Developmental Psychology
2010, Vol. 46, No. 1, 165–177

0012-1649/10/$12.00 DOI: 10.1037/a0016692

Children's Response to Adult Disgust Elicitors: Development and Acquisition

Richard J. Stevenson, Megan J. Oaten, and Trevor I. Case
Macquarie University

Betty M. Repacholi
University of Washington

Paul Wagland
Macquarie University

Little is known about when or how different disgust elicitors are acquired. In Study 1, parents of children (0–18 years old) rated how their child would react to 22 disgust elicitors. Different developmental patterns were identified for core, animal, and sociomoral elicitors, with core elicitors emerging first. In Study 2, children (2–16 years old) were exposed alone and then with their parent to a range of elicitors derived from Study 1. Self-report, behavioral, and facial expression data were obtained along with measures of contagion, conservation, and contamination. Convergent evidence supported the developmental patterns reported in Study 1. Evidence for parent–child transmission was also observed, with parents of young children emoting more disgust to their offspring and showing greater behavioral avoidance. Moreover, child reactivity to animal and sociomoral elicitors and contamination correlated with parental responsiveness. Finally, young children who failed to demonstrate contagion and conservation knowledge were as reactive to core elicitors and contamination as children of the same age who demonstrated such knowledge. These findings are interpreted within an evolutionary framework in which core disgust responses are acquired early to promote avoidance of pathogens.

Keywords: disgust, contagion, contamination, emotional development

Numerous stimuli elicit disgust in adults, but little is known about how these develop. Rozin, Haidt, and McCauley (2000) have suggested that particular categories of disgust elicitor appear in a certain sequence during development. According to this account, distaste emerges first, which refers to the innate rejection of bitter tastes (Steiner, 1979). This is followed by core disgust, which pertains to the imminent threat of oral incorporation of certain elicitors, notably food (e.g., rotting meat), body products (e.g., feces), and animals (e.g., maggots). Next to emerge are the animal-reminder disgusts pertaining to reminders of our animal origins and our own mortality. This category includes sex-related elicitors (e.g., incest), death, hygiene concerns, and body envelope violations (e.g., gaping wound). Last to emerge are the interpersonal (e.g., avoiding an ill or immoral person) and then the sociomoral disgusts. Although there is debate as to the accuracy of these categorizations (e.g. core, animal-reminder, and so forth) in adults (Haidt, McCauley, & Rozin, 1994; Marzillier & Davey, 2004; Olatunji et al., 2007), Rozin et al.'s (2000) account is currently the only developmental model of disgust.

One reason that we might expect Rozin et al.'s (2000) developmental sequence to be accurate comes from the association between cues that elicit disgust and cues that connote disease (e.g., Curtis & Biran, 2001; Davey, 1994). Several authors have suggested that disgust may be regarded as a behavioral disease-avoidance system (e.g., Oaten, Stevenson, & Case, 2009; Schaller & Duncan, 2007). If disgust serves a disease-avoidance function, then it would be advantageous if it arose early in development, especially toward cues that most directly signal disease such as core elicitors. However, Rozin and Fallon (1987) have argued that a fully developed disgust response requires the ability to understand the experience of contamination, whereby contact between a neutral object and the disgust elicitor renders the neutral object disgusting (i.e., contaminated). To understand contamination, a child arguably needs to comprehend two related concepts (Rosen & Rozin, 1993): first, contagion, understanding that contact with germs can cause illness, and second, conservation of matter, understanding, for example, that something one has touched can still be present on one's hand, even if it cannot currently be seen. Accordingly, contamination responses should not be evident if a child lacks such concepts, as the child would not understand that contact with, say, feces leaves invisible traces (germs) on his or her hands, which may then cause illness. If a child cannot then understand contamination, this would, according to Rozin and Fallon's (1987) definition, preclude an adultlike disgust response. In sum, while it would be advantageous for children to experience disgust in response to core elicitors early in development, this may not be possible until they are 4–5 years old when understanding of contagion and conservation concepts first becomes evident (e.g., Hejmadi, Rozin, & Siegel, 2004; Siegal, 1988; Solomon & Cassimatis, 1999).

Richard J. Stevenson, Megan J. Oaten, Trevor I. Case, and Paul Wagland, Department of Psychology, Macquarie University, Sydney, Australia; Betty M. Repacholi, Department of Psychology and Institute for Learning and Brain Sciences, University of Washington.

Correspondence concerning this article should be addressed to Richard J. Stevenson, Department of Psychology, Macquarie University, Sydney, NSW 2109, Australia. E-mail: richard.stevenson@psy.mq.edu.au

Rozin et al.'s (2000) developmental model is essentially untested, and indeed little is known about the development of disgust. With this in mind, our first aim was to address the following questions derived from the earlier discussion: (1) Can evidence be obtained for Rozin et al.'s (2000) developmental categorizations—core, animal-reminder, interpersonal, and sociomoral disgusts—in terms of differing age-related changes for each category? (2) Can responding to core disgust be detected before that to other elicitor categories? (3) Can responding to core disgust be observed in the absence of knowledge about contagion and conservation? (4) Is the ability to understand the experience of contamination actually related to an understanding of contagion and conservation concepts? (5) Can contamination sensitivity be detected in children in the absence of these concepts? We addressed these questions by asking parents in Study 1 about their child's disgust responding and in Study 2 by observing children's reactions to disgust elicitors (self-report, avoidance, facial expression) and by tests of contamination, contagion, and conservation knowledge.

A further question, about which we know even less, is how a stimulus first comes to elicit disgust in children. While distastes appear to be innate responses (Steiner, 1979), both Rozin et al., (2000) and Tomkins (1963) have suggested that new disgust elicitors may be acquired via some form of parent–child transmission. For example, the child encounters a stimulus (e.g., a dirty candy on the ground) and begins to make contact with it. The parent then facially (disgust face), vocally ("Urghh, don't touch that!"), and behaviorally (moves stimulus or child away) intervenes. Although there are plausible mechanisms that could support parent–child transmission of disgust—for example, some form of emotional contagion (Field, Woodson, Greenberg, & Cohen, 1982; Levenson, Ekman, & Friesen, 1990; Wicker et al. (2003) or social referencing (Feinman, 1982; Klinnert, 1984)—to date, we do not even know whether it takes place. Beyond knowing that parents and their adult offspring show moderate correlations in self-report measures of disgust and contamination sensitivity (i.e., individual variation in disgust and contamination responses; Rozin, Fallon, & Mandell, 1984), no one has as yet observed parent–child transmission under naturalistic or laboratory conditions. Thus, our second aim was to obtain some preliminary evidence for parent–child transmission by examining in Study 2, children's disgust responding both when alone with the experimenter and with their parent present. This would establish, first, whether parental responding is related to child age (i.e., do parents of younger children emote more?), and second, whether a child's response when tested alone is predicted by parental response (i.e., do more reactive children have more reactive parents?).

Study 1

Using parental informants, we undertook as the first aim of Study 1 to test Rozin et al.'s (2000) developmental model (i.e., Question 1 of previously discussed Aim 1) by determining whether there are discrete developmental trajectories (i.e., age-related changes in disgust responding) for the different elicitor categories that they identify. A second aim was to determine whether responses to disease-related elicitors (core disgust) develop first (i.e., Question 2 of Aim 1). For Study 1, we used a Web-based survey to obtain a large sample of parents with predominantly young children. Apart from collecting basic demographic data, the survey consisted of 22 items. Many of these were taken either verbatim or in modified form from the Disgust Sensitivity (DS) Scale (Haidt et al., 1994) so as to cover all of the domains of disgust identified in this scale. In addition, several sociomoral items were added that were of varying relevance to young children but of significance for older children and adults. Each parent completed two ratings for each vignette. For the first rating, they were asked to estimate the likelihood that their child would be disgusted. For the second, they were asked to estimate the likelihood that they would be disgusted. Interest here was focused solely on ratings of the child, with parental ratings included to clarify the distinction between parent and child responses. Child gender was initially included in all analyses (as for Study 2); however, as there were few differences (as with Study 2), this variable is not further reported (excepting demographic data).

Method

Participants. We had 381 parents respond to our invitations (posted on parent-related Web sites) to complete a survey of "emotional development." There was no incentive for participation.

Procedure. Parents were instructed to complete the survey with one child in mind. If they wished to complete it for another child, they were instructed to start the survey again, after completing it for the first child. Few participants completed the survey for a second or third child (11 completed the survey twice and 1 thrice). Background questions were the age and gender of the target child, relationship of the respondent to the target child, whether the respondent was the primary caregiver, parental age-band and gender of the respondent, parental country of origin, and whether English was spoken at home.

