Children's and adults' understanding of the "disgust face"

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By the age of 4 years, children ($N = 120$) know the meaning of the word *disgust* as well as they know the meaning of *anger* and *fear*; for example, when asked, they are equally able to generate a plausible cause for each of these emotions. Yet, in tasks involving facial expressions (free labelling of faces, deciding whether or not a face expresses disgust, or finding a "disgust face" in an array of faces), a majority of 3- to 7-year-old children ($N = 144$) associated the prototypical "disgust face" with anger and denied its association with disgust (25% of adults on the same tasks did so as well). These results challenge the assumption that all humans easily recognise disgust from its facial expression and that this recognition is a precursor to children's understanding of the emotion of disgust.

Disgust is commonly understood within the framework of "basic emotions" (Rozin, Haidt, & McCauley, 1993). According to certain major theories on basic emotions, each basic emotion is expressed in the face (Ekman, 1972, 1994; Frijda, 1986; Izard, 1971, 1994; Tomkins, 1962). According to one theory (Tomkins, 1962), proprioceptive feedback from the facial movements involved provides the conscious subjective experience of the emotion. Facial expressions evolved because of their value as signals. Darwin (1872/1965) suggested that evolution is responsible not only for the ability to send these signals but also for the ability to recognise them when we see them. Indeed, there is no adaptive value to unrecognised signals. Thus, recognition of basic emotions from faces has been suggested to occur universally (Ekman, 1972, 1994; Izard, 1971, 1994) and in early infancy—as early as 10 weeks

(D'Entremont & Muir, 1999; Haviland & Lelwica, 1987; Kahana-Kalman & Walker-Andrews, 2001). Recognition of emotion from facial expressions has also been suggested as an early step in a child's developing cognitive understanding of emotion (Denham, 1997; Harris, 1989, 1994), perhaps even as the basis for that understanding. For example, Repacholi and Gopnik (1997) offered evidence that a toddler's recognition of disgust in another person (via nonverbal cues) is part of their reasoning about the desires of others.

In short, major theories of emotion (Ekman & Friesen, 1976; Izard, 1971, 1994; Tomkins, 1962) place facial expressions at the centre of emotion. These theories assume that: (1) discrete basic-level emotions contain a facial expression programme; (2) facial expressions have a communicative function; and (3) facial production and facial recognition mechanisms need to co-evolve, if they are to evolve at all. Some theories (Izard, 1971, 1994) add that: (4) evidence for early recognition of facial expressions of emotion is evidence for an inborn recognition mechanism; and (5) therefore evidence for early facial recognition of emotion from facial expression is evidence for discrete basic-level emotions.

Figure 1 shows an example of the prototypical "disgust face" proposed by the most prominent accounts in psychology of the facial expression of emotion (e.g., Ekman & Friesen, 1976; Izard, 1971; Tomkins, 1962). On this account, the "disgust face" of Figure 1 presumably evolved from the act of spitting out foods that were rotten or poisonous. It is easy to speculate on the survival potential of an offspring who witnessed the caregiver's "disgust face" and thereby learned what foods to avoid without having to ingest them. This signalling system would seem especially important for children in the first years of life, prior to their acquisition of language.

Empirical studies on this account of the "disgust face" have been few, but mounting evidence points to problems. For example, preschoolers do poorly associating the type of expression seen in Figure 1 with disgust (Camras & Allison, 1985; Gosselin & Laroque, 2000; Gosselin, Roberge, & Lavalée, 1995; Harrigan, 1985; Markham & Adams, 1992; Russell & Widen, 2002; Widen & Russell, 2003, 2004, in press). When asked to simply label each of six basic-level facial expressions, preschoolers' worst performance was on the "disgust face", which they more often labelled as *anger* (Gosselin & Laroque, 2000; Markham & Adams, 1992; Widen & Russell, 2003, in press). For example, even for children who had spontaneously produced the word *disgust* in an earlier conversation, only 11% labelled the "disgust face" as *disgust*, compared with 75% who used the "correct" (predicted) label on average for all other faces (Widen & Russell, 2003, Study 3). A similar problem with the "disgust face" emerges in a variety of other tasks as well, including imagining causes for the emotion expressed in this face (Camras & Allison, 1985; Russell & Widen, 2002; Widen & Russell, 2004) and finding

Figure 1.   The "disgust" facial expression.

the "disgust face" in an array of facial expressions (Bullock & Russell, 1984; Markham & Adams, 1992).

Weak results for the "disgust face" are not limited to research with young children. Consider the well-known studies of preliterate cultures relatively isolated from the West. When observers from these cultures were asked to label the "disgust face", the modal responses of three different samples were *contempt*, *happiness*, and *happiness* (see Russell, 1994, Table 16). When the most common, standard method was used (for each facial expression observers chose one emotion from a list), results for the "disgust face" were especially weak; the percentage selecting *disgust* for the "disgust face" ranged from less than 23% to 44% in three samples (see summary by Russell, 1994, Table 15). However, when a story-based method was used (observers were told a story and asked to choose the appropriate face), one group, the Fore, associated the "disgust face" with the disgust story. Interestingly, the story that achieved this high score concerned smelling a dead animal; we return to this result below. Results on this same task with another group, the

Grand Valley Dani of New Guinea, were equivocal. The Dani chose the "anger" and "disgust" expressions equally often for both the anger and disgust stories.

This association of the "disgust face" with anger is not limited to preliterate cultures: Canadian adults asked to choose three angry persons from an array of nine different expressions, reliably chose the "anger face" first and the "disgust face" second (Bullock & Russell, 1984). When American adults were asked whether each of eight facial expressions was angry or not, all of them said *yes* to the "anger face" and 75% said *yes* to the "disgust face" (Widen & Russell, in press).

Thus, when adults and children are given an opportunity to associate proposed prototypical facial expressions with an emotion, they associate both "anger" and "disgust" faces with anger. This association is surprising from a basic-emotions perspective. Anger is prototypically an interpersonal emotion with the function of punishing another or stopping them from blocking a goal; the action tendency is to attack or threaten to attack (Frijda, 1986); the "anger face" signals this threat (Fridlund, 1994). Disgust, on the other hand, relates primarily to food: its function is protection from disease and toxins and its action tendency is rejection (Frijda, 1986); the "disgust face" signals a distasteful substance to be avoided (Fridlund, 1994). Thus, in their origins, there is no reason to anticipate an overlap in the communicative intent of the anger and disgust expressions. In addition, according to the Facial Action Coding System (Ekman & Friesen, 1978), anger and disgust facial expressions do not share anything but incidental action units (e.g., both may have an open mouth). Still, wrinkles around the brow and possibly raising of the upper lip may suggest some physical similarity between the two, but then other expressions of separate emotions similarly share some physical similarity.

This article reports two studies on children's understanding of the "disgust face". Study 1 offers evidence that 3- and 4-year-olds understand the label, the causes, and the behavioural consequences (but not the facial expression) of disgust as well as they understand those of fear and anger. Study 1 is a reanalysis of prior data in which we compare preschoolers' understanding of the causes of disgust with their understanding of the causes of anger and fear. In one condition, children were cued with facial expressions, but in two other conditions they were cued with either the emotion label or the emotion's behavioural consequence. In this way, we could separate their understanding of other aspects of the emotion from their understanding of the face. Study 2 examined, with three different methods, the emotions children attribute to the "disgust face" and the relation of that attribution to their use of the word *disgust* in a free-labelling task. We presented children (3 to 7 years) and adults with 3 different tasks involving facial expressions: free labelling, stating (yes or no) whether a

particular face expressed a particular emotion, and finding persons who feel a particular emotion from an array of facial expressions.

That children's attribution of disgust to the "disgust face" might be marked by their use of the word *disgust* in a free-labelling task was suggested by the differentiation model of children's understanding of emotion (Widen & Russell, 2003). According to this model, children acquire emotion concepts and their labels in a systematic order, an order that reflects a process of differentiation. Children begin with very broad emotion categories (essentially equivalent to dimensions such as pleasure–displeasure). Then gradually they differentiate within the broad categories, forming ever-narrower categories until adult-like categories of anger, fear, etc., are formed.

STUDY 1: REANALYSIS

This study is a reanalysis of data from a previously published study (Widen & Russell, 2004). Our purpose here is to show that 3- and 4-year-old children understand the label, cause, and behavioural consequence of disgust as well as they understand those for anger and fear. We also show that these children associate the "disgust face" not with disgust but with anger.

