Ekman, P., Hearn, V., Heider, K., Kudoh, T., & Ton, V. (1997). Matsumoto and Ekman's Japanese and Caucasian Facial Expressions of Emotion (JACFEE): Reliability data and cross-national differences. *Journal of Nonverbal Behavior, 21,* 3–21. doi:10.1023/A:1024902500935

Björklund, F., & Hursti, T. J. (2004). A Swedish translation and validation of the Disgust Scale: A measure of disgust sensitivity. *Scandinavian Journal of Psychology, 45,* 279–284. doi:10.1111/j.1467-9450.2004.00406.x

Blair, C. (2002). School readiness: Integrating cognition and emotion in a neurobiological conceptualization of children's functioning at school entry. *American Psychologist, 57,* 111–127. doi:10.1037/0003-066X.57.2.111

Blair, R. J. R., & Coles, M. (2000). Expression recognition and behavioral problems in early adolescence. *Cognitive Development, 15,* 421–434. doi:10.1016/S0885-2014(01)00039-9

Blankson, A. N., O'Brien, M., Leerkes, E. M., Markovitch, S., Calkins, S. D., & Weaver, J. M. (2012). Developmental dynamics of emotion and cognition processes in preschoolers. *Child Development.* Advance online publication. doi:10.1111/j.1467-8624.2012.01841.x

Bloom, P. (2004). *Descartes' baby: How the science of child development explains what makes us human.* New York, NY: Basic Books.

Bretherton, I., & Beeghly, M. (1982). Talking about internal states: The acquisition of an explicit theory of mind. *Developmental Psychology, 18,* 906–921. doi:10.1037/0012-1649.18.6.906

Bretherton, I., McNew, S., & Beeghly-Smith, M. (1981). Early person knowledge as expressed in gestural and verbal communication: When do infants acquire a "theory of mind"? In M. E. Lamb & L. R. Sherrod (Eds.), *Infant social cognition* (pp. 333–373). Hillsdale, NJ: Erlbaum.

Bridges, K. M. B. (1930). A genetic theory of the emotions. *Journal of Genetic Psychology: Research and Theory on Human Development, 37,* 514–527. doi:10.1080/00221325.1991.9914709

Brotman, M. A., Skup, M., Rich, B. A., Blair, K. S., Pine, D. S., Blair, J. R., & Leibenluft, E. (2008). Risk for bipolar disorder is associated with face-processing deficits across emotions. *Journal of the American Academy of Child & Adolescent Psychiatry, 47,* 1455–1461. doi:10.1097/CHI.0b013e318188832e

Brown, S. D., & Harris, G. (2012). Disliked food acting as a contaminant during infancy. A disgust based motivation for rejection. *Appetite, 58,* 535–538. doi:10.1016/j.appet.2012.01.010

Brown, S. D., Harris, G., Bell, L., & Lines, L. M. (2012). Disliked food acting as a contaminant in a sample of young children. *Appetite, 58,* 991–996. doi:10.1016/j.appet.2012.02.047

Buhlmann, U., McNally, R. J., Etcoff, N. L., Tuschen-Caffier, B., & Wilhelm, S. (2004). Emotion recognition deficits in body dysmorphic disorder. *Journal of Psychiatric Research, 38,* 201–206. doi:10.1016/S0022-3956(03)00107-9

Bullock, M., & Russell, J. A. (1984). Preschool children's interpretation of facial expressions of emotion. *International Journal of Behavioral Development, 7,* 193–214. doi:10.1016/S0163-6383(84)80255-6

Bullock, M., & Russell, J. A. (1985). Further evidence on preschoolers' interpretations of facial expressions of emotion. *International Journal of Behavioral Development, 8,* 15–38. doi:10.1177/016502548500800103

Buttelmann, D., Call, J., & Tomasello, M. (2009). Do great apes use emotional expressions to infer desires? *Developmental Science, 12,* 688–698. doi:10.1111/j.1467-7687.2008.00802.x

Calder, A. J., Keane, J., Manes, F., Antoun, N., & Young, A. W. (2000). Impaired recognition and experience of disgust following brain injury. *Nature Neuroscience, 3,* 1077–1078. doi:10.1038/80586

Campos, J. J., Thein, S., & Owen, D. (2003). A Darwinian legacy to understanding human infancy: Emotional expressions as behavior regulators. In P. Ekman, J. J. Campos, R. J. Davidson, & F. B. de Waal (Eds.), *Annals of the New York Academy of Sciences: Vol. 1000. Emotions inside out: 130 years after Darwin's The expression of the emotions in man and animals* (pp. 110–134). New York, NY: New York Academy of Sciences. doi:10.1196/annals.1280.040

Camras, L. A., & Allison, K. (1985). Children's understanding of emotional facial expressions and verbal labels. *Journal of Nonverbal Behavior, 9,* 84–94. doi:10.1007/BF00987140

Camras, L. A., Grow, J. G., & Ribordy, S. C. (1983). Recognition of emotional expression by abused children. *Journal of Clinical Child Psychology, 12,* 325–328. doi:10.1080/15374418309533152

Carroll, J. M., & Russell, J. A. (1997). Facial expressions in Hollywood's portrayal of emotion. *Journal of Personality and Social Psychology, 72,* 164–176. doi:10.1037/0022-3514.72.1.164

Cisler, J. M., Olatunji, B. O., & Lohr, J. M. (2009). Disgust, fear, and the anxiety disorders: A critical review. *Clinical Psychology Review, 29,* 34–46. doi:10.1016/j.cpr.2008.09.007

Corcoran, K. M., Woody, S. R., & Tolin, D. F. (2008). Recognition of facial expressions in obsessive-compulsive disorder. *Journal of Anxiety Disorders, 22,* 56–66. doi:10.1016/j.janxdis.2007.01.003

Cowart, B. J. (1981). Development of taste perception in humans. Sensitivity and preference throughout the life span. *Psychological Bulletin, 90,* 43–73. doi:10.1037/0033-2909.90.1.43

Curtis, V., De Barra, M., & Aunger, R. (2011). Disgust as an adaptive system for disease avoidance behaviour. *Philosophical Transactions of the Royal Society B: Biological Sciences, 366*(1563), 389–401. doi:10.1098/rstb.2010.0117

Danovitch, J., & Bloom, P. (2009). Children's extension of disgust to physical and moral events. *Emotion, 9,* 107–112. doi:10.1037/a0014113

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

Davidson, R. J., Ekman, P., Saron, C. D., Senulis, J. A., & Friesen, W. V. (1990). Approach-withdrawal and cerebral asymmetry: Emotional expression and brain physiology I. *Journal of Personality and Social Psychology, 58,* 330–341. doi:10.1037/0022-3514.58.2.330

Denham, S. A., & Couchoud, E. A. (1990). Young preschoolers' understanding of emotions. *Child Study Journal, 20,* 171–192.