A further preamble then defined what we meant by a disgust response. Participants were instructed that for each question, they were to judge whether the target child would be disgusted and then whether or not they (the respondents) would be disgusted. Twenty-two scenarios were presented (see Table 1) in a fixed random order. For each scenario, participants were asked first, "Would your son/daughter be disgusted?" (response options were 0 = *no/unsure*, 1 = *possibly*, 2 = *probably*, and 3 = *definitely*), and then, "Would you be disgusted? (same response options and coding). For each of the eight domains of disgust identified in the original DS Scale (see Haidt et al., 1994), there were two vignettes. In addition, a further six questions pertaining to sociomoral disgust, derived from prior pilot work, were included. Finally, parents were asked whether the target child had any condition that might influence their experience of disgust.

Results

Respondents and their offspring. Nineteen cases were eliminated as parents indicated that their child might have a condition affecting their experience of disgust. Of the remaining 362 participants, parents reported on 178 female and 184 male offspring who were between 0 and 18 years old. Distribution of gender by age was roughly equal for each year of child age. Most respondents had children 7 years old or younger (77.6%), and so we collapsed children 8 years old or older into age groups of 8–9 years ($M = 8.5$ years), 10–12 years ($M = 10.9$ years), and 13–18 years ($M = 15.4$

Table 1
Rotated Component Matrix for the Three Factors Identified in Study 1

Item (domain)	Factor 1 (core elicitor)	Factor 2 (sociomoral elicitor)	Factor 3 (animal elicitor)
Eating with very dirty hands (HY)	**0.67**	0.30	0.23
Strong-smelling flatulence (BP)	**0.63**	0.22	0.32
Eating messy food with fingers (FD)	**0.62**	0.12	0.23
Spitting on the sidewalk (S)	**0.60**	0.41	0.22
Profusely bleeding cut (BV)	**0.60**	−0.12	0.39
Caked shaped like a dog feces (MT)	**0.59**	0.01	0.29
Subway smelling of urine (BP)	**0.51**	0.39	0.39
Eating ice cream and ketchup (FD)	**0.50**	0.33	0.41
Politician lying on TV (S)	0.09	**0.83**	0.07
Company announces big profits after sackings (S)	0.05	**0.77**	0.09
Stealing a bag from a disabled person (S)	0.34	**0.76**	0.24
Sneezing on food (HY)	0.33	**0.72**	0.31
Teenager swearing at a senior (S)	0.44	**0.67**	0.17
Teenager marrying a senior (SX)	−0.13	**0.66**	0.51
Dropping litter in an attractive park (S)	0.55	**0.62**	−0.11
Touching a dead cat (DE)	0.37	0.07	**0.77**
Touching a dead bird (DE)	0.31	0.10	**0.77**
Two dogs vigorously mating (SX)	0.16	0.29	**0.61**
Cockroach runs across floor (AN)	0.46	0.15	**0.56**
Drinking from a dog's bowl at a party (MT)	0.36	0.25	**0.54**
Maggots in the garbage can (AN)	0.48	0.30	**0.53**
Human hand in jar (BV)	0.51	0.09	**0.52**

Bold type indicates items selected to represent that factor when component means were calculated. Domains: HY = hygiene; BP = body products; FD = food; S = sociomoral; BV = body envelope violation; MT = magical thinking; SX = sex; DE = death; AN = animal.

years). Thus, in total, there were 10 age groups: 1- (n = 64), 2- (n = 52), 3- (n = 52), 4- (n = 41), 5- (n = 28), 6- (n = 22), 7- (n = 22), 8.5- (n = 26), 10.9- (n = 29), and 15.4- (n = 26) year-olds. The parents completing the survey came mainly from Australia (84.5%), with parents from the United States (7.5%), Canada (3.6%), New Zealand (1.4%), and the United Kingdom (1.4%) making up most of the remainder. All but 4 spoke English at home. The survey was mainly completed by mothers (96.4%) and by the primary caregiver (93.6%). The median age-band for parents was 31–35 years (28.7% of respondents), and there was a positive association between parental age-band and child age, $r(362) = .50$, $p < .001$.

Categorization by common developmental trajectory. To identify which groupings of disgust elicitors tend to develop together, we subjected parent reports for each item (22) to principal components analysis. The data were appropriate for this technique as the Kaiser–Meyer–Olkin index was .94 and Bartlett's test of sphericity was significant, $\chi^2(231, N = 362) = 4{,}685$, $p < .001$. Three components had eigenvalues greater than 1 and the varimax rotated component matrix was straightforward to interpret (see Table 1). The first component (accounting for 21.1% of the variance following rotation) was composed of eight items, including food and body products, and resembled Rozin et al.'s (2000) core disgust category. However, this component also included items categorized in the DS Scale as hygiene and body envelope violation elicitors. We would suggest that core disgust here has a wider meaning than envisaged by Rozin et al., (2000) and that it includes mainly inanimate concrete elicitors that potentially signal disease threat. The second component (accounting for 20.5% of the variance following rotation) was composed of seven items, including mainly those driven by someone's aberrant behavior. We labeled this the sociomoral factor, and it is principally characterized by actions that are judged to be offensive. The third component (accounting for 18.2% of the variance following rotation) was also composed of seven items. This component bears some resemblance to Rozin et al.'s (2000) animal-reminder factor (i.e., sex, death, body envelope violations); however, the key characteristic here was the much more direct reference to animals (six of seven items), and so we labeled this the *animal factor*. The regression-derived component Z scores, by age group, are illustrated in the upper panel of Figure 1.

Sequence. To analyze the order of developmental emergence, we calculated component means for each child by averaging item scores falling within that component (see Figure 1, lower panel). It was not appropriate to use Z scores as they do not preserve the absolute scores, which were required for these analyses. Emergence was defined here as the first score for a particular component type to significantly exceed a value of 1 (i.e., a possible disgust response as judged by parents) at a given age group. This criterion was chosen as it was the first response to indicate the possible presence of disgust (rankings remain unchanged if a laxer or more conservative criterion is adopted). Significance testing used one-sample t tests, with mu equal to 1 and alpha adjusted by Bonferroni correction (with a one-tailed value used because only positive scores were of interest, this yielded an α of .005 for each elicitor category [i.e., .05 of 10 age groups]). With this approach, core responses were the first to exceed 1 at Age Group 3, $t(51) = 2.79$, $p < .005$, $r^2 = .13$, 95% confidence interval (CI) = .08–.46.

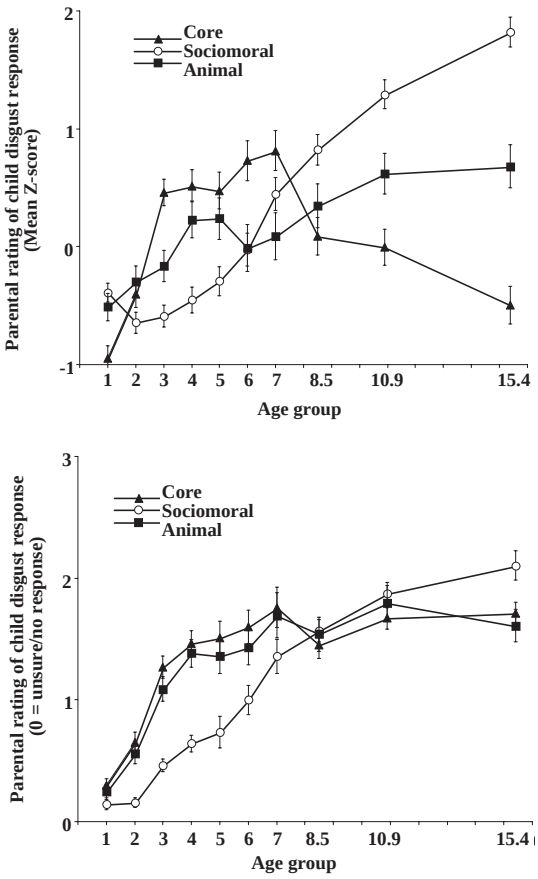

Figure 1. Upper panel: Factor analysis–derived regression scores (1 *SE*) for the core, sociomoral, and animal disgust elicitors by child age group for Study 1. Lower panel: Mean scores for each component (+1 *SE*), core, sociomoral, and animal elicitors by child age group for Study 1.

Animal elicitors significantly exceeded a score of 1 for the first time at Age Group 4, $t(40) = 3.27$, $p < .005$, $r^2 = .21$, 95% CI = .14–.62. Finally, sociomoral elicitors significantly exceeded a score of 1 for the first time at Age Group 7, $t(21) = 2.54$, $p < .005$, $r^2 = .24$, 95% CI = .07–.66.