Method

For a detailed description of the method, see Widen and Russell (2004).

Participants

These were 120 children, 30 boys and 30 girls in each of two age groups: 3s (35 to 47 months; $M = 42$ months) and 4s (48 to 70 months; $M = 58$ months). Six emotions (happiness, sadness, anger, fear, surprise, and disgust) were presented in one of three modes: label, behavioural consequence, or facial expression. The labels were presented verbally: *happy*, *sad*, *angry*, *scared*, *surprised*, *disgusted*. The behavioural consequences were six stories describing stereotypical behavioural consequences of each emotion, created based on prior work in our lab in which slightly older children generated consequences of specific emotions (Russell, 1990). The facial expressions were six $5'' \times 7''$ black-and-white glossy photographs (provided by Dr Linda Camras) of prototypical facial expressions posed by a 12-year-old boy. Camras, Grow, and Ribordy (1983) describe the development of the photographs, their coding according to Ekman and Friesen's (1978) Facial Action Coding System, and their use in a study on recognition of facial expressions.

The experimenter and the child took turns telling a story about an emotional reaction, with the emotion presented in one of three modes. For each mode of presentation, we will use disgust to illustrate. In the label mode of presentation, the experimenter said:

One day, something happened to Danny. It made him feel disgusted. Danny was feeling so disgusted that his mom could tell, his dad could tell, and all his friends could tell that Danny was disgusted.

In the behavioural consequence mode, the experimenter said:

One day, something happened that made Danny feel a certain way. It made Danny want to wash. He wanted to get it off himself as fast as he could. He didn't want to touch that stuff.

In the facial expression mode, the experimenter said:

One day, something happened to Danny. It made him feel like this [pointing to the "disgust face"]. Danny was feeling so much like this [pointing] that his mom could tell, his dad could tell, and all his friends could tell that Danny was feeling like this [pointing].

The facial expression was visible throughout the trial. In each mode, the experimenter asked, "What happened? What made Danny feel that way?" The child's task was to generate the cause of each emotion. The happiness trial, presented first, included all three modes simultaneously (label, face, and behavioural consequence). This trial served as a gatekeeper such that children failing to produce a plausible cause for happiness were replaced with same-sex age-mates; eight children failed this trial and were replaced by same-sex age-mates. Thus, all the children included in the sample understood the task. The remaining emotions were presented in random order.

The children's imagined causes were independently rated by three judges using two different procedures. Two procedures were used, because each procedure has drawbacks and so a robust result is best established through a convergence across procedures. First, in the best-guess rating, each rater chose from a list (happiness, surprise, fear, disgust, anger, sadness, or non-response) the emotion that best suited the child's story. Then, in the plausibility rating, the judges decided whether or not the story was plausible for the target emotion.

Examples of causes that the children in the current study generated for disgust are: in the label mode, "He ate rotten milk" and "There was so much garbage in the house"; in the behavioural consequence mode, "Yucky stuff on his hands. Dirty and muddy" and "Dirty because a dragon put grapes all over him and mushed them"; and in the face mode, "His nose shows that something smells bad—poopy" and "The baby stinks".

Results

All children in the sample understood the instructions and could perform the task, as evidenced by their performance in generating a recognisable cause for happiness. Generating recognisable stories for specific negative emotions proved more difficult and varied with mode of presentation and with emotion. Plausibility and best-guess ratings procedures yielded similar results (Widen & Russell, 2004) and so here we present the best-guess results.

To examine the effect of emotion, we combined results for anger and fear to produce a comparison level for disgust. Results for the anger and fear trials were averaged in order to provide a stable estimate of children's ability to generate a recognisable cause for a negative emotion. In a repeated measures ANOVA (alpha = .05), Mode was the between-subjects factor and Emotion (anger/fear, disgust) was the within-subject factor. The dependent variable was whether or not the target emotion was selected as the best guess for the emotion of the child's response. As expected, there was a main effect for Mode, $F(2, 117) = 11.60$, $p < .001$. There was a face inferiority effect overall, such that the prototypical facial expression resulted in lower performance (.23) than did either the label (.51) or behavioural consequence (.50). This result has been found before (Russell & Widen, 2002) and is not pursued here.

Our principal interest was whether children's understanding of disgust lagged behind their understanding of anger and fear for all cues or only for the face. First, consider the comparison results for the combination of anger and fear. The first row of Table 1 shows that approximately half the children generated a recognisable cause for anger and fear in the label and in the behavioural consequence conditions. Results were lower in the face condition: 30% generated a recognisable cause. Children's performance in the face condition was significantly lower than in the label, $t(78) = 2.85$, $p = .006$, and in the behavioural consequence, $t(78) = 2.90$, $p = .005$, conditions. Given the generative nature of the task and given that to be scored correct a story had

TABLE 1
Proportion of correct responses to disgust, anger, and fear cues, by 3- and 4-year-olds in Study 1

	Mode of presentation		
	Label	Behavioural consequence	Face
Anger/fear	0.51	0.53	0.30
Disgust	0.50	0.48	0.15
	$t(39) = 0.13$	$t(39) = 0.53$	$t(39) = 1.96$
	$p = .90$	$p = .60$	$p = .057$

Note: The dependent variable was producing a recognisable story for the target emotion.

to convey the target emotion better than any other negative emotion, the results of the anger and fear trials are impressive for this age group: At least half of these preschoolers likely understood the concepts of anger and fear in the sense of possessing a rudimentary script including cause, behavioural consequence, and label.

The interesting results occurred in the disgust condition. For the label and behavioural consequence modes of presentation, the preschoolers did as well on disgust as they did on anger and fear (Table 1); the second row shows no significant difference between disgust and anger/fear for these two modes of presentation. Thus, the majority of preschoolers understand the consequence and the label of disgust just as well as and in the same sense that they understand anger and fear: a rudimentary script including cause, behavioural consequence, and label. For the face mode, in contrast, performance was marginally significantly lower for disgust than for anger/fear. Only 15% of these children could generate a recognisable cause of disgust when shown its prototypical facial expression. Children's disgust performance in the face condition was significantly lower than in the label, $t(78) = 3.56$, $p = .006$, and in the behavioural consequence, $t(78) = 3.31$, $p = .001$, conditions.

This result raises a question. What kinds of events did the children offer as causes for the "disgust face"? Presented with the stories children generated as the causes of the disgust face, the judges' modal best guess was anger (33% of cases); the second highest was sadness (20% of cases). In addition, when we looked at the themes of the stories that were rated as plausible for disgust, children were significantly more likely to describe causes involving smelling or things that smelled bad (poo, vomit) in the face mode (5/9) than in the label mode (5/25; comparisons of proportions, $p = .03$) or in the story mode (1/25, $p = .001$). Stories that children in the face mode produced included "Something smells" and "Something smells bad—poopy". One possibility, then, is that even children whose disgust stories were coded as correct mainly associated the "disgust face" (wrinkled nose) with a foul odour. This result is reminiscent of Ekman and Friesen's (1971) finding that the Fore of Papua New Guinea associated the "disgust face" with a story of smelling a dead pig, even though they did not label the "disgust face" as *disgust*. It is even possible that our children and Ekman and Friesen's Fore respondents linked the smelly stimulus with the wrinkled nose without inferring any feelings of disgust. This issue remains for future research.

STUDY 2: UNDERSTANDING THE "DISGUST" FACIAL EXPRESSION

The purpose of Study 2 was to trace the development of children's understanding of the "disgust face". Thus, a wider range of ages (3 to 7

years) was included and children's performance on three different tasks was used to provide converging evidence independent of task details. Having established in Study 1 that 3- and 4-year-olds understand disgust as well as they understand anger and fear in tasks that do not involve faces, we first focus on similarly aged children's understanding of the disgust face relative to faces of fear and anger. We next examine the full sample's attribution of emotion to facial expressions in the three different tasks. Finally, we compare the performance on all three tasks for children who used *disgust* on the free-labelling task to those who did not in order to investigate whether children who used *disgust* would better discriminate the "anger" and "disgust" faces than those who did not use *disgust*. This study also included an adult comparison group so that we could test assumptions about adults' understanding of the "disgust face" on these three tasks. We predicted that children's performance on all three tasks would increase with age, but we included the adults to establish maximum performance.