D'Entremont, B., & Muir, D. (1999). Infant responses to adult happy and sad vocal and facial expressions during face-to-face interactions. *Infant Behavior & Development, 22,* 527–539. doi:10.1016/S0163-6383(00)00021-7

Dobson, A. P., & Carper, E. R. (1996). Infectious diseases and human population history. *BioScience, 46,* 115–126. doi:10.2307/1312814

Duchenne, G.-B. (1990). *The mechanism of human facial expression or an electro-physiological analysis of the expression of the emotions* (R. A. Cuthbertson, Ed. and Trans.). New York, NY: Cambridge University Press. (Original work published 1862)

Dunn, J., Bretherton, I., & Munn, P. (1987). Conversations about feeling states between mothers and their young children. *Developmental Psychology, 23,* 132–139. doi:10.1037/0012-1649.23.1.132

Ekman, P. (1972). Universals and cultural differences in facial expressions of emotions. In J. K. Cole (Ed.), *Nebraska Symposium on Motivation* (*Vol.* 19, pp. 207–283). Lincoln, NE: University of Nebraska Press.

Ekman, P. (1980). *The face of man.* New York, NY: Garland.

Ekman, P. (1992). An argument for basic emotions. *Cognition & Emotion, 6,* 169–200. doi:10.1080/02699939208411068

Ekman, P. (1993). Facial expression and emotion. *American Psychologist, 48,* 384–392. doi:10.1037/0003-066X.48.4.384

Ekman, P. (1994). Strong evidence for universals in facial expressions: A reply to Russell's mistaken critique. *Psychological Bulletin, 115,* 268–287. doi:10.1037/0033-2909.115.2.268

Ekman, P. (2003). *Emotions revealed: Recognizing faces and feelings to improve communication and emotional life.* New York, NY: Times Books/Henry Holt.

Ekman, P., & Cordaro, D. (2011). What is meant by calling emotions basic? *Emotion Review, 3,* 364–370. doi:10.1177/1754073911410740

Ekman, P., & Friesen, W. V. (1971). Constants across cultures in the face and emotion. *Journal of Personality and Social Psychology, 17,* 124–129. doi:10.1037/h0030377

Ekman, P., & Friesen, W. V. (1975). *Unmasking the face.* Englewood Cliffs, NJ: Prentice Hall.

Ekman, P., & Friesen, W. V. (1976). *Pictures of facial affect.* Palo Alto, CA: Consulting Psychologists Press.

Ekman, P., & Friesen, W. V. (1978). *Facial Action Coding System.* Palo Alto, CA: Consulting Psychologists Press.

Ekman, P., Friesen, W. V., & Ancoli, S. (1980). Facial signs of emotional experience. *Journal of Personality and Social Psychology, 39,* 1125–1134. doi:10.1037/h0077722

Ekman, P., Friesen, W. V., & Ellsworth, P. (1972). *Emotion in the human face: Guidelines for research and an integration of findings.* New York, NY: Pergamon Press.

Ekman, P., Friesen, W. V., & Hager, J. C. (2002). *Facial Action Coding System: The investigator's guide.* Salt Lake City, UT: Research Nexus.

Ekman, P., Friesen, W. V., & Tomkins, S. S. (1971). Facial Affect Scoring Technique: A first validity study. *Semiotica, 3,* 37–58. doi:10.1515/semi.1971.3.1.37

Ekman, P., Levenson, R. W., & Friesen, W. V. (1983). Autonomic nervous system activity distinguishes among emotions. *Science, 221,* 1208–1210. doi:10.1126/science.6612338

Ekman, P., Sorenson, E. R., & Friesen, W. V. (1969). Pan-cultural elements in the facial displays of emotions. *Science, 164,* 86–88. doi:10.1126/science.164.3875.86

Elfenbein, H. A. (2007). It takes one to know one better: Controversy about the cultural ingroup advantage in communicating emotion as a theoretical rather than methodological issue. In U. Hess & P. Philippot (Eds.), *Group dynamics and emotional expression* (pp. 51–68). New York, NY: Cambridge University Press. doi:10.1017/CBO9780511499838.004

Elfenbein, H. A., & Ambady, N. (2002). Is there an in-group advantage in emotion recognition? *Psychological Bulletin, 128,* 243–249. doi:10.1037/0033-2909.128.2.243

Elfenbein, H. A., & Ambady, N. (2003). Universals and cultural differences in recognizing emotions of a different cultural group. *Current Directions in Psychological Science, 12,* 159–164. doi:10.1111/1467-8721.01252

Engen, T., & Corbit, T. E. (1970). *Feasibility of olfactory coding of noxious substances to assure aversive responses in young children* (Injury Control Research Laboratory Research Report ICRL-RR-69). Washington, DC: U.S. Department of Health, Education, and Welfare, Public Health Service, Environmental Health Service, Environmental Control Administration, Bureau of Community Environmental Management.

Fairchild, G., Van Goozen, S. H., Calder, A. J., Stollery, S. J., & Goodyer, I. M. (2009). Deficits in facial expression recognition in male adolescents with early-onset or adolescence-onset conduct disorder. *Journal of Child Psychology and Psychiatry, 50,* 627–636. doi:10.1111/j.1469-7610.2008.02020.x

Fallon, A. E., Rozin, P., & Pliner, P. (1984). The child's conception of food: The development of food rejections with special reference to disgust and contamination sensitivity. *Child Development, 55,* 566–575. doi:10.2307/1129968

Fehr, B., & Russell, J. A. (1984). Concept of emotion viewed from a prototype perspective. *Journal of Experimental Psychology: General, 113,* 464–486. doi:10.1037/0096-3445.113.3.464

Feinman, S., & Lewis, M. (1983). Social referencing at ten months: A second-order effect on infants' responses to strangers. *Child Development, 54,* 878–887. doi:10.2307/1129892

Fernández-Dols, J.-M., Sánchez, F., Carrera, P., & Ruiz-Belda, M.-A. (1997). Are spontaneous expressions and emotions linked? An experimental test of coherence. *Journal of Nonverbal Behavior, 21,* 163–177. doi:10.1023/A:1024917530100

Fischer, K. W. (1980). A theory of cognitive development: The control and construction of hierarchies of skills. *Psychological Review, 87,* 477–531. doi:10.1037/0033-295X.87.6.477

Frank, M. G., & Stennett, J. (2001). The forced-choice paradigm and the perception of facial expressions of emotion. *Journal of Personality and Social Psychology, 80,* 75–85. doi:10.1037/0022-3514.80.1.75

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

Garner, P. W., & Waajid, B. (2008). The associations of emotion knowledge and teacher–child relationships to preschool children's school-related developmental competence. *Journal of Applied Developmental Psychology, 29,* 89–100. doi:10.1016/j.appdev.2007.12.001

Gates, G. S. (1923). An experimental study of the growth of social perception. *Journal of Educational Psychology, 14,* 449–461. doi:10.1037/h0074941

Gelman, S. A. (2003). *The essential child: Origins of essentialism in everyday thought.* New York, NY: Oxford University Press.