Discussion

Insomuch as parents' ratings of their children's disgust responses are accurate, three different developmental groupings emerged as discrete for the elicitor set studied here. These broadly agreed with Rozin et al.'s (2000) proposed developmental categorization scheme; however, the core category was broader than they envisaged, and the animal category was more concrete in form (i.e., actual animals) in contrast to Rozin et al.'s (2000) more conceptual view (i.e., reminders of animal origins). With the criterion of exceeding a "possible" disgust response, core elicitors emerged first at Age Group 3, animal elicitors second at Age Group 4, and sociomoral elicitors last at Age Group 7—confirming the predicted developmental sequence of core elicitors emerging first.

Study 2

In Study 2, we explored all of the questions raised in the introduction. First, using sets of real elicitors grouped to represent the three factors identified earlier, we tested whether core, animal, and sociomoral categories would differ in the degree to which they generated behavioral avoidance, disgust facial expressions, and self-reported affect across children 2–16 years old. That is, would the age-related changes that differentiated these categories in Study 1 also be observed in Study 2? The minimum age for inclusion in this study was based on the need for adequate verbal communication skills and for children to be sufficiently attentive and independent during testing. On the basis of the findings of Study 1, we expected interactions between elicitor category (e.g., core vs. animal) and child age, thus reflecting different developmental trajectories (i.e., Question 1 of Aim 1 in the introduction). Second, we also expected that responses to core elicitors would emerge first, followed by those to animal elicitors, and that both of these would appear before sociomoral responses (i.e., Question 2 of Aim 1). Because Study 2 had a long lead time (for ethical clearance and piloting), the factor solution obtained from Study 1 was not initially known. Consequently, we designed Study 2 to include elicitors spanning most of the domains identified in the original DS Scale. Items were selected on the basis of compliance with ethical principles (i.e., minimal risk of harm), recruitment issues (i.e., minimal perceived risk of harm), and conceptual similarity to Study 1.

We also wished to determine the dependence of disgust responding on contagion and conservation knowledge. Thus, we used established tasks to measure knowledge of conservation (i.e., dissolving sucrose in water; after Piaget & Inhelder, 1974) and contagion (i.e., how people catch colds; after Siegal, 1988) and examined whether core (and animal) disgust responding could be observed in children who did not demonstrate such knowledge (i.e., Question 3 of Aim 1). A behavioral test of contamination was also included, in the form of placing a preferred piece of candy on to the bottom of a new potty and asking the child if he or she would eat it. A potty was chosen as the contaminant because it would be of high salience to the youngest children (i.e., having recently undergone potty training) and would offer a further test of any prior parent–child training. We also wished to examine whether responding on this task was related to contagion and conservation knowledge (i.e., Question 4 of Aim 1) and whether a contamination response (i.e., not taking the candy) was evident in children with no contagion or conservation knowledge (i.e., Question 5 of Aim 1).

Study 2 was also used to explore, for the first time under experimental conditions, parent–child disgust transmission. To examine this transmission, we first tested children alone with the experimenter and then again with their parent present. Here, we addressed two particular questions: first, whether parental responses—self-report, behavioral avoidance, and facial expression—were related to child age, and second, whether parental responses were related to children's behavior in the first session (i.e., when the parent was not present), on the basis of the assumption that prior parental influence may be reflected in children's initial response.

Method

Participants. We recruited 101 parent–child dyads. Five pairs were excluded because the children (all were preschoolers) were either unable to demonstrate an understanding of the self-report measure or did not complete the entire session, which left 96 pairs for analysis. Parents (and older children) received a small cash payment. Demographic data is provided in the *Results* section.

Procedure. The study consisted of three phases: (a) a telephone screening interview to exclude children with a developmental disability or sensory impairment, (b) completion at home of parental and child demographic data and of the DS Scale for the primary caregiver, and (c) a 40-min laboratory session. On test, after providing consent, the mother was seated behind a screen and was asked to listen to the radio via headphones. Only the top part of her head was visible to the child throughout testing. The child was then seated at a desk at the 12 o'clock position with the experimenter sitting at the same desk at the 9 o'clock position. Four cameras were employed. Two were placed on the desk at which the child sat, both focused on the child's face. A third was mounted further back and up from the desk, again centered on the child's face but also encompassing the experimenter and desk. A fourth was wall mounted to provide a view of the whole scene. Camera output was sent to a video splitter and recorded.

Preschoolers (i.e., those not yet attending elementary school) received a simplified version of the self-report scale. They were told that they would be asked whether certain things were "good" or "bad." If they did not know, they were instructed to say "don't know." To determine whether they understood this procedure, experimenters asked them three pretest questions: (a) "Do you think getting into trouble is good or bad?" (b) "Do you think getting presents at Christmas is good or bad?" (c) "Do you think feeling sick is good or bad?"

For children who were attending school, a different self-report scale and pretest procedure were used. Participants were asked to identify their favorite food. They were then asked what food they "hated." If they could not generate a food, they were asked about TV shows instead. They were then shown a 5-point bipolar hedonic scale, with the following anchors: *really like*, *like a bit*, *unsure*, *dislike a bit*, and *really dislike*. Underneath each anchor were cartoon faces indicating a matching facial expression. Each participant was asked, "If I [gave/showed] you [the child's favorite food/favorite TV show], which face would you point to?" This was followed by the same question but for the food (or TV show) that the child disliked. All participants were able to use this scale appropriately on the pretest.

Before the experimental phase began, all participants were informed that they did not have to touch, look at, or smell anything to which they objected. Eight disgust modules were then presented, counterbalanced across participants:

Food module (core elicitor). The experimenter took a single scoop of ice cream and placed it in a bowl. After the participants evaluated it, the experimenter took a ketchup bottle and covered the ice cream with sauce. The ice cream was evaluated again, and the participants were asked whether they would like to try a tiny spoonful. If the participants did, they were then asked whether they would like to try a larger spoonful.

Contamination module. Participants were asked to select their most preferred candy from three different types. The experimenter said, "This is a brand new potty; I'm going to put the [candy] on the bottom of it." The experimenter then asked whether they wanted to eat the candy. If they did, they took and ate it. If not, the candy was thrown conspicuously into a garbage can, and a new piece of candy was placed in a plastic sample cup, which was then placed on the bottom of the potty. Again participants were asked whether they wished to eat it.

Animal module (animal elicitor). A transparent plastic jar containing the larval form of *Tenebrio molitor* (mealworms, which look like maggots) was placed in front of the participants, and the experimenter said, "This is a jar of maggots." The maggots were then evaluated. Next, participants were asked whether they wanted the experimenter to remove the lid so they could have a closer look. If they responded "yes," then after being shown the maggots, they were asked whether they would like to touch one. If so, they were then asked whether they would like one placed on their hand.

Hygiene module (core elicitor). A filthy white sock was placed on the table in a transparent plastic bag. The experimenter said, "This is somebody's sock," and participants were asked to evaluate it. They were then asked whether they would like the experimenter to open the bag so they could have a closer look. If so, they were then asked whether they would like to touch it.

Body products module (core elicitor). Participants sniffed and evaluated two odors. One was organic fertilizer (fecal, 10 g) and the other fermented shrimp paste (urinous, 5 g).

Sociomoral module (sociomoral elicitor). Participants were shown a picture of a garbage-strewn park and asked to evaluate it. They were then asked whether people should litter. Next, they were shown a picture of a disabled man and an able-bodied man. The child's attention was drawn to the distinction between the two men. The experimenter then said, "Which is worse: If this man (pointed to disabled man) had his bag stolen, or if this man (pointed to other man) had his bag stolen?" Finally, participants were shown a picture of a Ku Klux Klan (KKK) meeting and asked to evaluate it.

Sex module (sociomoral elicitor). Participants were shown a wedding photograph of a much older woman marrying a young man. The experimenter said, "This is a photograph of a wedding between a man and a very much older woman." They were then asked to evaluate it after which they were asked, "Do you think these two people should get married?"

Body envelope violation module (animal elicitor). The experimenter opened a box containing a glistening (Vaseline-coated) glass eye (obtained from an ocularist) and said, "When someone loses an eye, say in a bad accident, they put in a glass eye—into the socket—just like this one." This was accompanied by gestures to illustrate the account. The participants were then asked to evaluate the glass eye and then asked whether they wished to touch it.