Method

Participants

These were 144 children, all proficient in English and enrolled in daycare centres in the Greater Boston area. There were 24 boys and 24 girls in each of three age groups: 3-year-olds (29 to 48 months; $M = 43.6$ months, $SD = 3.8$), 5-year-olds (54 to 69 months; $M = 61.8$ months, $SD = 3.3$), and 7-year-olds (63 to 94 months; $M = 78.4$ months, $SD = 8.46$). A group of 48 university-aged adults was also included; they received course credit in exchange for their participation.

Materials

Photographs of facial expressions for free labelling.   Two sets of seven black and white $5'' \times 7''$ photographs (each set posed by a different woman) of prototypical facial expressions of emotion (happiness, sadness, anger, fear, surprise, disgust, neutral) were selected from Ekman and Friesen's (1976) Pictures of Facial Affect.

Photographs of animals for the yes/no task.   The animal pictures were four colour photographs, one each of a cat, dog, horse, and cow.

Photographs of facial expressions for yes/no task.   Three sets of four facial expressions (happiness, fear, anger, disgust), each set posed by a different Caucasian woman, were selected from the Montreal Set of Facial Displays of Emotion (Beaupré, Cheung, & Hess, 2000). Models from the

Caucasian set were selected to make faces in this task comparable to the faces in the other two tasks, which were also Caucasian.

Photographs of facial expressions for choice-from-array task.   Three sets of six facial expressions (surprise, happiness, sadness, disgust, anger, fear), all posed by women, were selected from Ekman and Friesen's (1976) Pictures of Facial Affect. No facial expression was used twice in this task, but four of the faces used in the choice-from-array task were also used in free labelling.

Procedure

The design of this study was 3 (Age group) × 2 (Sex) × 2 (Presentation Order of sets of faces in free labelling) × 2 (Order of Categorisation tasks) × 3 (Tasks; within-subject factor). The experimenter spent the first visit getting to know each child. On a subsequent visit, the experimenter invited an individual child to play some games with her.

Priming.   The experimenter initiated a conversation in which each of the target emotion labels (*happy*, *sad*, *angry*, *scared*, *surprised*, *disgusted*) was introduced by saying, "Today we are going to play a game about feelings. Feelings are like when you feel happy or sad. Do you ever feel *happy*? What about *sad*? Do you ever feel *sad*?" And so on, until each of the target emotion labels had been mentioned. The experimenter did not discuss *when* or *why* these emotions might occur. If the child spontaneously offered an example of when someone had felt a particular emotion, the experimenter listened but did not comment on the child's story or encourage further explanation. Every effort was made throughout the experiment to use a neutral tone of voice when presenting the emotion words.

Labelling facial expressions.   The order of presentation for the two sets of facial expressions was counterbalanced. In the Ronda-first condition, the experimenter introduced the faces by saying:

> Today, I brought some pictures of a woman named Ronda with me. This is what Ronda looks like [showing neutral photo]. Do you know what Ronda is going to do? Ronda is going to show us how she feels. In this game, you get to tell me how Ronda feels. Ready?

The experimenter then showed the child the six facial expressions, one at a time in a random order. For the first face, the experimenter said, "One day, Ronda felt like this [pointing to the face]". For the other faces, the experimenter said, "One week later, Ronda felt like this [pointing to the picture]". After each picture, the experimenter asked, "How do you think Ronda feels in this picture?" Responses were not corrected and all were

mildly praised (e.g., "Good answer"; "You are good at this game"). If no response was given, the experimenter used various prompts ("Have you ever made this face?" "What do you think happened to make Ronda feel this way?"). If the child still did not respond, the experimenter went on to the next photograph, and, after all the trials for both sets of photographs, returned to any to which the child had not responded. At no time did the experimenter use the word *emotion*, provide any other emotion label, or otherwise direct the child to try to use an emotion label beyond asking how Ronda was feeling. After seeing all six of the first set of faces, the experimenter introduced the second set: "That was great. Do you know what else I brought with me today? I brought some pictures of Alice. Would you like to see them?"

Yes/no task.   The two emotion categorisation tasks, yes/no and choice-from-array, were presented in counterbalanced order. Half the children completed the yes/no task first, followed by the choice-from-array; the other half had the reverse order.

The yes/no task was introduced as a game in which the experimenter was trying to be tricky and thus the child had to be particularly careful. In the training trial, the experimenter showed the child photographs of four different animals (dog, cat, horse, cow), one at time in random order. For each photograph, the experimenter asked, "Is this a dog?" The purpose of this training trial was to encourage and reinforce the child for correctly saying "no" to the experimenter. Children's performance on the animal trial was perfect for all four animals. Thus, they understood the task, and were willing and able to say "no" to the experimenter when it was appropriate to do so.

The next three trials followed the same format as the training trial, but now with four different facial expressions (one each of happiness, fear, anger, disgust). On each trial, the four expressions were posed by the same person, and the experimenter asked the same question for all four facial expressions: On one trial, the question "Is this person angry?" was repeated for each of the four faces. On another trial, the question "Is this person disgusted?" was repeated, and so on. The order of the trials was random, as was order of presentation of the three sets of photographs, and the order of the four photographs within each trial. The happiness trial served as a control trial to ensure that children would indeed exclude "anger", "fear", and "disgust" faces from an emotion category.

Choice-from-array task.   In the choice-from-array task, six facial expressions (one each for *happiness, sadness, anger, fear, surprise, disgust*) for a given trial were presented simultaneously, spread out on a surface. The child was encouraged to look closely at each one. The experimenter then asked the

child, "Which one of these people feels X?" (*angry*, *disgusted*, *happy*). When the child had made a selection, it was mildly praised and the experimenter removed that photograph, and then asked, "Does anyone else feel X? Or did you get them all?" This procedure was repeated until the child indicated that no one else felt the target emotion (or until there were no photographs left), and then the next trial was introduced with a new set of photographs. The order of the trials was random, as was order of presentation of the three sets of photographs; the order of the facial expressions within the array was random. The happiness trial served as a control trial to ensure that children would indeed exclude "anger", "fear", "disgust", etc., faces from an emotion category.

Scoring

Free labelling facial expressions.   On the free-labelling task, the participants were allowed to use any label they chose. The scoring key used in this study was drawn from Widen and Russell (2003), who described the development of a scoring key based on ratings of two judges blind to the source of the labels. Any labels that were used by children in the current study that had not been previously rated underwent the same rating procedure. The labels that children used that were scored as correct for each category were: for happiness, *happy*, *good*, *excited*, *glad*; for fear, *scared*, *frightened*, *afraid*, *nervous*, *worried*; for disgust, *disgusted*, *yucky*, *gross*; for anger, *angry*, *mad*, *grumpy*, *frustrated*, *annoyed*, *cranky*, *cross*, *jealous*; for surprise, *surprised*; and for sadness, *sad*, *disappointed*. Responses varied from what was just listed in syntax or by being embedded in a phrase (e.g., *very scared*). These were all the labels children used in the current study that came close to specifying the specific emotion. Any other responses that the children used did not fit into one of the target emotion categories and were rated as "non-responses" (e.g., all different kinds of things; better; bored; I don't know; stinky; silly; tired).

Responses to the free-labelling task were also scored for "correctness". The children had a total of 1728 opportunities to provide a label. Of these, 1085 (62.8%) were emotion labels scored correct for the stimulus given, 568 (32.7%) were emotion labels scored incorrect for the stimulus, and 75 (4.3%) were other, non-emotion responses (e.g., "I dunno"). Of the 57 times children used a label from the disgust category, 80.7% (46) were *disgust*, 12.3% (7) were *yucky*, and 7.0% (4) were *grossed out*.

Yes/no task.   Children's responses on the yes/no task were scored as inclusions and exclusions in order to measure the breadth of children's emotion categories. Thus, all "yes" responses were given a score of 1, and all "no" responses a 0.

Choice-from-array task.   Children's responses on the choice-from-array task were scored in two ways. First, they were scored as inclusions and exclusions in order to measure the breadth of children's emotion categories. Thus, all the faces that a child chose on a given trial were given a score of 1, and all remaining faces were given a 0.

The second way that the choice-from-array task was scored was in terms of the face a child chose first on each trial. By this scoring method, the face that was chosen first was given a score of 1, and all other faces were given a score of 0.