Gentner, D., & Goldin-Meadow, S. (Eds.). (2003). *Language in mind.* Cambridge, MA: MIT Press.

Giner-Sorolla, R., Bosson, J. K., Caswell, T. A., & Hettinger, E. (2012). Emotions in sexual morality: Testing the separate elicitors of anger and disgust. *Cognition & Emotion, 26,* 1208–1222. doi:10.1080/02699931.2011.645278

Giner-Sorolla, R., & Espinosa, P. (2011). Social cuing of guilt by anger and of shame by disgust. *Psychological Science, 22,* 49–53. doi:10.1177/0956797610392925

Gosselin, P., & Laroque, C. (2000). Facial morphology and children's categorization of facial expressions of emotions: A comparison between Asian and Caucasian faces. *Journal of Genetic Psychology: Research and Theory on Human Development, 161,* 346–358. doi:10.1080/00221320009596717

Gosselin, P., Roberge, P., & Lavalée, M. F. (1995). Le développement de la reconnaissance des expressions faciales émotionnelles du répertoire humain [The development of recognition of human facial expressions of emotion]. *Enfance, 48,* 379–396. doi:10.3406/enfan.1995.2144

Grinspan, D., Hemphill, A., & Nowicki, S. (2003). Improving the ability of elementary school-age children to identify emotion in facial expression. *Journal of Genetic Psychology: Research and Theory on Human Development, 164,* 88–100. doi:10.1080/00221320309597505

Gur, R. C., Sara, R., Hagendoorn, M., Marom, O., Hughett, P., Macy, L. . . . Gur, R. E. (2002). A method for obtaining 3-dimensional facial expressions and its standardization for use in neurocognitive studies. *Journal of Neuroscience Methods, 115,* 137–143. doi:10.1016/S0165-0270(02)00006-7

Haidt, J. (2003). The moral emotions. In R. J. Davidson, K. R. Scherer, & H. H. Goldsmith (Eds.), *Handbook of affective sciences* (pp. 852–870). Oxford, England: Oxford University Press.

Haidt, J., & Keltner, D. (1999). Culture and facial expression: Open-ended methods find more expressions and a gradient of recognition. *Cognition & Emotion, 13,* 225–266. doi:10.1080/026999399379267

Harrigan, J. A. (1984). The effect of task order on children's identification of facial expressions. *Motivation and Emotion, 8,* 157–169. doi:10.1007/BF00993071

Harris, P. L. (1989). *Children and emotion: The development of psychological understanding.* Oxford, England: Basil Blackwell.

Hart, B. L. (1990). Behavioral adaptations to pathogens and parasites: Five strategies. *Neuroscience & Biobehavioral Reviews, 14,* 273–294. doi:10.1016/S0149-7634(05)80038-7

Haviland, J. M., & Lelwica, M. (1987). The induced affect response: 10-week-old infants' responses to three emotion expressions. *Developmental Psychology, 23,* 97–104. doi:10.1037/0012-1649.23.1.97

Herba, C. M., Benson, P., Landau, S., Russell, T., Goodwin, C., Lemche, E. . . . Phillips, M. (2008). Impact of familiarity upon children's developing facial expression recognition. *Journal of Child Psychology and Psychiatry, 49,* 201–210. doi:10.1111/j.1469-7610.2007.01835.x

Herba, C. M., Landau, S., Russell, T., Ecker, C., & Phillips, M. L. (2006). The development of emotion-processing in children: Effects of age, emotion, and intensity. *Journal of Child Psychology and Psychiatry, 47,* 1098–1106. doi:10.1111/j.1469-7610.2006.01652.x

Herz, R. (2012). *That's disgusting: Unraveling the mysteries of repulsion.* New York: NY: Norton.

Herz, R. S., & von Clef, J. (2001). The influence of verbal labeling on the perception of odors: Evidence for olfactory illusions? *Perception, 30,* 381–391. doi:10.1068/p3179

Heuer, K., Lange, W. G., Isaac, L., Rinck, M., & Becker, E. S. (2010). Morphed emotional faces: Emotional detection and misinterpretation in social anxiety. *Journal of Behavior Therapy and Experimental Psychiatry, 41,* 418–425. doi:10.1016/j.jbtep.2010.04.005

Hjortsjö, C. H. (1969). *Man's face and mimic language.* Lund, Sweden: Studentlitteratur.

Hosie, J. A., Gray, C. D., Russell, P. A., Scott, C., & Hunter, N. (1998). The matching of facial expressions by deaf and hearing children and their production and comprehension of emotion labels. *Motivation and Emotion, 22,* 293–313. doi:10.1023/A:1021352323157

Izard, C. E. (1971). *The face of emotion.* New York, NY: Appleton Century Crofts.

Izard, C. E. (1979). *The maximally discriminant facial movement coding system (MAX).* Available from Instructional Resource Center, University of Delaware, Newark, Delaware.

Izard, C. E. (1994). Innate and universal facial expressions: Evidence from developmental and cross-cultural research. *Psychological Bulletin, 115,* 288–299. doi:10.1037/0033-2909.115.2.288

Izard, C. E. (2011). Forms and functions of emotions: Matters of emotion–cognition interactions. *Emotion Review, 3,* 371–378. doi:10.1177/1754073911410737

Jabbi, M., Bastiaansen, J., & Keysers, C. (2008). A common anterior insula representation of disgust observation, experience and imagination shows divergent functional connectivity pathways. *PLoS ONE, 3*(8), e2939. doi:10.1371/journal.pone.0002939

Jack, R. E., Blais, C., Scheepers, C., Schyns, P. G., & Caldara, R. (2009). Cultural confusions show that facial expressions are not universal. *Current Biology, 19,* 1543–1548. doi:10.1016/j.cub.2009.07.051

Jack, R. E., Caldara, R., & Schyns, P. G. (2012). Internal representations reveal cultural diversity in expectations of facial expressions of emotion. *Journal of Experimental Psychology: General, 141,* 19–25. doi:10.1037/a0023463

Jarros, R. B., Salum, G. A., Belum da Silva, C. T., Toazza, R., Costa, M. A., Salles, J. F., & Manfro, G. G. (2012). Anxiety disorders in

adolescence are associated with impaired facial expression recognition to negative valence. *Journal of Psychiatric Research, 46,* 147–151. doi:10.1016/j.jpsychires.2011.09.023

Jones, C. R. G., Pickles, A., Falcaro, M., Marsden, A. J. S., Happé, F., Scott, S. K., . . . Charman, T. (2011). A multimodal approach to emotion recognition ability in autism spectrum disorders. *Journal of Child Psychology and Psychiatry, 52,* 275–285. doi:10.1111/j.1469-7610.2010.02328.x

Kayyal, M. H., & Russell, J. A. (2012). *Americans and Palestinians judge spontaneous facial expressions of emotion*. Manuscript submitted for publication.