Three further tasks were then administered (these three were not presented to parents). For the contagion task, participants were shown a photograph of a sick child and told that the child was unwell and had a bad cold. They were then asked how the child came to have a cold. They were then shown two further pictures, one of the target child having a tantrum and the other of a similar-aged child who was also sick. The experimenter asked the participants, "Do you think the kid got sick because he was naughty [pointed to tantrum picture] or because he played with his friend who had a cold [pointed to sick friend picture]?" The conservation task then followed. Participants were shown a trans-

parent glass containing warm water. The experimenter said, "Here is a glass of water; now I'm adding a teaspoon of sugar and stirring it." They were then asked why they could not see the sugar anymore. Following their response, they were asked, "Did it break into tiny pieces we can't see," or "did it just turn into plain water?" Finally, participants completed the conformity task. For preschoolers, the experimenter said, "Do you know I really don't like Christmas, and I don't even like getting presents!" He then asked, "Do you think getting presents is good or bad?" For school-aged children, the experimenter stated that his favorite food or TV program was the food or TV program that the participant had earlier indicated that he or she hated. The participant was then asked to evaluate this food or TV program again.

The mother then joined her child and the experimenter. She was seated where the child had sat, and the child was seated next to her on the side furthest from the experimenter. The disgust modules were then presented in the same sequence as for the child. Each module was administered as described earlier, except that once each parent component was complete, an additional child task always followed. For example, after the parent had completed the food module, the child was asked to evaluate the ice cream and ketchup and then whether he or she would try some. The next module was then presented, with a parent part, then a child part, and so forth. Finally, parents were also asked whether, for each of the stimuli presented, the child had experienced anything like it before. These measures of novelty were unrelated to child responses and are not further reported.

Coding. All self-report hedonic ratings were recoded to form a common scale ranging from −.5 to .5, so that all child responses were comparable. A −.5 represented negative responses, 0 represented *unsure/don't know*, and .5 represented positive responses. For the sex module, participants' responses to the marriage question (−.5 = *should not marry*, 0 = *unsure*, .5 = *should marry*) were averaged with the evaluative score. For the sociomoral module, evaluative responses were also averaged with those to the bag theft question (−.5 = *steal from disabled man worse*, 0 = *unsure*, .5 = *steal from other man worse*) and garbage question (−.5 = *bad to litter*, 0 = *unsure*, .5 = *OK to litter*).

Behavioral responses were also recoded, such that 0 represented *full contact* and 1 *total avoidance*. Intermediate responses were recoded so as to lie at equal intervals between 0 and 1. For the contagion task, participants who correctly indicated that the target child caught the cold were scored 1 (0 for incorrect) and a score of 1 was obtained if they indicated that the target boy's friend gave him the cold (0 for incorrect). The conservation task was coded in a similar manner.

Two coders, blinded to the study's aims, were trained to code the following facial expressions: anger, sadness, surprise, disgust, fear, and happiness. Training was conducted using the Ekman faces obtained from the *Facial Expressions of Emotion: Stimuli and Tests* (Young, Perrett, Calder, Sprengelmeyer, & Ekman, 2002). Following training, coders' facial identification performance was tested on a further four sets of faces (24 faces total). Both coders were able to identify these correctly, one perfectly and the other with two errors. Coding then took place in two tranches. The first dealt with the child alone. The second with the mother and child. Each is described in turn.

For the child alone, videos were randomized into two sets, one contained 65 tapes and the other 66, with 34 tapes common to both. Each coder was allocated one of these sets, due to the volume of material and to maximize attention on this demanding task. Coders could not be blinded to test stimuli, but then all stimuli were potentially disgust evoking. The child's facial expressions for each module and for certain parts within modules were coded for the presence or absence of one of the following three categories immediately following stimulus presentation: (a) disgust, (b) other negative emotions, and (c) laughter and smiling. For each category, a hit was coded as 1, whereas the absence of an expression was coded as 0. In a minority of cases, two expressions might rapidly follow stimulus presentation. In these cases, coders were asked to record both. Overall, laughter and smiling were the predominant emotion, then disgust. While disgust was relatively infrequent within many modules (median for whole sample = 22%), overall 88% of participants still generated at least one disgust facial expression. Few other negative emotions were detected (<1%). To assess reliability for disgust faces, we adopted two approaches. First, the total number of disgust faces for each participant was calculated across modules for each coder, and these two values were correlated. There was moderate overall agreement, $r(34) = .80$, $p < .001$. Second, we examined reliability within each module. For some modules, this was not possible, as either no or very few (<2) disgust responses were evident, notably for the sociomoral and sexual items (as with the full data set). For the remaining modules, kappa values ranged from .41 to .82, with a median of .64.

Once the child coding was complete, the same coders then coded parental facial responses and parent–child interactions for the same set of tapes. First, by module, the mother's reaction to the stimulus was coded for disgust (present or absent) and all other emotions (present or absent) and then whether either response had been directed at the child. Second, by module, facial expression of the child was coded (as previously described) and whether this expression was directed at the mother. Third, when the stimulus was offered to the child, the mother's reaction was coded again (as previously described). Fourth, the child's reaction on being presented a second time was coded (as previously described). For parents, disgust expressions were relatively sparse within certain modules (median response = 27%; 93% emoted disgust at least once), again especially for sociomoral or sexual items. For children, there were few disgust responses (8% generated at least one expression), and most parental expressions were met with laughter or smiling (i.e., other emotions category) or no response. Consequently, we report these data in two ways: (a) parental disgust expressions on receiving the stimulus, and (b) for each parent, the total number of disgust faces directed at their child. There was modest agreement for the mother's disgust responses, collapsed across modules, $r(34) = .71$, $p < .001$. Within modules, excluding the sociomoral or sexual items, median kappa value was .61, with a range from .37 to .67. For parental expressions of disgust directed at the child, there was moderate agreement, $r(34) = .77$, $p < .001$.

Analysis. To establish whether core, animal, and sociomoral categorizations have different developmental trajectories and sequences, we assembled child self-report, behavioral, and facial scores so as to represent the three components (elicitor type) identified in Study 1. These scores were averages of the individual components (see Table 2 for raw data): ice cream/ketchup, odors, and sock for the core factor; maggots and

the glass eye for the animal factor; and the garbage, KKK, theft, and marriage items for the sociomoral factor. All of the collapsed variables met the necessary assumptions for parametric testing, with the exception of the facial data for sociomoral or sexual elicitors, which had to be excluded because there were few expressions of disgust. (Sign tests revealed that both core and animal elicitors generated significantly more facial expressions of disgust than the sociomoral items, *p*s $< .001$).

Results

Demographic data. Children were assigned to one of five age groups (mean age in years; *SD*s in parentheses): 2.5 (0.5); 4.5 (0.5); 6.8 (0.9); 10.1 (1.0); and 14.3 (0.9), in order to give approximately equal cells ($n = 19$, 21, 21, 17, and 18, respectively). There was no significant difference in the relative frequency of gender within each age group. The child's primary caregiver was generally the mother (94 of 96 dyads). Parental age increased across the child age groups from a mean of 34.8 years ($SD = 4.9$ years) for the youngest to 43.5 years ($SD = 8.6$ years) for the oldest. Most of the mothers had more than one child ($M = 2.20$, $SD = 1.10$) and reported being the primary care giver during the first 2 years of the target child's life and during the last month. The mothers reported a median family income of $80,000–$100,000 (AUD), and most were university graduates (65%). Fifty-four percent were born locally, with the largest remainder coming from other English-speaking nations (24%).

Developmental trajectory. In this analysis, we addressed Question 1 of Aim 1, namely whether core, animal, and sociomoral elicitor categories have discrete developmental trajectories, as indicated by significant interactions between elicitor type and age group. To test these interactions for core and animal elicitors, in which we had three measures of disgust, we used a multiple analysis of variance (MANOVA) with age group as a between-participant factor and elicitor (core vs. animal) and measure (facial vs. behavior vs. self-report) as within-participant factors. The MANOVA revealed a significant Elicitor × Age Group interaction, $F(4, 91) = 2.41$, Wilks' lambda = .90, $p < .05$, $\eta_p^2 = .10$, but no other interactions involving Age Group (see Figures 2, 3, and 4 for responses by measure). Significant main effects were observed for age group and elicitor, as well as for Elicitor × Measure, but these were of lesser interest. The Elicitor × Age Group interaction suggests that across the three measures of disgust, animal and core elicitors have different developmental trajectories (from Bonferroni-corrected *t* tests, significant differences were apparent at the 6.8-, 10.1-, and 14.3-year-old age groups). Finally, analysis of each elicitor category alone (collapsed across measure) revealed significant age-related changes for core (linear and quadratic trends, $F < 16.8$) but not for animal elicitors.