Results and discussion

Interpreting anger/fear and ''disgust'' facial expressions

In order to pursue the findings of Study 1, we first analysed the present data provided by 3- and 4-year-olds ($n = 58$; $M_{age} = 47.1$ months, $SD = 5.96$ months; range $= 37$ to 59 months). Table 2 shows the results. Again, to provide a stable estimate of performance with a negative emotion, we averaged results for anger and fear. For anger and fear, as expected, the majority of 3- and 4-year-olds associated the prototypical facial expression with the appropriate label: 51% correct in free labelling, 72% in the yes/no task, and 62% choosing from an array given multiple opportunities. In contrast, the majority of these children were unable to associate the "disgust face" with the label *disgust*: 10%, 39%, and 42%, respectively, each significantly lower than results from the anger/fear trials. In other words, shown the hypothesised "disgust" facial expression, 90% failed to generate the label *disgust*, 61% denied that a person showing that face felt disgust, and 58% of them failed to select that face (given repeated opportunities) when asked to find all those who felt disgust.

TABLE 2
Proportion of correct responses to disgust, anger, and fear cues, by 3- and 4-year-olds
in Study 2

	Facial expression task		
	Free labelling	*Yes/no*	*Choice-from-array*
Anger/fear	0.51	0.72	0.62
Disgust	0.10	0.39	0.42
	$t(57) = 8.79$	$t(57) = 6.65$	$t(57) = 3.45$
	$p < .001$	$p < .001$	$p < .001$

Note: The dependent variable was producing a "correct" label, responding "yes" to the appropriate facial expression, or choosing the target face from an array of faces.

Table 3 makes the same comparison but for the full age range (3 to 7 years, adults). The 3-, 5-, and 7-year-olds all showed the same discrepancy between anger and fear faces on the one hand and the "disgust face" on the other.

Adults responded differently from the children (Table 3). As typically expected for adults, the majority of adults associated the "disgust face" with the label *disgust*. Nevertheless, the availability here of data from two complementary tasks yielded an interesting caveat on this common finding: 30% of the adults failed to label the "disgust face" as *disgust*, 27% actively denied that the person shown felt disgust, and 25% failed to select that face when asked to select someone who felt disgust. Thus, for approximately a

TABLE 3
Proportion of correct responses to disgust, anger, and fear cues for the full sample in Study 2

Age group	Facial expression	Facial expression task		
		Free labelling	Yes/no	Choice-from-array
3-year-olds	Anger/fear	0.48	0.72	0.60
	Disgust	0.08	0.41	0.43
5-year-olds	Anger/fear	0.62	0.71	0.72
	Disgust	0.10	0.41	0.38
7-year-olds	Anger/fear	0.75	0.76	0.78
	Disgust	0.18	0.53	0.45
Adults	Anger/fear	0.84	0.85	0.88
	Disgust	0.70	0.73	0.75

Note: On each task, participants were presented with facial expressions. The dependent variable was producing a "correct" label, responding "yes" to the appropriate facial expression, or choosing the target face from an array of faces. In three parallel repeated measures ANOVAs (alpha = .05), one for each task, Age was a between-subjects factor, and Emotion (anger/fear, disgust) was a within-subject factor. The Age × Emotion interaction was significant in each analysis: Free labelling, $F(3, 188) = 11.83$, $p < .001$; yes/no, $F(1, 188) = 3.09$, $p = .03$; and choice-from-array, $F(3, 188) = 3.86$, $p = .01$. LSD comparisons indicated that, on the free-labelling task, children's performance increased significantly ($p < .02$) with age for each age group for anger/fear, but there was no significant difference between the 7-year-olds and adults. Children's performance did not increase significantly with age for disgust, but the adults' performance was significantly higher ($p < .02$) than each of the children's groups. On the yes/no task, children's performance was high and did not differ significantly for anger/ fear; the adults' performance was marginally significantly higher ($p = .09$) than that of the 7-year-olds. The 3- and 5-year-olds' performance was significantly lower ($p = .03$) on disgust than that of the 7-year-olds; the 7-year-olds' performance was significantly lower ($p < .001$) than that of the adults. On the choice-from-array task, the 3-year-olds' performance was significantly lower ($p = .03$) than the other children's for anger/fear; the 5- and 7-year-olds did not differ significantly, but both were significantly lower ($p < .05$) than the adults. None of the children's groups differed significantly on disgust; each of the children's group performances was significantly lower ($p < .02$) than that of the adults.

quarter of the adults, their failure to label the "disgust face" as *disgust* was not simply a momentary lapse, such as a temporary inaccessibility of the label, but rather a reliable rejection of disgust as an interpretation of the "disgust face".

Interpreting the "disgust face" as anger

That most children (and a quarter of the adults) do not interpret the "disgust face" as disgust raises a question: How do they interpret that face? We turn to what have been traditionally called "incorrect" labels.[1]

The children provided an "incorrect" label for the "disgust face" 240 times. Of those mislabels, 95% (229/240) were *anger*. (The other mislabels were 7 *sadness*, 3 *happiness*, 1 *fear*). The adults mislabelled the "disgust face" 20 times. Of those mislabels, 90% (18/20) were *anger*. (The others were 2 *sadness*.)

Table 4 shows the proportion of trials on which the "disgust face" was identified as anger on each of the three tasks. At least two-thirds of the children spontaneously labelled the "disgust face" as *anger*, agreed that a "disgust face" was anger, and selected the "disgust face" when asked to find the person who feels anger.

An interesting result occurred with adults as well. Although 70–75% associated the "disgust face" with disgust (Table 3), nearly half also associated it with anger (Table 4). Only 19% of adults labelled the "disgust face" as anger on free labelling, but on this task, anger and disgust are

TABLE 4
Proportion of participants who identified the "disgust face" as *anger* in Study 2

	Facial expression task		
Age group	Free labelling	Yes/no	Choice-from-array
3-year-olds	0.74	0.71	0.79
5-year-olds	0.85	0.77	0.90
7-year-olds	0.79	0.67	0.81
Adults	0.19	0.46	0.48

Note: On each task, participants were presented with facial expressions. The dependent variable was labelling the "disgust face" as *anger*, agreeing that the "disgust face" was *anger*, or choosing the "disgust face" from an array of faces when asked to find who feels anger.

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[1] On our alternative perspective, we do not ascribe to the traditional assumption that non-target responses are "errors". Rather, we believe that children's non-target responses reveal a great deal about their understanding of emotion categories and that it is important to analyse all of children's responses on emotion tasks, both "correct" and "incorrect". However, for ease of communication, we have bent somewhat to tradition, and identify responses as "target" and "mislabellings" on the free-labelling task.

mutually exclusive. On the yes/no and choice-from-array tasks, the participants were asked whether the "disgust face" was an exemplar of the target category, and on these tasks almost half of the adults agreed that the "disgust face" was anger and selected the "disgust face" when asked to find the person who feels anger.

One traditional interpretation of mislabelling is that observers "confuse" "anger" and "disgust" faces. To explore this idea, we divided participants into four mutually-exclusive groups: those who associated the "disgust face" with disgust only, with anger only, with both disgust and anger, and with neither anger nor disgust. On the free-labelling task, responses to the two "disgust faces" were included; on the yes/no task, responses to the "disgust face" on the anger and disgust trials were included; and on the choice-from-array trial, participants' selection or omission of the "disgust face" on the anger and disgust trials were included. Figure 2 shows the results. On the free-labelling task (Figure 2, top), children were most likely to label the "disgust face" as *anger* with few responses in the other three categories. The free-labelling task required participants to make a spontaneous attribution of emotion; children clearly interpret this face as *anger*. In contrast to the children, adults were most likely to label the "disgust face" as *disgust*, but some labelled it as both *anger* and *disgust* or only *anger*. The yes/no (Figure 2, middle) and choice-from-array (Figure 2, bottom) tasks were more interesting because in each task participants were asked to decide whether the "disgust face" was an exemplar of both the anger and disgust categories. In both tasks, children were most likely to categorise the "disgust face" as both anger and disgust: at least 44% of children and 40% of adults did so. The children's next most likely categorisation was as anger only: About 30% of children, with the exception of the 7-year-olds (13%), did so on the yes/no task. Only adults were most likely to categorise the "disgust face" as disgust only, and they did so by only a narrow margin on the yes/no and choice-from-array tasks. The results in Figure 2 for adults were telling. If "recognition" means selecting the correct emotion and excluding all incorrect ones, then only about half the adults were precisely correct in their recognition of disgust.