Kayyal, M. H., Widen, S. C., & Russell, J. A. (2012a). *Palestinian and American children's understanding of facial expressions of emotion*. Manuscript in preparation.

Kayyal, M. H., Widen, S. C., & Russell, J. A. (2012b). *Palestinian and American children's understanding of emotion from facial expressions, situational causes, and behavioral consequences*. Manuscript in preparation.

Kellogg, W. N., & Eagleson, B. M. (1931). The growth of social perception in different racial groups. *Journal of Educational Psychology, 22,* 367–375. doi:10.1037/h0071038

Kessler, H., Roth, J., von Wietersheim, J., Deighton, R. M., & Traue, H. C. (2007). Emotion recognition patterns in patients with panic disorder. *Depression and Anxiety, 24,* 223–226. doi:10.1002/da.20223

Ketelaar, T., Davis, J., & Mena, F. (2011). *Kith, kin, and disgust: Evidence for a kin-directed signaling of emotion*. Poster presented at the meeting of the Society for Personality and Social Psychology, San Antonio, TX.

Klinnert, M. D., Emde, R. N., Butterfield, P., & Campos, J. J. (1986). Social referencing: The infant's use of emotional signals from a friendly adult with mother present. *Developmental Psychology, 22,* 427–432. doi:10.1037/0012-1649.22.4.427

Lang, P. J., Greenwald, M. K., Bradley, M. M., & Hamm, A. O. (1993). Looking at pictures: Affective, facial, visceral, and behavioral reactions. *Psychophysiology, 30,* 261–273. doi:10.1111/j.1469-8986.1993.tb03352.x

Lariviere, L. A. (2005). *Children and the emotion of disgust*. Unpublished doctoral dissertation, Tufts University.

Larsen, J. T., Berntson, G. G., Poehlmann, K. M., Ito, T. A., & Cacioppo, J. T. (2008). The psychophysiology of emotion. In R. Lewis, J. M. Haviland-Jones, & L. F. Barrett (Eds.), *The handbook of emotions* (3rd ed., pp. 180–195). New York, NY: Guilford Press.

Lawrence, N. S., Kyoon, A. S., Mataix-Cols, D., Florian, R., Speckens, A., & Phillips, M. L. (2007). Neural responses to facial expressions of disgust but not fear are modulated by washing symptoms in OCD. *Biological Psychiatry, 61,* 1072–1080. doi:10.1016/j.biopsych.2006.06.033

Law Smith, M. J., Montagne, B., Perrett, D. I., Gill, M., & Gallagher, L. (2010). Detecting subtle facial emotion recognition deficits in high-functioning autism using dynamic stimuli of varying intensities. *Neuropsychologia, 48,* 2777–2781. doi:10.1016/j.neuropsychologia.2010.03.008

Lench, H. C., Flores, S. A., & Bench, S. W. (2011). Discrete emotions predict changes in cognition, judgment, experience, behavior, and physiology: A meta-analysis of experimental emotion elicitations. *Psychological Bulletin, 137,* 834–855. doi:10.1037/a0024244

Leppänen, J. M., & Nelson, C. A. (2006). The development and neural bases of facial emotion recognition. In R. J. Kail (Ed.), *Advances in child development and behavior* (pp. 207–246). San Diego, CA: Academic Press. doi:10.1016/S0065-2407(06)80008-X

Levenson, R. W. (2011). Basic emotion questions. *Emotion Review, 3,* 379–386. doi:10.1177/1754073911410743

Lindquist, K. A., Barrett, L. F., Bliss-Moreau, E., & Russell, J. A. (2006). Language and the perception of emotion. *Emotion, 6,* 125–138. doi:10.1037/1528-3542.6.1.125

Lindquist, K. A., Siegel, E. H., Quigley, K. S., & Barrett, L. F. (2012). The hundred-year emotion war: Are emotions natural kinds or psychological constructions? Comment on Lench, Flores, and Bench (2011). *Psychological Bulletin*. Advance online publication. doi:10.1037/a0029038

Lindquist, K. A., Wager, T. D., Kober, H., Bliss-Moreau, E., & Barrett, L. F. (2012). The brain basis of emotion: A meta-analytic review. *Behavioral and Brain Sciences, 35,* 121–143. doi:10.1017/S0140525X11000446

Lumley, M. A., & Melamed, B. G. (1992). Blood phobics and nonphobics: Psychological differences and affect during exposure. *Behaviour Research and Therapy, 30,* 425–434. doi:10.1016/0005-7967(92)90026-D

Ma, R., Pochedly, J. T., & Widen, S. C. (2012). *Emotion stories are stronger cues to emotion than are facial expressions for older children and adolescents*. Manuscript in preparation.

MacWhinney, B. (2000). *The CHILDES Project: Tools for analyzing talk: Vol. 2. The database* (3rd ed.). Mahwah, NJ: Erlbaum.

Marian, D. E., & Shimamura, A. P. (2012). Emotions in context: Pictorial influences on affective attributions. *Emotion, 12,* 371–375. doi:10.1037/a0025517

Markham, R., & Adams, K. (1992). The effect of type of task on children's identification of facial expressions. *Journal of Nonverbal Behavior, 16,* 21–39. doi:10.1007/BF00986877

Markham, R., & Wang, L. (1996). Recognition of emotion by Chinese and Australian children. *Journal of Cross-Cultural Psychology, 27,* 616–643. doi:10.1177/0022022196275008

Massarani, R., Gosselin, P., Montembeault, P., Gagnon, M., & Suurland, A. (2011). *French-speaking children's freely produced labels for facial expressions*. Poster presented at the meeting of the Society for Research in Child Development, Montreal, Quebec, Canada.

Matsumoto, D., & Ekman, P. (1988). *Japanese and Caucasian facial expressions of emotion (JACFEE)*. Available from David Matsumoto, Department of Psychology, San Francisco State University, 1600 Holloway, San Francisco, CA, 94132.

Maynard Smith, J., & Harper, D. (2003). *Animal signals*. New York, NY: Oxford University Press.