Using planned contrasts, we then tested whether self-report ratings for core and animal, respectively, differed from sociomoral responses (recalling that only self-report measures were available for the latter). The contrast of core versus sociomoral responses by age group was significant, $F(4, 91) = 4.96$, $MSE = .01$, $p < .001$, $\eta_p^2 = .18$, and significant differences were present for all age groups except for the oldest (*p*s $> .01$; see Figure 4). The contrast of animal versus sociomoral responses by age group was also

Table 2
Mean and Standard Deviations of Responses to Each Elicitor Type by Age Group and Dependent Variable

Elicitor/dependent variable	Age group									
	2.5 years		4.5 years		6.8 years		10.1 years		14.3 years	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Food[a]										
Facial	0.0	0.0	0.1	0.2	0.5	0.5	0.4	0.5	0.2	0.4
Behavior	0.4	0.5	0.6	0.4	0.8	0.3	0.7	0.3	0.7	0.4
Self-report	0.0	0.2	−0.1	0.3	0.4	0.1	−0.4	0.2	0.4	0.1
Hygiene[a]										
Facial	0.0	0.1	0.1	0.3	0.3	0.5	0.5	0.5	0.1	0.3
Behavior	0.4	0.4	0.6	0.4	0.7	0.4	0.5	0.5	0.7	0.5
Self-report	−0.4	0.3	−0.5	0.0	−0.5	0.2	−0.5	0.0	−0.5	0.1
Body products[a]										
Facial	0.2	0.3	0.2	0.3	0.5	0.4	0.6	0.4	0.5	0.4
Self-report	−0.2	0.3	−0.3	0.3	−0.4	0.2	−0.5	0.0	−0.4	0.2
Animal[b]										
Facial	0.1	0.2	0.1	0.3	0.2	0.4	0.2	0.4	0.2	0.4
Behavior	0.6	0.4	0.6	0.4	0.6	0.4	0.6	0.5	0.6	0.5
Self-report	−0.2	0.5	−0.2	0.4	−0.2	0.4	−0.3	0.4	−0.2	0.4
Body envelope violation[b]										
Facial	0.1	0.2	0.1	0.3	0.2	0.4	0.2	0.4	0.2	0.4
Behavior	0.6	0.5	0.5	0.5	0.6	0.5	0.5	0.5	0.3	0.4
Self-report	0.1	0.5	−0.2	0.4	−0.2	0.4	−0.1	0.4	0.0	0.5
Litter[c]/Self-report	0.0	0.5	−0.3	0.2	−0.4	0.2	−0.5	0.0	−0.5	0.0
Disabled scenario[c]/Self-report	0.0	0.5	−0.2	0.4	−0.2	0.4	−0.4	0.3	−0.5	0.1
KKK[c]/Self-report	0.0	0.5	0.1	0.5	0.0	0.4	−0.3	0.3	−0.3	0.4
Sex[c]/Self-report	0.2	0.3	0.2	0.4	−0.2	0.3	−0.3	0.2	−0.1	0.3

Note. KKK = Ku Klux Klan.
[a] Core category. [b] Animal category. [c] Sociomoral category.

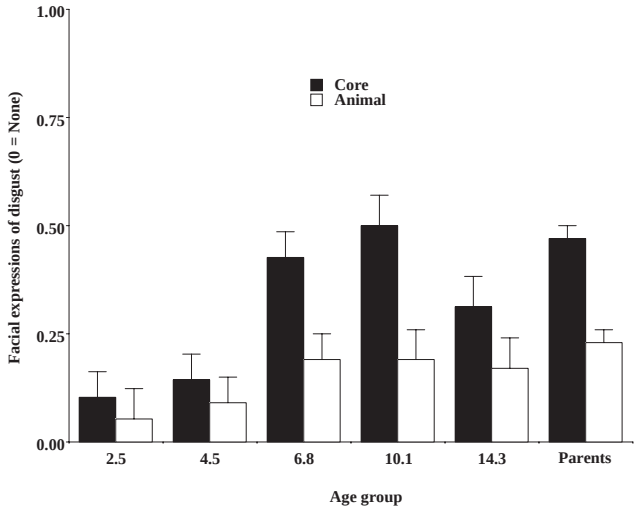

Figure 2. Mean number (+1 *SE*) of child facial disgust responses in Study 2 for the core and animal disgust elicitors by child age group. A score of 0 indicates no facial disgust response and 1 indicates facial disgust responses to all items.

significant, $F(4, 91) = 5.14$, $MSE = .05$, $p < .001$, $\eta_p^2 = .18$, but a significant difference was present only for the oldest age group ($p > .01$; see Figure 4). In sum, these data confirm the findings observed in Study 1 and suggest that core, animal, and sociomoral elicitors do indeed have differing developmental trajectories.

Developmental sequence. These analyses addressed Question 2 of Aim 1, namely whether responding to core elicitors can be detected earlier than responding to animal and sociomoral elicitors.

Facial expression. One-sample *t* tests with mu equal to 0 (i.e., no response; with one-tailed Bonferroni-corrected α) showed that core elicitors first significantly differed from "no response" at Age Group 2.5 years, $t(18) = 2.65$, $p < .01$, $r^2 = .28$, 95% CI = .02–.19, and for animal elicitors at Age Group 6.8 years, $t(20) = 2.61$, $p < .01$, $r^2 = .25$, 95% CI = .04–.34.

Behavior. One-sample *t* tests with mu equal to 0 (i.e., no avoidance; with one-tailed Bonferroni-corrected α) showed that both core elicitors, $t(18) = 5.18$, $p < .01$, $r^2 = .60$, 95% CI = .25–.59, and animal elicitors, $t(18) = 6.22$, $p < .01$, $r^2 = .68$, 95% CI = .38–.78, evidenced detectable levels of behavioral avoidance at the Age Group 2.5 years.

Self-report. One-sample *t* tests with mu equal to 0 (i.e., indifference; with one-tailed Bonferroni-corrected $\alpha = .01$) showed core elicitors first evidenced significant negative affect at Age Group 2.5 years, $t(18) = 4.81$, $p < .01$, $r^2 = .56$, 95% CI = from −.13 to .32; animal elicitors at Age Group 4.5 years, $t(20) = 3.29$, $p < .01$, $r^2 = .35$, 95% CI = from −.08 to .35; and sociomoral elicitors at Age Group 6.8 years, $t(20) = 5.50$, $p < .01$, $r^2 = .60$, 95% CI = −.14 to .32.

These data suggest that affectively negative responses to core elicitors can be detected on all three measures in the youngest children. However, behavioral avoidance of animal elicitors was also evident in the youngest children, but facial expression and self-report data indicated a later onset. Sociomoral responses were, unsurprisingly, the last to emerge.

Contagion, conservation, contamination, and disgust. The analyses that follow explore whether core (disease-related) disgust responding can be observed in the absence of knowledge about contagion and conservation (Question 3 of Aim 1), whether there is a relationship between contamination sensitivity and understanding of contagion and conservation concepts (Question 4 of Aim 1), and whether contamination sensitivity can be detected in children in the absence of these concepts (Question 5 of Aim 1).

First, we established whether age-related changes in contagion and conservation responses were evident in our data (see Table 3)—as one would expect. On the contagion task, there were significant age-related changes (by age group) for the forced choice, $\chi^2(4, N = 96) = 12.47$, $p < .02$, and free response questions, $\chi^2(4, N = 96) = 24.36$, $p < .001$. On the conservation task, there were also significant age-related changes (by age group) for the forced choice, $\chi^2(4, N = 96) = 30.21$, $p < .001$, and free response, $\chi^2(4, N = 96) = 50.36$, $p < .001$, questions. Responses to all of these four questions were correlated (ϕ coefficients ranged from .26 to .54).