It is clear that children and even adults label the "disgust face" as *anger*, but are they equally likely to label the anger face as *disgust*? That is, is the "confusion" between disgust and anger symmetric? It is not: Neither children nor adults mislabelled the anger face very often, and when they did, they were most likely to mislabel it as *sadness*. The children mislabelled the anger face 33 times; of those, 70% (23/33) were *sadness*, and 18% (6/33) were *disgust*. (The other mislabels were 7 *happiness*, 2 *fear*, 1 *surprise*.) The adults mislabelled the anger face 7 times; of those, 71% (5/7) were *sadness*, and 14% (1/7) were *disgust*. (The other mislabel was *fear*.)
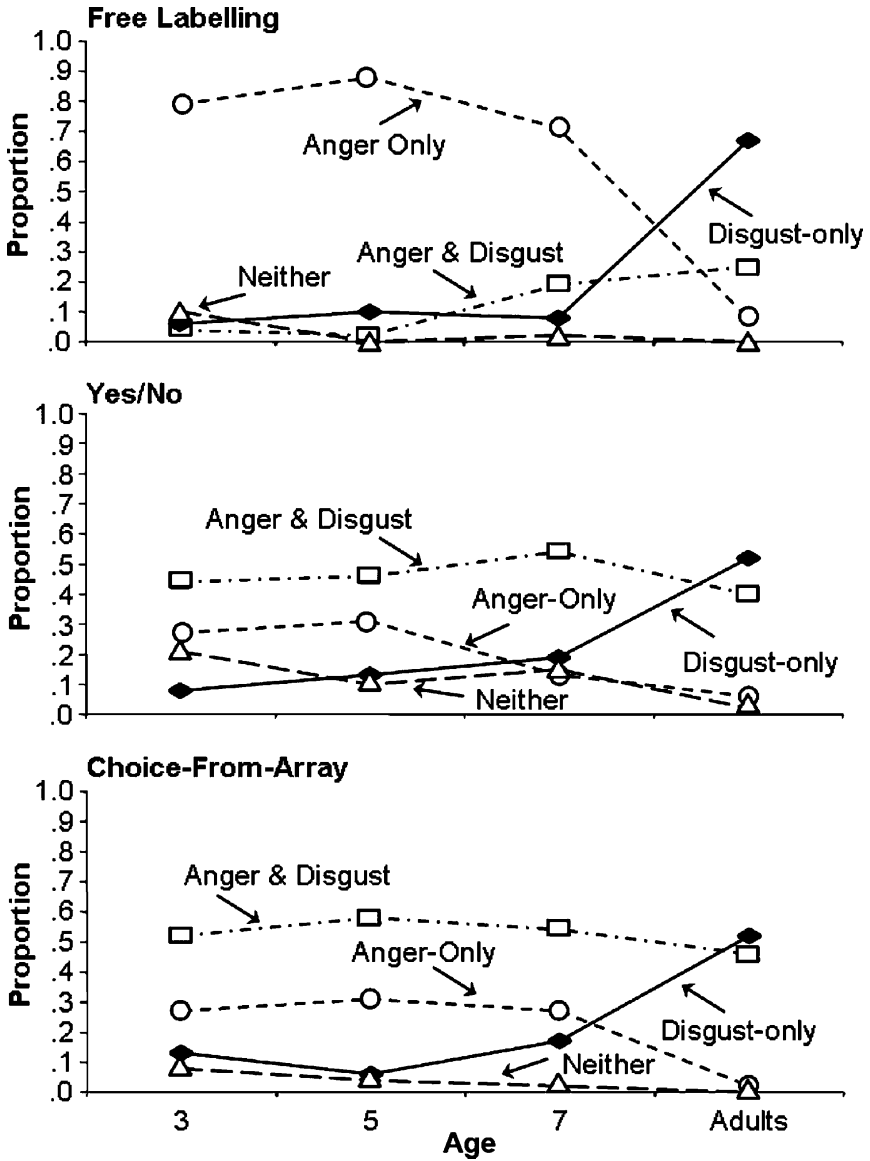
Figure 2. Participants' categorisation of the "disgust face" on the free-labelling task (top), the yes/no task (middle), and the choice-from-array task (bottom) in Study 2.

Could children's use of the label *anger* for the "disgust face" be interpreted as their proneness to making errors? No, because the pattern of labelling the "disgust face" as *anger* is atypical (Figure 3). Figure 3
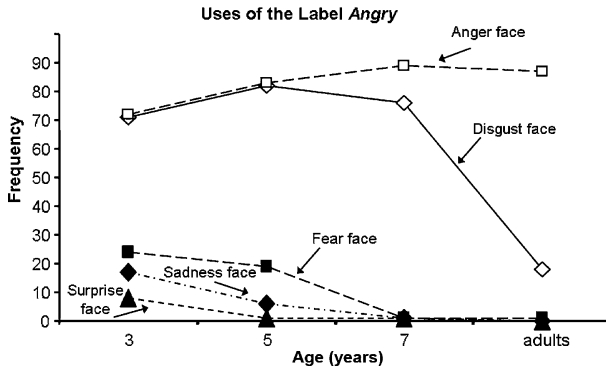
Figure 3.   Frequency with which participants labelled the fear, sadness, surprise, disgust, and anger facial expressions as anger on the free-labelling task in Study 2.

illustrates the frequency with which each face was labelled *anger*. In the typical pattern, children's use of a label for a non-target face decreases with age, as is illustrated by children's use of *anger* for the sadness, fear, and surprise faces. Decline in "errors" with age conforms to expectations about the nature of conceptual development and is consistent with much prior research. But the labelling of the "disgust face" as *anger* was high at all ages and increasing, not decreasing, among the children. Indeed, both groups of preschoolers labelled the "disgust face" as *anger* as often as they did the anger face; 7-year-olds show only a slight decrease in labelling the "disgust face" as *anger*. Only the adults show a sharp decrease in labelling the "disgust face" as *anger*, and even they are not at floor level.

Changes in children's categories

We next turn to the development of the interpretation of the "disgust face". Correlations between children's proportion "correct" on the three tasks showed that performance on the free-labelling task correlated significantly ($r = .30$, $p = .001$) with the choice-from-array task, but not with the yes/no task; performance on the choice-from-array task correlated significantly ($r = .37$, $p < .001$) with the yes/no task. The next question was: *When* do children interpret the "disgust face" as disgust?

Age as a predictor

Adults are more likely to label the "disgust face" as *disgust* than are children, and so one might assume that age similarly predicts when children do so. This was not the case. Although we had a wide range of ages (2;5 to 7;10), on the free-labelling task, age was but weakly correlated with the probability of correct responses to the "disgust faces" (total correct,

maximum possible $= 2$; $r = .06$, *ns*) and, on the choice-from-array task, for responses to the "disgust faces" on the anger and disgust trials (total correct, maximum possible $= 2$; $r = -.03$, *ns*). On the yes/no task, age correlated with the probability of correct responses (total correct, maximum possible $= 2$) to the "disgust faces" on the anger and disgust trials for children, but the correlation was low ($r = .19$, $p = .02$).

Labelling level as predictor

An alternate approach to our question can be had through Widen and Russell's (2003) differentiation model, which is illustrated in Figure 4. We first verified that the differentiation model fit the data from the present study. Children were sorted, irrespective of age and "correctness", by the emotion labels they used on the free-labelling task. The frequency with which each predicted combination of emotion labels occurred was counted, and is illustrated by Figure 4. The frequency for each of the non-predicted combinations was low. This model accounted for 86.1% (124) of the children—a proportion significantly greater ($p < .001$) than the 27.1% expected by chance.[2] These results replicated prior findings, except that there were no children at Labelling Levels 0 or 1 and there were more children at Labelling Level 6 likely due to the slightly older age of the younger preschoolers, the inclusion of Kindergarten and Grade 1 children in our sample, and the opportunity to label two sets of facial expressions.

Age increased with labelling level, and the mean difference in age between labelling levels was 7.35 months.[3] Nevertheless, labelling level and age are not equivalent, with only moderate correlation between age and labelling levels, $r = .53$, $p < .001$. The differentiation model groups children into seven clusters: Those at Labelling Level 0 use none of the target labels when asked

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[2] If, as the number of labels that children used increased, any label was as likely to be added as any other, then 27.1% would fit this pattern. The number of children who would have fit the model by chance alone was calculated by, first, counting the total number of combinations possible for each number of labels (e.g., for two labels used out of the six target categories, there were 15 possible combinations). Next, we divided the number of children who produced that number of labels (e.g., 6 children used two labels) by the total number of possible combinations (i.e., $6/15 = 0.40$) and multiplied that number by the number of paths at that labelling level (i.e., $2 \times 0.40 = 0.80$; at Labelling Levels 2 and 4, there were 2 paths; at all other labelling levels there was one path). This number was the number expected by chance for that number of labels used. This process was repeated for each number of labels used (2 to 6 for this sample), and the numbers expected by chance for each were added together (39.03) and divided by the number of children in the sample (144).