McDougall, W. (1960). *An introduction to social psychology*. London, England: Methuen. (Original work published 1908)

Michalson, L., & Lewis, M. (1985). What do children know about emotion and when do they know it? In M. Lewis & C. Saarni (Eds.), *The socialization of emotions* (pp. 117–139). New York, NY: Plenum Press. doi:10.1007/978-1-4613-2421-8_6

Miller, A. L., Fine, S. E., Gouley, K. K., Seifer, R., Dickstein, S., & Shields, A. (2006). Showing and telling about emotions: Interrelations between facets of emotional competence and associations with classroom adjustment in Head Start preschoolers. *Cognition & Emotion, 20,* 1170–1192. doi:10.1080/02699930500405691

Montagne, B., Schutters, S., Westenberg, H. G., van Honk, J., Kessels, R. P., & de Haan, E. H. (2006). Reduced sensitivity in the recognition of anger and disgust in social anxiety disorder. *Cognitive Neuropsychiatry, 11,* 389–401. doi:10.1080/13546800444000254

Montirosso, R., Peverelli, M., Frigerio, E., Crespi, M., & Borgatti, R. (2010). The development of dynamic facial expression recognition at different intensities in 4- to 18-year-olds. *Social Development, 19,* 71–92. doi:10.1111/j.1467-9507.2008.00527.x

Moriguchi, Y., Ohnishi, T., Kawachi, T., Mori, T., Hirakata, M., Yamada, M. . . . Komaki, G. (2005). Specific brain activation in Japanese and Caucasian people to fearful faces. *NeuroReport, 16,* 133–136. doi:10.1097/00001756-200502080-00012

Moses, L. J., Baldwin, D. A., Rosicky, J. G., & Tidball, G. (2001). Evidence for referential understanding in the emotions domain at twelve and eighteen months. *Child Development, 72,* 718–735. doi:10.1111/1467-8624.00311

Mullins, D. T., & Duke, M. P. (2004). Effects of social anxiety on nonverbal accuracy and response time I: Facial expressions. *Journal of*

Nonverbal Behavior, 28, 3–33. doi:10.1023/B:JONB.0000017865 .24656.98

Muris, P., Huijding, J., Mayer, B., Leemreis, W., Passchier, S., & Bouw-meester, S. (2009). The effects of verbal disgust- and threat-related information about novel animals on disgust and fear beliefs and avoidance in children. *Journal of Clinical Child & Adolescent Psychology, 38,* 551–563. doi:10.1080/15374410902976379

Murphy, F. C., Nimmo-Smith, I., & Lawrence, A. D. (2003). Functional neuroanatomy of emotions: A meta-analysis. *Cognitive, Affective, & Behavioral Neuroscience, 3,* 207–233. doi:10.3758/CABN.3.3.207

Naab, P. J., & Russell, J. A. (2007). Judgments of emotion from spontaneous facial expressions of New Guineans. *Emotion, 7,* 736–744. doi: 10.1037/1528-3542.7.4.736

Nelson, C. A., & Dolgin, K. G. (1985). The generalized discrimination of facial expressions by seven-month-old infants. *Child Development, 56,* 58–61. doi:10.2307/1130173

Nelson, N. L., Hudspeth, K., & Russell, J. A. (2012). *Story, still face, or dynamic expression: Which is the best cue to emotion for children?* Manuscript submitted for publication.

Nelson, N. L., & Russell, J. A. (2012). *A facial expression of pax: Revisiting children's "recognition of expressions."* Manuscript in preparation.

Nelson, N. L., & Russell, J. A. (in press). Universality revisited. *Emotion Review.*

Nunner-Winkler, G., & Sodian, B. (1988). Children's understanding of moral emotions. *Child Development, 59,* 1323–1338. doi:10.2307/ 1130495

Oaten, M., Stevenson, R. J., & Case, T. I. (2009). Disgust as a disease-avoidance mechanism. *Psychological Bulletin, 135,* 303–321. doi: 10.1037/a0014823

Olatunji, B. O., & McKay, D. (2007). Disgust and psychiatric illness: Have we remembered? *British Journal of Psychiatry, 190,* 457–459. doi: 10.1192/bjp.bp.106.032631

Panksepp, J. (2004). *Affective neuroscience: The foundations of human and animal emotions.* Oxford, England: Oxford University Press.

Parkinson, B. (2005). Do facial movements express emotions or communicate motives? *Personality and Social Psychology Review, 9,* 278–311. doi:10.1207/s15327957pspr0904_1

Penfield, W., & Faulk, M. E. (1955). The insula: Further observations on its function. *Brain, 78,* 445–470. doi:10.1093/brain/78.4.445

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,* 331–348. doi:10.1006/nimg.2002 .1087

Phillips, M. L., Fahy, T., David, A. S., & Senior, C. (1998). Disgust: The forgotten emotion of psychiatry. *British Journal of Psychiatry, 172,* 373–375. doi:10.1192/bjp.172.5.373

Pochedly, J. T., Widen, S. C., & Russell, J. A. (2012). What emotion does the "facial expression of disgust" express? *Emotion, 12,* 1315–1319. doi:10.1037/a0027998

Pochedly, J. T., & Zeman, J. L. (2012). *Children match the angry face with immoral stories.* Manuscript in preparation.

Pollak, S. D., Cicchetti, D., Hornung, K., & Reed, A. (2000). Recognizing emotion in faces: Developmental effects of child abuse and neglect. *Developmental Psychology, 36,* 679–688. doi:10.1037/0012-1649.36.5 .679

Pollak, S. D., & Sinha, P. (2002). Effects of early experience on children's recognition of facial displays of emotion. *Developmental Psychology, 38,* 784–791. doi:10.1037/0012-1649.38.5.784

Porges, S. W. (2003). The polyvagal theory: Phylogenetic contributions to social behavior. *Physiology & Behavior, 79,* 503–513. doi:10.1016/ S0031-9384(03)00156-2

Posner, M. I., & Rothbart, M. K. (2007). Research on attention networks as a model for the integration of psychological science. *Annual Review of Psychology, 58,* 1–23. doi:10.1146/annurev.psych.58.110405.085516

Prinz, J. J. (2007). *The emotional construction of morals.* Oxford, England: Oxford University Press.

Raman, L., & Gelman, S. A. (2008). Do children endorse psychosocial factors in the transmission of illness and disgust? *Developmental Psychology, 44,* 801–813. doi:10.1037/0012-1649.44.3.801

Raver, C. C., Garner, P. W., & Smith-Donald, R. (2007). The roles of emotion regulation and emotion knowledge for children's academic readiness: Are the links causal? In R. C. Pianta, M. J. Cox, & K. L. Snow (Eds.), *School readiness and the transition to kindergarten in the era of accountability* (pp. 121–147). Baltimore, MD: Paul H Brookes.

Reichenbach, L., & Masters, J. C. (1983). Children's use of expressive and contextual cues in judgments of emotion. *Child Development, 54,* 993–1004. doi:10.2307/1129903

Reisenzein, R. (2007). *The case of disgust.* Unpublished presentation, University of Greifswald, Germany.

Reisenzein, R., Studtmann, M., & Horstmann, G. (in press). Coherence between emotion and facial expression: Evidence from laboratory experiments. *Emotion Review.*

Repacholi, B. M. (1998). Infants' use of attentional cues to identify the referent of another person's emotional expression. *Developmental Psychology, 34,* 1017–1025. doi:10.1037/0012-1649.34.5.1017

Repacholi, B. M., & Gopnik, A. (1997). Early reasoning about desires: Evidence from 14- and 18-month-olds. *Developmental Psychology, 33,* 12–21. doi:10.1037/0012-1649.33.1.12

Rich, B. A., Grimley, M. E., Schmajuk, M., Blair, K. S., Blair, R. J. R., & Leibenluft, E. (2008). Face emotion labeling deficits in children with bipolar disorder and severe mood dysregulation. *Development and Psychopathology, 20,* 529–546. doi:10.1017/S0954579408000266

Ridgeway, D., Waters, E., & Kuczaj, S. A. (1985). Acquisition of emotion-descriptive language: Receptive and productive vocabulary norms for ages 18 months to 6 years. *Developmental Psychology, 21,* 901–908. doi:10.1037/0012-1649.21.5.901

Rieffe, C., Meerum Terwogt, M., & Jellesma, F. C. (2008). Emotional competence and health in children. In A. Vingerhoets, I. Nyklícek, & J. Denollet (Eds.), *Emotion regulation: Conceptual and clinical issues* (pp. 184–201). New York, NY: Springer Science + Business Media.