We then tested whether children who did not demonstrate any contagion or conservation knowledge would be able to show evidence of disgust responding. Eleven children demonstrated no such knowledge ($n = 11$; ages 2–6 years), and their responses were compared with children of similar age who did ($n = 40$; ages 2–6 years; age did not significantly differ by group). Using analyses of variance (ANOVAs), we found no significant differences in response to core elicitors between these two groups of children on any measures, nor to animal and sociomoral elicitors. We then examined whether the 11 children with no demonstrable contagion or conservation knowledge evidenced responses to core and animal elicitors, using the approach used in the developmental sequence testing described earlier. These 11 children showed significant levels of avoidance for both core elicitors, $t(10) = 6.71$, $p < .001$, $r^2 = .82$, 95% CI = .36–.73, and animal elicitors, $t(10) = 4.84$, $p < .001$, $r^2 = .71$, 95% CI = .29–.77, and significant levels of negative affect for core elicitors, $t(10) = 6.84$, $p < .001$, $r^2 =$

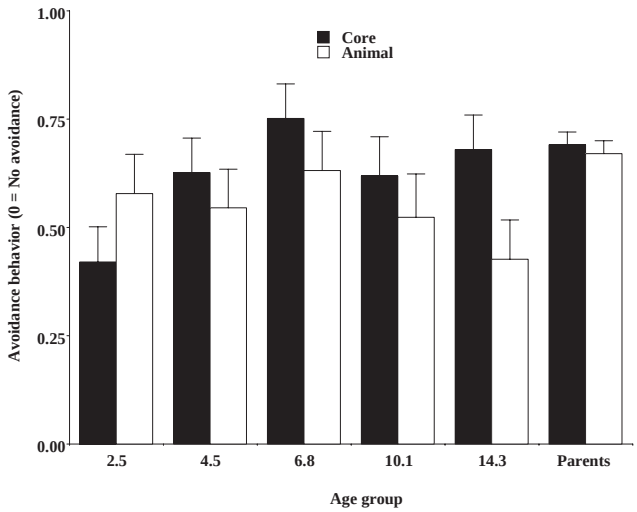

Figure 3. Mean child behavioral avoidance scores (+1 *SE*) in Study 2 for the core and animal elicitors by child age group. A score of 0 indicates no avoidance and a score of 1 indicates avoidance for all items.

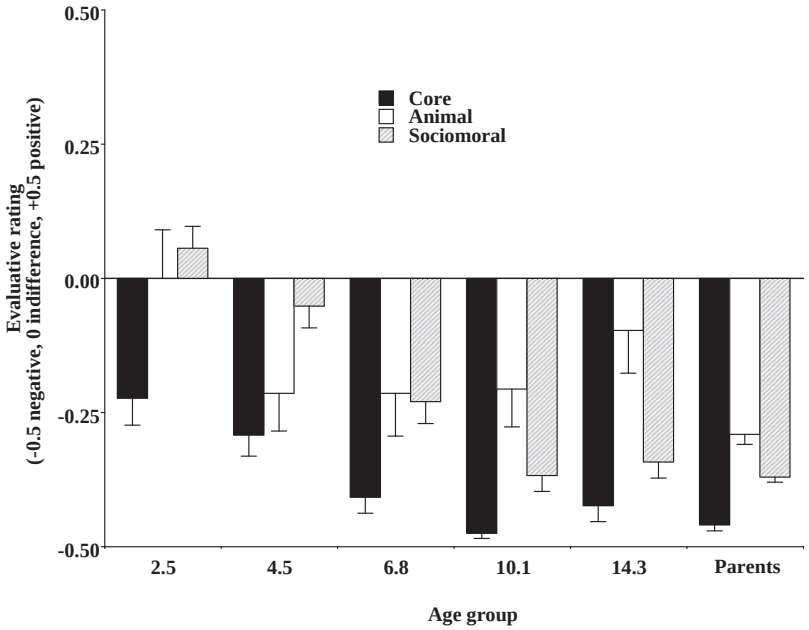

Figure 4. Mean child self-report evaluative ratings (1 *SE*) in Study 2 for the core, animal, and sociomoral items by child age group. A score of .5 = *positive evaluation*, 0 = *indifference*, and −.5 = *negative evaluation*.

.82, 95% CI = from −.19 to .38, but not for animal or sociomoral elicitors. Facial expression data for core elicitors approached significance, $t = 2.10$, $p = .06$, but not for animal elicitors. These findings suggest that children can evidence disgust in the absence of contagion and conservation knowledge.

Next, we established for the whole child sample whether there was any relation between performance on the potty test of contamination and any of the individual contagion or conservation responses or with the overall summed score. No significant relations emerged. We then tested whether rates of taking the candy (or not) from the bottom of the potty differed between the 11 children who evidenced no contagion or conservation knowledge and the 40 children of similar age who did. In those with no detectable knowledge, 7 of the 11 (64%) took the sweet compared with 26 of the 40 (65%) in those evidencing some knowledge. These two proportions did not significantly differ. These findings indicate that for the test of contamination used here, knowledge of contagion and conservation was unrelated to performance, and, indeed, children who had no detectable contagion and conservation knowledge evidenced contamination responses at similar rates to children who did.

Parent–child transmission. We started by examining whether parental disgust responding was affected by child age group. Child age group had no significant effect on parental self-report ratings. However, when we analyzed parental behavioral avoidance scores (collapsed across elicitors as the focus here was on response type) using two-way ANOVA (by child age group [between-factor] and elicitor type [within-factor]), they revealed a significant effect of child age group, $F(4, 91) = 4.97$, $MSE = 0.15$, $p = .001$, $\eta_p^2 = .18$. As we thought that this effect would be most marked in the youngest children and least marked in the oldest, we tested for linear and quadratic contrasts by age group. There was just a significant linear contrast ($p < .001$), suggesting that parents demonstrate more avoidant behavior to young children (see Figure 5). This finding remained even when parental DS score was used as a covariate.

Table 3
Responses on the Contagion and Conservation Tasks (Percentage of Participants Responding Correctly) and the Potty Contamination Task (Percentage Not Taking the Sweet From the Bottom of the Potty)

	Contagion task		Conservation task		
Age group	Open	Forced choice	Open	Forced choice	Contamination task
2.5 years (%)	5.3	73.7	10.5	10.5	26.3
4.5 years (%)	9.5	71.4	14.2	23.8	42.9
6.8 years (%)	23.8	90.5	57.1	52.4	38.1
10.1 years (%)	47.1	100.0	94.1	82.3	35.3
14.3 years (%)	66.7	100.0	94.4	77.8	50.0

Note. Open = open question; forced choice = forced-choice question.

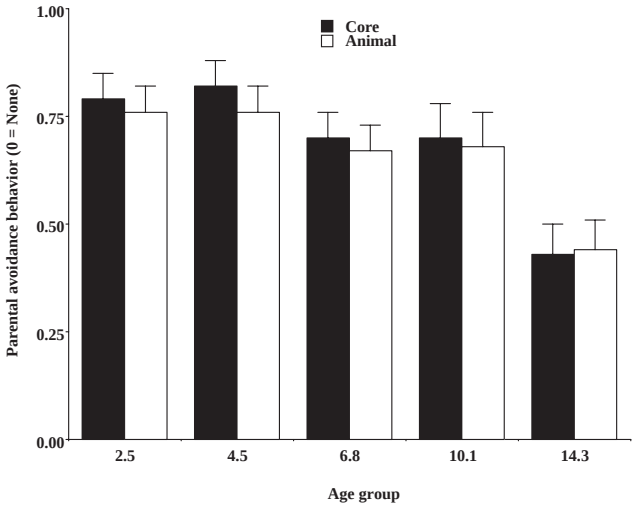

Figure 5. Mean avoidance scores (1 *SE*) for parents in Study 2 for the core and animal disgust elicitors as a function of their child's age group. A score of 0 indicates no avoidance, and 1 indicates avoidance for all items.

ANOVA revealed no child age group effect on parental facial data. We then examined whether the number of facial expressions of disgust directed at the child varied as a function of child age group (see Figure 6). ANOVA revealed no significant effect; however, there was a significant linear contrast by child age group, $p < .05$. This linear relation between child age group and child-directed disgust expression was still significant even with parental disgust sensitivity partialled out, $r(93) = -.21$, $p < .05$.

We then examined whether children's responses when tested in the absence of their parent would reveal any parental influence. Using regression, with backward elimination, we tested whether children's responses to core elicitors (collapsing across measures to control error rates) could be predicted by parental responses to core, animal, and sociomoral elicitors (again collapsing across measures) and by child age group. The final model for child core responses was significant, $F(1, 94) = 16.79$, mean squared residual error ($MSRE$) = 0.03, $p < .001$, adjusted $R^2 = .14$, and only one predictor was included in this model, child age group. No parental predictors were significant here. For child responses to animal elicitors, the final model was significant, $F(1, 94) = 6.20$, $MSRE = 0.05$, $p < .02$, adjusted $R^2 = .05$, and only one predictor was included in the model, parental responses to animal elicitors. For child responses to sociomoral elicitors, the final model was significant, $F(2, 93) = 37.36$, $MSRE = 0.03$, $p < .001$, adjusted $R^2 = .43$, and two predictors were included. The most important was child age group, $t(93) = 8.64$, $p < .001$, squared semipartial correlation coefficient (Sr^2) = .44, followed by parental responses to core elicitors, $t(93) = 2.52$, $p < .02$, $Sr^2 = .04$.