[3] Comparisons of means indicated that the mean age for each Labelling Level from 2 to 5 did not differ significantly ($p > .12$) between the current study and Widen and Russell's (2003) study, but the mean age of children at Labelling Level 6 was significantly older ($p = .04$) in the current study than in that of Widen and Russell (mean age $= 55.7$ months).
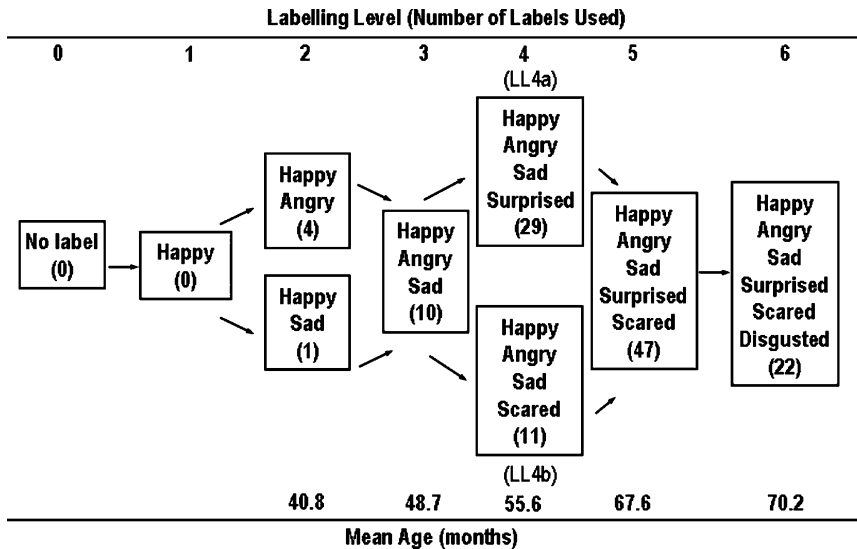
Figure 4. Systematic emergence of emotion labels in Study 2. The number of children who used the specified set of labels is given in brackets [n].

to label the set of six faces. Those at Labelling Level 1 use one label, *happiness*, and so forth, up to those at Labelling Level 6 who use all six target emotion labels. Of the sample of children, 124 could be classified by labelling level. Of these, 22 were at Labelling Level 6, meaning that they used all 6 target emotion labels, including disgust (although not necessarily for the "disgust face").

Even controlling for age, labelling level predicted responses on the three tasks. For the 124 children, on the free-labelling task, labelling level (five levels: 2, 3, 4, 5, 6), controlling for age, predicted correct labelling of the "disgust face" [total correct, maximum possible $= 2$; $r(121) = .64$, $p < .001$]. On the yes/no task, labelling level, controlling for age, predicted total correct for the "disgust face" on the anger and disgust trials [maximum possible $= 2$; $r(121) = .23$, $p = .009$]. And on the choice-from-array task, labelling level, controlling for age, also predicted total correct for the "disgust face" on the anger and disgust trials [maximum possible $= 2$; $r(121) = .26$, $p = .003$].[4]

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[4] Children's performance on the yes/no task and on the choice-from-array task was also positively correlated. These two tasks used different sets of faces, different numbers of faces, and different responses from the children, and thus a perfect correlation was not expected. The total target ("correct") responses made on the yes/no task (maximum $= 12$) correlated significantly ($N = 144$; $r = .34$, $p < .001$) with the total target ("correct") responses made on the choice-from-array task (maximum $= 18$).

In the subsequent analyses, Labelling Levels 2, 3, and 4 were grouped together, as these levels represent earlier stages of emotion understanding, Labelling Level 5 was considered a transitional level, and Labelling Level 6 was, of course, the focal level at which children added *disgust*. Thus, we had four groups: Labelling Levels 2–4 ($n = 55$), Labelling Level 5 ($n = 47$), Labelling Level 6 ($n = 22$), and adults ($n = 48$).

Labelling Levels 2–4.   First, consider the children in Labelling Levels 2–4. All of these children knew and used *anger* on free labelling, yet on both the yes/no and choice-from-array tasks they treated the "disgust" and "anger" faces as equivalent. That is, on free labelling, they were most likely to label both faces as *anger* (Figure 5, top), on the choice-from-array task, they were as likely to choose the "disgust face" as the "anger" face on the anger trial (Figure 6, top), and also to choose both faces as disgust (Figure 6, bottom). In addition, when the first choices of Labelling Levels 2–4 were analysed, they were more likely to choose the "disgust face" as anger than they were the "anger" face. On the yes/no task, they were as likely to agree that both the "anger" and "disgust" faces were anger (Figure 7, top) but somewhat less likely to agree both faces were disgust (Figure 7, bottom)— indeed, the proportion of Labelling Levels 2–4s who agreed that the "anger face" was disgust was significantly lower that the proportion who agreed that the "disgust" face was, $t(54) = 3.04$, $p = .004$.

Labelling Level 5.   All the children at Labelling Level 5 knew and used *anger* on free labelling, and these children were 13 months older, on average, than the children in Labelling Levels 2–4. But the changes from the Labelling Levels 2–4 to this group proved immeasurable on the anger trials, and only gradual on the disgust trials. On free labelling, Labelling Level 5s were most likely to label both "anger" and "disgust" faces as *anger* (Figure 5, top). On the anger trials, Labelling Level 5s included as many or more of the "disgust" faces in the anger category as they did "anger" faces. That is, on the choice-from-array task (Figure 6, top), they were as likely to choose the "disgust face" as the "anger face" on the anger trial. And, on the yes/no task (Figure 7, top), they were as likely to agree that both the "disgust" and "anger" faces were anger. On the disgust trial, in both the choice-from-array task (Figure 6, bottom) and in the yes/no task (Figure 7, bottom), the Labelling Level 5s included fewer "anger faces" than "disgust faces" in the disgust category. This difference was significant on both the choice-from-array trial, $t(46) = 2.66$, $p = .01$, and the yes/no trial, $t(46) = 4.31$, $p < .001$.

In sum, the children at Labelling Level 5 were predicted to be a transitional group from the lower labelling levels to the focus Labelling Level 6s who used all six labels including *disgust*. But these results suggest instead that, at least for their categorisation of the "anger" and "disgust"
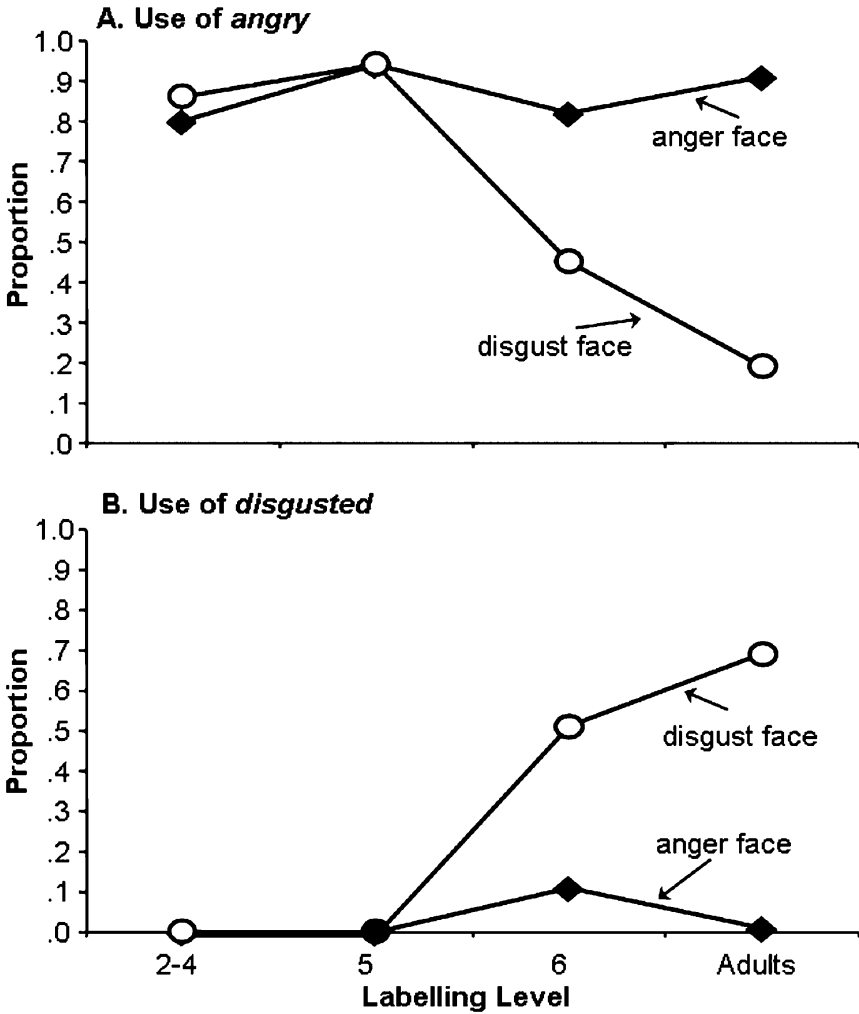
A. Use of *angry*

B. Use of *disgusted*

Figure 5. Participants' use of (A) anger and (B) disgust for the anger and "disgust" facial expressions on the free-labelling task in Study 2.

faces into the anger and disgust categories, there was very little change from the children at Labelling Levels 2–4 to the children at Labelling Level 5.