Ritz, T., Thons, M., Fahrenkrug, S., & Dahme, B. (2005). Airways, respiration, and respiratory sinus arrhythmia during picture viewing. *Psychophysiology, 42,* 568–578. doi:10.1111/j.1469-8986.2005.00312.x

Roberson, D., Damjanovic, L., & Kikutani, M. (2010). Show and tell: The role of language in categorizing facial expression of emotion. *Emotion Review, 2,* 255–260. doi:10.1177/1754073910361979

Roberson, D., Kikutani, M., Döge, P., Whitaker, L., & Majid, A. (2012). *Who's happy now? Developmental changes in emotion classification from facial expressions.* Manuscript submitted for publication.

Rosen, A. B., & Rozin, P. (1993). Now you see it, now you don't: The preschool child's conception of invisible particles in the context of dissolving. *Developmental Psychology, 29,* 300–311. doi:10.1037/0012-1649.29.2.300

Rosenberg, E. L., & Ekman, P. (1994). Coherence between expressive and experiential systems in emotion. *Cognition & Emotion, 8,* 201–229. doi:10.1080/02699939408408938

Rosenstein, D., & Oster, H. (1988). Differential facial responses to four basic tastes in newborns. *Child Development, 59,* 1555–1568. doi: 10.2307/1130670

Rossignol, M., Anselme, C., Vermeulen, N., Philippot, P., & Campanella, S. (2007). Categorical perception of anger and disgust facial expression is affected by non-clinical social anxiety: An ERP study. *Brain Research, 1132,* 166–176. doi:10.1016/j.brainres.2006.11.036

Rozin, P., & Fallon, A. E. (1987). A perspective on disgust. *Psychological Review, 94,* 23–41. doi:10.1037/0033-295X.94.1.23

Rozin, P., Fallon, A. E., & Augustoni-Ziskind, M. (1985). The child's conception of food: The development of contamination sensitivity to "disgusting" substances. *Developmental Psychology, 21,* 1075–1079. doi:10.1037/0012-1649.21.6.1075

Rozin, P., Fallon, A. E., & Mandell, R. (1984). Family resemblance in attitudes to foods. *Developmental Psychology, 20,* 309–314. doi:10.1037/0012-1649.20.2.309

Rozin, P., Haidt, J., & McCauley, C. R. (1993). Disgust. In M. Lewis & J. M. Haviland (Eds.), *Handbook of emotions* (pp. 575–594). New York, NY: Guilford Press.

Rozin, P., Haidt, J., & McCauley, C. R. (2000). Disgust. In M. Lewis & J. M. Haviland-Jones (Eds.), *Handbook of emotion* (pp. 637–653). New York, NY: Guilford Press.

Rozin, P., Haidt, J., & McCauley, C. R. (2008). Disgust. In M. Lewis, J. M. Haviland-Jones, & L. F. Barrett (Eds.), *Handbook of emotions* (3rd ed., pp. 757–776). New York, NY: Guilford Press.

Rozin, P., Haidt, J., McCauley, C. R., Dunlop, L., & Ashmore, M. (1999). Individual differences in disgust sensitivity: Comparisons and evaluations of paper-and pencil versus behavioral measures. *Journal of Research in Personality, 33,* 330–351. doi:10.1006/jrpe.1999.2251

Rozin, P., Hammer, L., Oster, H., Horowitz, T., & Marmora, V. (1986). The child's conception of food: Differentiation of categories of rejected substances in the 16 months to 5 year age range. *Appetite, 7,* 141–151. doi:10.1016/S0195-6663(86)80014-9

Rozin, P., Lowery, L., & Ebert, R. (1994). Varieties of disgust faces and the structure of disgust. *Journal of Personality and Social Psychology, 66,* 870–881. doi:10.1037/0022-3514.66.5.870

Russell, J. A. (1991). Culture and the categorization of emotions. *Psychological Bulletin, 110,* 426–450. doi:10.1037/0033-2909.110.3.426

Russell, J. A. (1993). Forced-choice response format in the study of facial expression. *Motivation and Emotion, 17,* 41–51. doi:10.1007/BF00995206

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. doi:10.1037/0033-2909.115.1.102

Russell, J. A. (1995). Facial expressions of emotion: What lies beyond minimal universality? *Psychological Bulletin, 118,* 379–391. doi:10.1037/0033-2909.118.3.379

Russell, J. A., & Bullock, M. (1986). Fuzzy concepts and the perception of emotion in facial expressions. *Social Cognition, 4,* 309–341. doi:10.1521/soco.1986.4.3.309

Russell, J. A., & Paris, F. A. (1994). Do children acquire concepts for complex emotions abruptly? *International Journal of Behavioral Development, 17,* 349–365. doi:10.1177/016502549401700207

Russell, J. A., & Widen, S. C. (2002a). A label superiority effect in children's categorization of facial expressions. *Social Development, 11,* 30–52. doi:10.1111/1467-9507.00185

Russell, J. A., & Widen, S. C. (2002b). Words versus faces in evoking children's knowledge of the causes of emotions. *International Journal of Behavioral Development, 26,* 97–103. doi:10.1080/01650250042000582

Sarlo, M., & Munafò, M. (2010). When faces signal danger: Event-related potentials to emotional facial expressions in animal phobics. *Neuropsychobiology, 62,* 235–244. doi:10.1159/000319950

Sato, W., Uono, S., Matsuura, N., & Toichi, M. (2009). Misrecognition of facial expressions in delinquents. *Child and Adolescent Psychiatry and Mental Health, 3*(27). doi:10.1186/1753-2000-3-27

Sawchuk, C. N. (2009). The acquisition and maintenance of disgust: Developmental and learning perspectives. In B. O. Olatunji & D. McKay (Eds.), *Disgust and its disorders: Theory, assessment, and treatment implications* (pp. 77–97). Washington, DC: American Psychological Association.