We suggested in the introduction to this experiment that potty training might be one area in which evidence for parent–child transmission of disgust could be obtained. We focused here on the youngest age group, as these children would have most recently been exposed to potty training. We tested whether there was a difference among parental avoidance, parental facial expression, and parental self-report (in each case, averaged across elicitor types as interest here focused on responses) by grouping parents according to whether or not their child took the candy from the bare floor of the potty. Although there were no significant differences in parental self-report and avoidance scores (both were in the expected direction), parents whose children had refused to take the sweet from the bottom of the potty generated significantly more disgust facial expressions ($M = 0.48$), $t(17) = 2.81$, $p < .02$, $r^2 =$

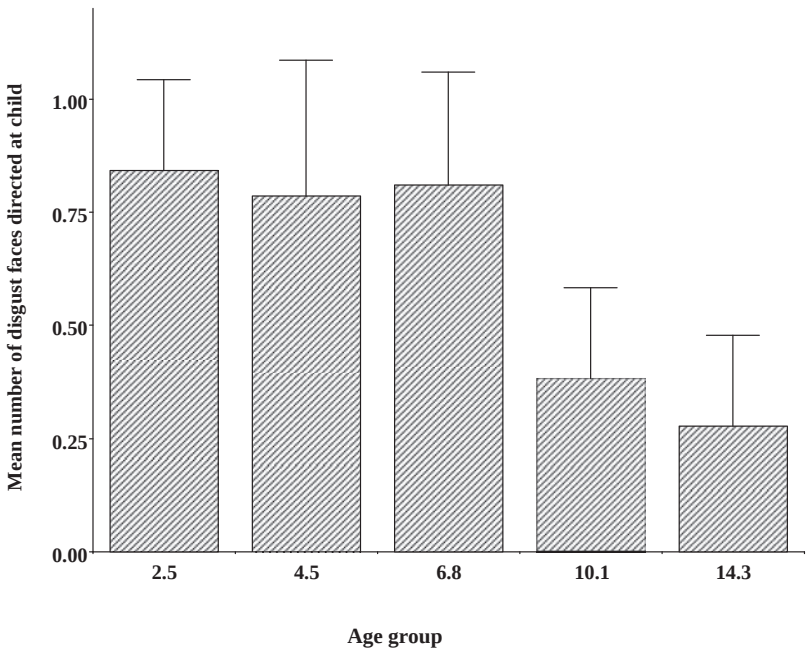

Figure 6. Mean (1 *SE*) number of facial expressions of disgust directed by parents at their child in Study 2 as a function of the child's age group.

.32, 95% CI = from −.36 to .05, than parents whose children took the sweet (M = 0.20).

External validity and conformity. The DS Scale was associated with parental self-report animal scores, $r(96) = .38$, $p < .001$, and sociomoral scores, $r(96) = .38$, $p < .001$, but with not core scores (due to less variability), The DS Scale also was associated with parental behavioral scores for core elicitors, $r(96) = .39$, $p < .001$, and animal elicitors, $r(96) = .37$, $p < .001$, and with disgust facial expression data for core elicitors, $r(96) = .27$, $p < .01$, and animal elicitors, $r(96) = .25$, $p < .02$. Finally, no significant associations were observed between child age and the conformity score, nor between the conformity score and the children's summed core, sociomoral, and animal scores, nor among the children's summed facial, behavioral, or self-report scores.

Discussion

In Study 2, we examined whether core, animal, and sociomoral disgust have distinct developmental trajectories and sequences, as suggested by parental reports obtained in Study 1. The convergence of several pieces of evidence suggests this distinction is a valid one: (a) Child responses to sociomoral elicitors develop later; they are age related and do not generate disgust facial expressions; (b) child responses to core elicitors are age related, and they generate facial expressions of disgust, behavioral avoidance, and negative affect even in the youngest age group (2.5 years old); and (3) child responses to animal elicitors develop early, avoidance is present in the youngest age group (2.5 years old), negative affect in next oldest age group (4.5 years old), and disgust facial expressions in the following age group (6.8 years old), but there is no age-related change. While these findings are broadly consistent with Rozin et al.'s (2000) developmental model, when considered with the other findings that follow, they suggest some grounds for revision.

We also examined whether children who do not appear to understand contagion and conservation concepts can still demonstrate appropriate responses to disgust elicitors. Children who were unable to demonstrate any understanding of contagion or conservation were still able to show appropriate (and significant) affective responses, avoidant behavior, and facial expressions of disgust, although the latter only approached significance. We also observed that there was no significant relation between the scores for contagion and conservation concepts and our measure of contamination and that contamination responses were as frequent in children with no contagion or conservation knowledge as in children who did evidence such knowledge. These findings are consistent with the notion that disgust and contamination responding may occur in the absence of related cognitions (contagion, conservation) and suggest that disgust can occur earlier in development than previously assumed (e.g. Rozin & Fallon, 1987).

In Study 2, we also examined whether evidence favoring parent–child transmission of disgust could be obtained. Parents of younger children demonstrated more marked avoidance of both core and animal elicitors than parents of older children, even when we controlled for disgust sensitivity. This finding is consistent with parents entraining disgust in young children. Disgust responding by children when they were tested alone also evidenced parental influence. Parental responding toward animal elicitors was associated with their child's response to these stimuli, and parents who were more reactive to core elicitors during the experiment had children who were also more responsive to sociomoral elicitors. Finally, Rozin et al. (2000) has noted that potty training may be instrumental in the early entraining of disgust. We obtained evidence here favoring this suggestion. Whether the youngest children took a candy from the bottom of a potty was predicted by their parents' frequency of emoting of disgust during the experiment. As we know that disgust sensitivity is minimally heritable (Rozin & Millman, 1987), these findings are consistent with the long-held suspicion that parents are instrumental in entraining disgust responding.

General Discussion

Before discussing the implications of our findings for the questions raised in the introduction, it is important to consider issues of validity. There are four potential concerns in this regard. The first relates to the use of parent informants in Study 1. Parents are in a particularly unique position to observe a child's behavior. Arguably, their insights offer a high level of ecological validity relative to results obtained in the laboratory, and in this regard it is noteworthy that the emergence ages for core, animal, and sociomoral disgust based upon parental report (Study 1) and self-report (Study 2) were almost identical (3 vs. 2.5, 4 vs. 4.5, 7 vs. 6.8 years old for each category and study, respectively).

A second concern is whether the disgust scenarios used in Study 1 and the disgust stimuli used in Study 2 were actually disgust evoking. For Study 1, parents reported them to be disgusting, and many of the questions were similar to those from the DS Scale, which has been behaviorally validated (Rozin, Haidt, McCauley, Dunlop, & Ashmore, 1999). Parents also reported that the sociomoral items were disgusting, and it has been argued that such reactions involve disgust (e.g. Schnall, Haidt, Clore, & Jordan, 2008). For Study 2, parental responses on all measures indicated that they found many stimuli disgusting. Moreover, parental responses obtained on these tests and measures (i.e., self-report, behavioral avoidance, emoting disgust) were found to correlate with the DS Scale score. Together, this suggests that our stimuli evoked disgust in adults and that this was evident in each of the different types of measures used.

A third issue concerns whether children's reaction to the stimuli in Study 2 represented an accurate reflection of their feelings and behavior. Even the youngest children were able to successfully apply the evaluative rating scale on a pretest, which suggests that they could understand the scale. Again, the youngest children were able to indicate consistent negative affect to the core elicitors, while not doing so for the animal and sociomoral items. Even when the experimenter placed the child in a situation of strong demand by opposing an earlier response the child had given, response reversals were relatively uncommon (22%) and were not related to test performance, child age, or gender. Finally, there was internal consistency among the child self-report, behavioral, and facial measures in that age-related trends across measures tended to be apparent for all (core elicitors) or none (animal elicitors).