Labelling Level 6.   The small subsample of children who used *disgust* on free labelling (though not necessarily for the "disgust face") and fit the differentiation model were of particular interest. The mean age of the 22 children at Labelling Level 6 was 5;10 ($SD = 13.48$ months); 12 were girls
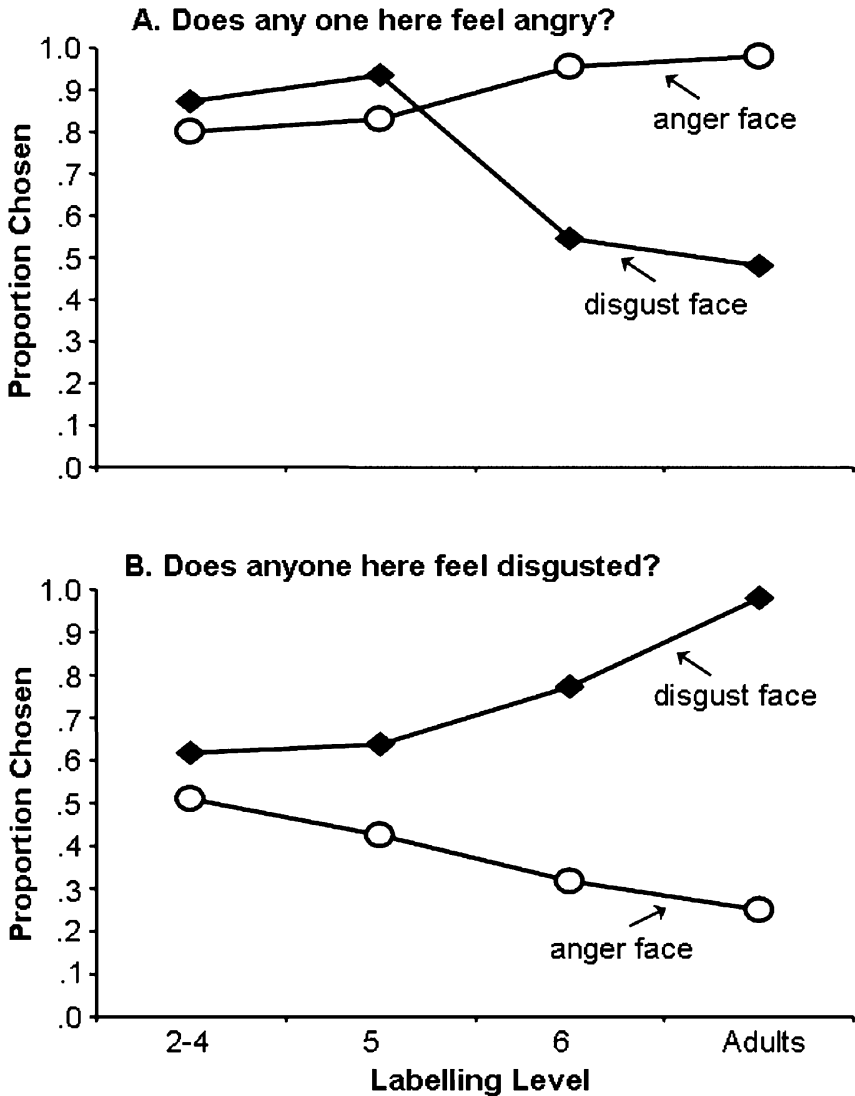
Figure 6. Children's and adults' responses on the anger and disgust trials on the choice-from-array task in Study 2.

and 10 were boys. On average, the Labelling Level 6s were only 3 months older than the Labelling Level 5s, and the age range of the two groups was largely overlapping: from 3;1 to 7;8 for Labelling Level 5s, and from 3;8 to 7;10 for Labelling Level 6. On free labelling, Labelling Level 6s were less likely to label the "disgust" face as *anger* than the "anger" face, and they
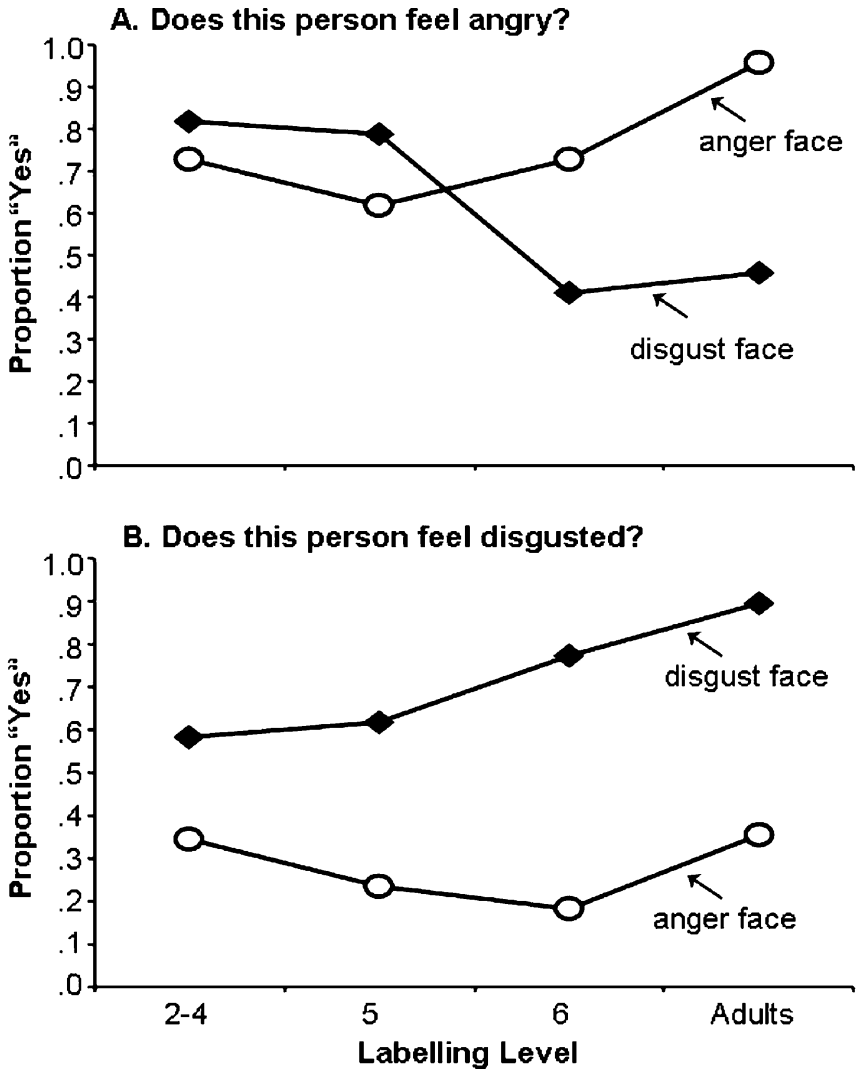
A. Does this person feel angry?

B. Does this person feel disgusted?

Figure 7.   Children's and adults' responses on the anger and disgust trials on the yes/no task in Study 2.

were also less likely to label the "disgust face" as *anger* than were the lower labelling levels (Figure 5, top). Labelling Level 6s were unlikely to label the "anger face" as disgust (Figure 5, bottom). The question was whether using *disgust* on free labelling would correspond with a change in children's anger or disgust categories on the two categorisation tasks. Labelling Level 6s' performance on the disgust trials on both the choice-from-array (Figure 6,

bottom) and the yes/no (Figure 7, bottom) tasks showed no dramatic change from Labelling Level 5s. Instead, correct performance on the disgust category increased only slightly.