Schaller, M., & Park, J. (2011). The behavioral immune system (and why it matters). *Current Directions in Psychological Science, 20,* 99–103. doi:10.1177/0963721411402596

Schienle, A., Schäfer, A., Stark, R., Walter, B., & Vaitl, D. (2005). Gender differences in the processing of disgust- and fear-inducing pictures: An fMRI study. *NeuroReport, 16,* 277–280. doi:10.1097/00001756-200502280-00015

Schmidt, H. J., & Beauchamp, G. K. (1988). Adult-like odor preferences and aversions in three-year-old children. *Child Development, 59,* 1136–1143. doi:10.2307/1130280

Schofield, C. A., Coles, M. E., & Gibb, B. E. (2007). Social anxiety and interpretation biases for facial displays of emotion: Emotion detection and ratings of social cost. *Behaviour Research and Therapy, 45,* 2950–2963. doi:10.1016/j.brat.2007.08.006

Siegal, M. (1988). Children's knowledge of contagion and contamination as causes of illness. *Child Development, 59,* 1353–1359. doi:10.2307/1130497

Siegal, M., & Share, D. L. (1990). Contamination sensitivity in young children. *Developmental Psychology, 26,* 455–458. doi:10.1037/0012-1649.26.3.455

Simonian, S. J., Beidel, D., Turner, S. M., Berkes, J. L., & Long, J. H. (2001). Recognition of facial affect by children and adolescents diagnosed with social phobia. *Child Psychiatry and Human Development, 32,* 137–145. doi:10.1023/A:1012298707253

Smetana, J. G., Rote, W. M., Jambon, M., Tasopoulos-Chan, M., Villalobos, M., & Comer, J. (2012). Developmental changes and individual differences in young children's moral judgments. *Child Development, 83,* 683–696. doi:10.1111/j.1467-8624.2011.01714.x

Smiley, P., & Huttenlocher, J. (1989). Young children's acquisition of emotion concepts. In C. Saarni & P. Harris (Eds.), *Children's understanding of emotions* (pp. 27–49). New York, NY: Cambridge University Press.

Sorenson, E. R. (1976). *The edge of the forest: Land, childhood and change in a New Guinea protoagricultural society*. Washington, DC: Smithsonian Institution Press.

Soussignan, R., & Schaal, B. (1996). Children's facial responsiveness to odors: Influences of hedonic valence of odor, gender, age, and social presence. *Developmental Psychology, 32,* 367–379. doi:10.1037/0012-1649.32.2.367

Soussignan, R., Schaal, B., Marlier, L., & Jiang, T. (1997). Facial and autonomic responses to biological and artificial olfactory stimuli in human neonates: Re-examining early hedonic discrimination of odors. *Physiology and Behavior, 62,* 745–758. doi:10.1016/S0031-9384(97)00187-X

Sprengelmeyer, R., Rausch, M., Eysel, U. T., & Przuntek, H. (1998). Neural structures associated with recognition of facial expressions of basic emotions. *Proceedings of the Royal Society B: Biological Sciences, 265,* 1927–1931. doi:10.1098/rspb.1998.0522

Sprengelmeyer, R., Young, A. W., Calder, A. J., Karnat, A., Lange, H., Homberg, V. . . . Rowland, D. (1996). Loss of disgust: Perception of faces and emotions in Huntington's disease. *Brain: A Journal of Neurology, 119,* 1647–1665. doi:10.1093/brain/119.5.1647

Stark, R., Zimmermann, M., Kagerer, S., Schienle, A., Walter, B., Weygandt, M., & Vaitl, D. (2007). Hemodynamic brain correlates of disgust and fear ratings. *NeuroImage, 37,* 663–673. doi:10.1016/j.neuroimage.2007.05.005

Stein, M., Ottenberg, P., & Roulet, N. (1958). A study of the development of olfactory preferences. *Archives of Neurology & Psychiatry, 80,* 264–266. doi:10.1001/archneurpsyc.1958.02340080134028

Stevenson, R. J., Oaten, M. J., Case, T. I., Repacholi, B. M., & Wagland, P. (2010). Children's response to adult disgust elicitors: Development and acquisition. *Developmental Psychology, 46,* 165–177. doi:10.1037/a0016692

Thielscher, A., & Pessoa, L. (2007). Neural correlates of perceptual choice and decision making during fear–disgust discrimination. *Journal of Neuroscience, 27,* 2908–2917. doi:10.1523/JNEUROSCI.3024-06.2007

Tomkins, S. S. (1962). *Affect, imagery, consciousness: Vol. I. The positive affects*. New York, NY: Springer.

Tomkins, S. S., & McCarter, R. (1964). What and where are the primary affects? Some evidence for a theory. *Perceptual and Motor Skills, 18,* 119–158. doi:10.1017/CBO9780511663994.015

Tottenham, N., Tanaka, J. W., Leon, A. C., McCarry, T., Nurse, M., Hare T. A. . . . Nelson, C. (2009). The NimStim set of facial expressions: Judgments from untrained research participants. *Psychiatry Research, 168,* 242–249. doi:10.1016/j.psychres.2008.05.006

Toyama, N. (1999). Developmental changes in the basis of associational contamination thinking. *Cognitive Development, 14,* 343–361. doi:10.1016/S0885-2014(99)00008-8

Tracy, J. L., & Robins, R. W. (2008). The automaticity of emotion recognition. *Emotion, 8,* 81–95. doi:10.1037/1528-3542.8.1.81

Tracy, J. L., Robins, R. W., & Schriber, R. A. (2009). Development of a FACS-verified set of basic and self-conscious emotion expressions. *Emotion, 9,* 554–559. doi:10.1037/a0015766

Tremblay, C., Kirouac, G., & Dore, F. Y. (1987). The recognition of adults' and children's facial expressions of emotions. *Journal of Psychology: Interdisciplinary and Applied, 121,* 341–350. doi:10.1080/00223980.1987.9712674

Trentacosta, C. J., & Izard, C. E. (2007). Kindergarten children's emotion competence as a predictor of their academic competence in first grade. *Emotion, 7,* 77–88. doi:10.1037/1528-3542.7.1.77

Turiel, E. (1983). *The development of social knowledge: Morality and convention*. Cambridge, England: Cambridge University Press.

Ulutaş, I., & Ömeroğlu, E. (2007). The effects of an emotional intelligence education program on the emotional intelligence of children. *Social Behavior and Personality, 35,* 1365–1372. doi:10.2224/sbp.2007.35.10.1365

van der Schalk, J., Hawk, S. T., Fischer, A. H., & Doosje, B. (2011). Moving faces, looking places: Validation of the Amsterdam Dynamic Facial Expression Set (ADFES). *Emotion, 11,* 907–920. doi:10.1037/a0023853

Vernon, L. L., & Berenbaum, H. (2002). Disgust and fear in response to spiders. *Cognition & Emotion, 16,* 809–830. doi:10.1080/02699930143000464

Vicari, S., Reilly, J. S., Pasqualetti, P., Vizzotto, A., & Caltagirone, C. (2000). Recognition of facial expression of emotions in school-age children: The intersection of perceptual and semantic categories. *Acta Pæ´ditr, 89,* 836–845. doi:10.1007/s100720050019

Von dem Hagen, E. A. H., Beaver, J. D., Ewbank, M. P., Keane, J., Passamonti, L., Lawrence, A. D., & Calder, A. J. (2009). Leaving a bad taste in your mouth but not in my insula. *Social, Cognitive, and Affective Neuroscience, 4,* 379–386. doi:10.1093/scan/nsp01

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. doi:10.1162/jocn.2009.21366

Walker, D. W., & Leister, C. (1994). Recognition of facial affect cues by adolescents with emotional and behavioral disorders. *Behavioral Disorders, 19,* 269–276.