In contrast, on the anger trial on both tasks, there was a dramatic change in how the Labelling Level 6s categorised the "disgust face". That is, on the choice-from-array task (Figure 6, top), significantly fewer Labelling Level 6s selected the "disgust face" as anger than had the Labelling Level 5s, $t(67) = 4.31$, $p < .001$, and significantly fewer Labelling Level 6s selected the "disgust face" as anger than selected the "anger face", $t(67) = 3.25$, $p = .004$. On the yes/no task (Figure 7, top), significantly fewer Labelling Level 6s agreed that the "disgust face" was anger than had the Labelling Level 5s, $t(67) = 3.30$, $p = .002$, and marginally significantly fewer Labelling Level 6s agreed that the "disgust face" was anger than agreed that the "anger face" was anger, $t(67) = 1.94$, $p = .07$. Thus, Labelling Level 6s, who used *disgust* on free labelling, had begun to exclude the "disgust face" from the anger category.

CONCLUSION

In this article, we take no stance on genetic versus epigenetic origins of facial expressions or their recognition. Our results do join with prior research (e.g., Bullock & Russell, 1984; Camras & Allison, 1985; Gosselin & Laroque, 2000; Gosselin et al., 1995; Harrigan, 1984; Izard, 1971; Markham & Adams, 1992; Nelson, Widen, & Russell, 2006; Russell & Widen, 2002; Widen & Russell, 2002, 2003, 2004, in press) in raising questions about one aspect of the account of disgust provided by basic emotions theory: Preschool children do not readily associate the "disgust face" with disgust. In the age range of 3–7 years, we found only 14% of children made this interpretation and a majority who actively denied it. Interestingly, although a majority of our adults did label the "disgust face" as *disgust*, a quarter of them actively denied that interpretation. (Of course, it is possible that children and adults, even when explicitly denying the association, implicitly associate the "disgust face" with disgust, but evidence is lacking on this point.)

Might these results depend on the specific word, *disgust*? That is, might *yucky* or *grossed out* have yielded substantially different results? In Study 1, the experimenter used the word *disgusted* and the children generated a cause. Given the productive nature of that task, it is impressive that at least half of the 3- and 4-year-olds showed that they understood the specific word *disgusted*. Probably many more had *disgust* in their passive vocabulary. This result is consistent with results from another study in which *all* 80 3- and 4-year-olds in the sample used *disgust* in a conversation prior to a labelling task (Widen & Russell, 2003, Study 3); but, only 12% labelled the "disgust face" as *disgust*; 63% labelled it *anger*, and 18% labelled it *sadness*

(5% labelled it *fear*, and 2% *happiness*). In the current study, not only did most children between the ages of 3 to 7 years not label the "disgust face" as *disgust*, but they denied that the person shown was disgusted and they did not select the "disgust face" from an array of faces when asked to find someone who felt disgust. Taken together, these results suggest that an understanding of the "disgust face" lags behind children's understanding of other aspects of disgust, perhaps by a number of years, and, furthermore, that the interpretation is far from inevitable even in adults.

The association of the "disgust face" with anger occurs on a variety of tasks as well. Young children (2 to 6 years) often do not distinguish the "anger" and "disgust" facial expressions (e.g., Gosselin et al., 1995; Markham & Adams, 1992; Widen & Russell, 2003, in press). Indeed, they are more likely to label the "disgust face", such as the one in Figure 1, as *anger* than as *disgust*. The majority of children in Study 2 also labelled the "disgust face" as *anger*. On a matching task, 5-year-olds were read brief emotion stories, which included the emotion label, and were asked to choose the protagonist's facial expression from an array of three (Markham & Adams, 1992) or six (Gosselin & Laroque, 2000) facial expressions. The children frequently chose the "disgust face" for *anger* and the anger face for *disgust*.

But, of course, some children do label the "disgust face" as disgust. In Study 2, children who used the word *disgust* on the free-labelling task on some trial (i.e., either "correctly" or "incorrectly") were also more likely to exclude the "disgust face" from the anger category on the two categorisation tasks. This finding supports preliminary evidence from another study (Widen & Russell, in press), in which children (2 to 5 years) were asked to free label facial expressions, including a disgust face, prior to doing a categorisation task. In the categorisation task, children decided whether each of eight facial expressions should be included in the target category (represented by a box) or left out. On the categorisation task for other emotion categories (e.g., fear), using a particular emotion label (i.e., *fear*) did not result in a sudden change in how those children categorised facial expressions. Rather, the fear category began to narrow prior to use of *fear*, and narrowing continued to be gradual after as well. In contrast, children who did not use *disgust* in free labelling treated the "disgust face" just as they treated the "anger face". That is, as many of these children included the "disgust face" in the anger category as included the "anger face". In contrast, of the small group of children who used *disgust* in free labelling, substantially fewer included the "disgust face" than included the "anger face". This finding again suggests that children associate the "disgust face" with anger, at least until they begin to use *disgust* in free labelling.

Let us offer a different perspective on children's understanding of the facial expression of Figure 1—a perspective that does not postulate an innate ability to interpret that face as signalling the basic emotion of disgust or even

a readiness to do so. Human beings may inherit from their evolutionary past certain responses to facial expressions, but these responses need not correspond to interpretation in terms of basic emotions. They may involve social signals such as threat (Fridlund, 1994) or stop/go (P. Winkelman, personal communication, 23 May 2007). At the same time, children of each culture inherit from that culture a set of categories, often lexicalised, into which they divide the emotions. These categories bear some similarity across cultures but show differences as well. Each category has a script. In the script for the category of anger seen in English-speaking people, for example, someone blocks your goal, your body tenses, you want to punish that person and reinstate your goal. The script for disgust is quite different: You come into contact with something repellent and want to distance yourself from it. Children may acquire their emotion scripts in part by witnessing other persons' reactions. For example, if children must learn to recognise the face of Figure 1 as a "disgust face", which consists principally of the Action Unit 9 (the nose wrinkle), then they must acquire from the external world information about what facial changes go with what emotion. A study by Reisenzein (2007) found that when people experienced disgust, Action Unit 9 was rarely displayed. Reisenzein induced disgust reactions in the laboratory by presenting participants with both pictures of, and real, disgust objects. Even for those cases in which self-reported feelings of disgust were high, only 9.8% of participants showed an Action Unit 9. On the other hand, in the same cases, 26.1% showed an Action Unit 4 (furrowing of the brow), which also occurred when anger was induced. If children's observations of others' disgust reactions parallel these, it is perhaps less surprising that they do not associate the "disgust face" of Figure 1 with disgust.

There is also a developmental story for emotion categories. Each emotion category with its script does not arise independently of the others. Instead, children begin with very broad categories and very simple scripts (Bullock & Russell, 1986; Harris, 1989). One of the initial categories may be as simple as something bad happens and you feel bad about it. Over the preschool years, children differentiate within these broad categories to form more and finer-graded categories. This process involves adding new elements to the script. One of children's earliest scripts is anger, although to the child anger is much broader than it is for the adult. Initially, for some children, the word *anger* includes anything bad. As differentiation proceeds, first sadness and then fear/surprise are differentiated from anger. At this point, anger and disgust remain one category.

We speculate that, for the emotion of disgust, adding the "disgust face" of Figure 1 to the disgust script may be one of the last steps in the acquisition of that script. Earlier steps involve linking a cause (such as biting into a rotten apple), a behavioural consequence (spitting it out, moving away), and a label. At the moment, we have no data on the order in which these three elements are linked or just how.

It is not clear how the "disgust face" joins the script. Several events are involved. Children must begin to exclude the "disgust face" from the anger category and to associate that face with the label *disgust*. We found a hint in our data that children who did so were seeing the "disgust face" as a part of the act of smelling. The process of associating the "disgust face" with the disgust label/script is surprisingly poorly correlated with age. Rather, it appears more as an individual difference. Thus, the children we have designated as Labelling Level 6, who used all 6 emotion labels for facial expressions, come from a large range of ages. Further evidence on the age-insensitivity of this process is that even among adults aged 18–25, at least a quarter continue to interpret the "disgust face" as anger and reliably deny the disgust interpretation.

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