Walker, E., Marwit, S., & Emory, E. (1980). A cross-sectional study of emotion recognition in schizophrenics. *Journal of Abnormal Psychology, 89,* 428–436. doi:10.1037/0021-843X.89.3.428

Walker-Andrews, A. (2005). Perceiving social affordances: The development of emotional understanding. In B. D. Homer & C. S. Tamis-LeMonda (Eds.), *The development of social cognition and communication* (pp. 93–116). Mahwah, NJ: Erlbaum.

Wellman, H. M., Harris, P. L., Banerjee, M., & Sinclair, A. (1995). Early understanding of emotion: Evidence from natural language. *Cognition & Emotion, 9,* 117–149. doi:10.1080/02699939508409005

Wicker, B., Keysers, C., Plailly, J., Royet, J. P., Gallese, V., & Rizzolatti, G. (2003). Both of us disgusted in my insula: The common neural basis

of seeing and feeling disgust. *Neuron, 40,* 655–664. doi:10.1016/S0896-6273(03)00679-2

Widen, S. C. (2005). Preschoolers' use of emotion labels and understanding of emotion categories. *Dissertation Abstracts International: Section B: The Sciences and Engineering, 65*(12-B), 6692.

Widen, S. C. (in press). Children's interpretation of other's facial expressions. *Emotion Review*.

Widen, S. C., Acevedo, L., Gallucci, J., & Russell, J. A. (2011). *The power of posture and external situation over facial expression on attributions of emotion*. Manuscript in preparation.

Widen, S. C., Christy, A. M., Hewett, K., & Russell, J. A. (2011). Do proposed facial expressions of contempt, shame, embarrassment, and sympathy communicate the predicted emotion? *Cognition & Emotion, 25,* 898–906. doi:10.1080/02699931.2010.508270

Widen, S. C., & Naab, P. (2012). Can an anger face also be scared? Malleability of facial expressions. *Emotion, 12,* 919–925. doi:10.1037/a0026119

Widen, S. C., & Russell, J. A. (2002). Gender and preschoolers' perception of emotion. *Merrill-Palmer Quarterly, 48,* 248–262. doi:10.1353/mpq.2002.0013

Widen, S. C., & Russell, J. A. (2003). A closer look at preschoolers' freely produced labels for facial expressions. *Developmental Psychology, 39,* 114–128. doi:10.1037/0012-1649.39.1.114

Widen, S. C., & Russell, J. A. (2004). The relative power of an emotion's facial expression, label, and behavioral consequences to evoke preschoolers' knowledge of its cause. *Cognitive Development, 19,* 111–125. doi:10.1016/j.cogdev.2003.11.004

Widen, S. C., & Russell, J. A. (2008a). Children acquire emotion categories gradually. *Cognitive Development, 23,* 291–312. doi:10.1016/j.cogdev.2008.01.002

Widen, S. C., & Russell, J. A. (2008b). Children's and adults' understanding of the "disgust face". *Cognition & Emotion, 22,* 1513–1541. doi:10.1080/02699930801906744

Widen, S. C., & Russell, J. A. (2008c). Young children's understanding of other's emotions. In M. Lewis & J. M. Haviland-Jones (Eds.), *Handbook of emotions* (pp. 348–363). New York, NY: Guilford Press.

Widen, S. C., & Russell, J. A. (2010a). Children's scripts for social emotions: Causes and consequences are more central than are facial expressions. *British Journal of Developmental Psychology, 28,* 565–581. doi:10.1348/026151009X457550d

Widen, S. C., & Russell, J. A. (2010b). Differentiation in preschooler's categories for emotion. *Emotion, 10,* 651–661. doi:10.1037/a0019005

Widen, S. C., & Russell, J. A. (2010c). To children the "disgust face" conveys anger. *Emotion, 10,* 455–466. doi:10.1037/a0019151

Widen, S. C., & Russell, J. A. (2011). In building a script for an emotion, do preschoolers add its cause before its behavior consequence? *Social Development, 20,* 471–485. doi:10.1111/j.1467-9507.2010.00594.x

Widen, S. C., & Russell, J. A. (2012a). *Children's understanding of disgusted, yucky, and grossed out in a story-telling task*. Manuscript in preparation.

Widen, S. C., & Russell, J. A. (2012b). *Dynamic vs. still facial expressions: Do older children's free labeling responses show an advantage for one?* Manuscript in preparation.

Wierzbicka, A. (1992). Defining emotion concepts. *Cognitive Science, 16,* 539–581. doi:10.1207/s15516709cog1604_4

Wierzbicka, A. (1994). Emotion, language, and cultural scripts. In S. Kitayama & H. R. Markus (Eds.), *Emotion and culture: Empirical studies of mutual influence* (pp. 133–196). Washington, DC: American Psychological Association. doi:10.1037/10152-004

Wiggers, M., & van Lieshout, C. F. M. (1985). Development of recognition of emotions: Children's reliance on situational and facial expressive cues. *Developmental Psychology, 21,* 338–349. doi:10.1037/0012-1649.21.2.338

Williams, L. M., Mathersul, D., Palmer, D. M., Gur, R. C., Gur, R. E., & Gordon, E. (2008). Explicit identification and implicit recognition of facial emotions: I. Age effects in males and females across 10 decades. *Journal of Clinical and Experimental Neuropsychology, 31,* 257–277. doi:10.1080/13803390802255635

Wolfgang, A., & Cohen, M. (1988). Sensitivity of Canadians, Latin Americans, Ethiopians, and Israelis to interracial facial expressions of emotions. *International Journal of Intercultural Relations, 12,* 139–151. doi:10.1016/0147-1767(88)90045-4

Yik, M., Widen, S. E., & Russell, J. A. (in press). The within-subject design in the study of facial expressions. *Cognition & Emotion*.

Yuki, M., Maddux, W. W., & Masuda, T. (2007). Are the windows to the soul the same in the East and West? Cultural differences in using the eyes and mouth as cues to recognize emotions in Japan and the United States. *Journal of Experimental Social Psychology, 43,* 303–311. doi:10.1016/j.jesp.2006.02.004

Zajonc, R. B., & McIntosh, D. N. (1992). Emotions research: Some promising questions, some questionable promises. *Psychological Science, 3,* 70–74. doi:10.1111/j.1467-9280.1992.tb00261.x

Zeidner, M., Matthews, G., Roberts, R. D., & MacCann, C. (2003). Development of emotional intelligence: Towards a multi-level investment model. *Human Development, 46,* 69–96. doi:10.1159/000068580