A fourth issue relates to the stimuli and tests used in Study 2, and the implications these have for drawing distinctions about different developmental trajectories and sequences. If any of the selected stimuli were poor exemplars of a particular category (i.e., they were not particularly effective in eliciting, say, disgust in

response to an animal elicitor), then differences might emerge between categories simply because of their relative effectiveness, not because of any more fundamental difference. Taking first the distinction between core and animal elicitors, we suggest this not a problem for several reasons. First, in Study 1, in which multiple items were used, very similar differences between these two elicitor categories in developmental trajectory (factor analysis) and sequence (i.e., core elicitor, then animal elicitor) were observed. Second, somewhat similar distinctions between core and animal–nature elicitors have been identified in adult studies, both in self-report data (Olatunji et al., 2007) and in behavioral and physiological response data (Olatunji, Haidt, McKay, & Bieke, 2008). Third, there are good conceptual grounds to expect this category difference on the basis of parental responding (more discussion later). Fourth, items in Study 2 were selected as far as possible to resemble items from Study 1, and as is evident in Table 2 (recalling that this information was not known when stimuli were being selected), factor loadings for analogous core and animal items in Study 2 substantially overlap, making it arguably harder to observe differences between animal and core elicitors in Study 2. Finally, it is possible that certain forms of stimulus interaction may contribute to what makes for core disgust—especially the prospect of ingestion (see Rozin & Fallon, 1987; Rozin, Nemeroff, Horowitz, Gordon, & Voet, 1995; Simpson, Anthony, Schmeer, & Overton, 2007). However, an examination of Table 2 suggests that the hygiene (sock) and body product (odors) cues, both being core elicitors, generated similar responses to food—the only cue here to involve ingestion.

These concerns regarding effectiveness also need to be considered for the sociomoral cues, which as a set were different in several ways from animal and core elicitors. Such differences are arguably unavoidable because they reflect the very nature of sociomoral elicitors. For example, knowing that a brother and sister have had a child together might be judged disgusting because it brings to mind sex between siblings. In contrast, core and animal disgust elicitors are effective primarily because of their appearance. The implications of this are important here because implied cues require knowledge, and so choosing implied cues will almost always reveal age-related differences. This is the reason that for the sociomoral elicitors, we selected items that we thought would require progressively more knowledge—littering, theft from a disabled person, marriage between an older person and a young person, and the KKK picture; these individual age-related trends are apparent in Table 2.

As outlined in the introduction, Rozin et al. (2000) suggested that disgust might develop by a progressive expansion through five different stages. Our developmental data, from both Study 1 and Study 2, suggest three categories on the basis of commonality of age-related changes, which bear a relatively close resemblance to Rozin et al.'s (2000) theoretical model. However, we suggest that there may be a simpler underlying distinction present in our data between concrete elicitors (i.e., cues that generate disgust based upon their appearance) and abstract elicitors (i.e., those that drive disgust via their meaning (see previous paragraph). Animal and core elicitors here are clearly concrete cues, yet in both Study 1 and Study 2 they had differing age-related changes. We suggest this distinction may emerge as a consequence of individual differences in parental responsiveness to core and animal elicitors. Davey, Forster, and Mayhew (1993) have already reported similarities in parent–child responses to animal elicitors of disgust using self-report questionnaires. In our data, we too observed a small but significant association between parental responsiveness to animal elicitors and child responsiveness to those elicitors when tested alone. These findings may suggest why age-related changes were less apparent for animal elicitors as a category. Some children may never receive animal-related disgust entraining while others may receive considerable amounts. In contrast, core elicitors may be entrained by all parents. This may then lead to the difference between the core and animal categories, rather than representing a more fundamental distinction. In contrast, sociomoral elicitors clearly develop later, as Rozin et al. (2000) suggested. Our data suggest that child responsiveness to such cues may also be affected by parental disgust responsiveness, as we observed that children of parents who were more reactive to core elicitors were also more reactive to sociomoral elicitors, although age group here was by far the most significant predictor (i.e., reflecting the child's ability to understand what the sociomoral elicitor implies). This parent–child correlation is particularly interesting as it is the first evidence that parental disgust responsiveness may play a role in shaping the child's reaction to sociomoral cues. In sum, our data, the first to actually explore children's reaction to a range of disgust elicitors, suggest a far more basic distinction between concrete and abstract elicitors than the broader conceptual scheme originally suggested by Rozin et al. (2000).

From an evolutionary perspective, there may be good grounds for requiring disgust responding to emerge as soon as possible during development, so as to protect the child from ingesting or contacting items that may result in infection and death (e.g. Oaten et al., 2009; Schaller & Duncan, 2007). We found here that children evidenced detectable disgust responses on all measures in the youngest age group in Study 2 and that these responses were evident to the same degree in children who lacked knowledge of contagion and conservation. In addition, we also observed a simple form of contamination that may emerge at the same time as response to core elicitors and that was unrelated to conceptual knowledge of contagion and conservation. The failure to obtain any association between avoidance on this task and the contagion and conservation tasks may reflect the physical presence of the potty. Fallon et al. (1984) observed in a study using vignettes that the absence of direct contact (i.e., feces removed from juice) may eliminate negative hedonic responding in young children that is apparent when the elicitor is in contact with the stimulus. It may be this persistence in responding after removal of the contaminant that is sensitive to an understanding of contagion and conservation.

Several observations from Study 2 contribute to our nascent understanding of parent–child transmission of disgust. First, we note that this is the first time that parent–child transmission has been directly observed in terms of greater behavioral avoidance and more direction of facial expressions of disgust by the parents of younger children. Both of these effects were independent of differences in disgust sensitivity, suggesting that these behaviors are probably invoked by the presence (and/or behavior) of young children. Second, we observed correlations between parent and child reactions to animal elicitors and found a similar relationship between parental response to core elicitors and children's response to sociomoral elicitors. Third, we also found that parents of young children who avoided taking the candy from the bottom of the potty generated significantly more facial expressions of disgust

than parents of children who did take the candy. These relations could, of course, reflect genetic variation in predisposition to disgust; however, previous twin study data (albeit based on self-report) suggest that disgust responding is minimally heritable (Rozin & Millman, 1987). Alternatively, parents may generate more disgust facial expressions as well as doing a number of other things to entrain disgust responding in their offspring. Clearly, this is a possibility, as our data are correlational. Thus, while we must remain "agnostic" as to the mechanism that underpins the acquisition of disgust elicitors, our data are consistent with claims made by several authors (e.g. Rozin et al., 2000; Tomkins, 1963) that parent–child transmission underpins disgust acquisition and that facial expression is involved in this process.

The early acquisition of core elicitors may have distinct functional benefits in allowing the child to avoid contact with potential pathogens, even if the child does not have the cognitive capacity to understand more abstract forms of contamination (i.e., contamination after the contaminant has been removed). This is consistent with the view advanced in the introduction that disgust may serve a disease-avoidance function (e.g. Oaten et al., 2009; Schaller & Duncan, 2007). As infectious disease has historically accounted for a significant proportion of child morbidity (Dobson & Carper, 1996), both parents and children have much to gain from the early acquisition of disgust.

References

Curtis, V., & Biran, A. (2001). Dirt, disgust, and disease: Is hygiene in our genes? *Perspectives in Biology and Medicine, 44,* 17–31.

Davey, G. C. L. (1994). Disgust. In V. S. Ramachandran (Ed.), *Encyclopedia of human behavior* (Vol. 2, pp. 135–143). San Diego, CA: Academic Press.

Davey, G. C. L., Forster, L., & Mayhew, G. (1993). Familial resemblances in disgust sensitivity and animal phobias. *Behavior Research and Therapy, 31,* 41–50.

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

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.

Feinman, S. (1982). Social referencing in infancy. *Merrill-Palmer Quarterly, 28,* 445–470.

Field, T. M., Woodson, R., Greenberg, R., & Cohen, D. (1982, October 8). Discrimination and imitation of facial expressions by neonates. *Science, 218,* 179–181.

Haidt, J., McCauley, C., & Rozin, P. (1994). Individual differences in sensitivity to disgust: A scale sampling seven domains of disgust elicitors. *Personality and Individual Differences, 16,* 701–713.

Hejmadi, A., Rozin, P., & Siegal, M. (2004). Once in contact, always in contact: Contagious essence and conceptions of purification in American and Hindu Indian children. *Developmental Psychology, 40,* 467–476.

Klinnert, M. D. (1984). The regulation of infant behavior by maternal facial expression. *Infant Behavior and Development, 7,* 447–465.

Levenson, R. W., Ekman, P., & Friesen, W. V. (1990). Voluntary facial action generates emotion-specific autonomic nervous system activity. *Psychophysiology, 27,* 363–384.

Marzillier, S. L., & Davey. G. L. (2004). The emotional profiling of disgust-eliciting stimuli: Evidence for primary and complex. *Cognition and Emotion, 18,* 131–316.

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

Olatunji, B. O., Haidt, J., McKay, D., & Bieke, D. (2008). Core, animal reminder, and contamination disgust: Three kinds of disgust with distinct personality, behavioral, physiological, and clinical correlates. *Journal of Research in Personality, 42,* 1243–1259.

Olatunji, B. O., Williams, N. L., Tolin, D. F., Abramowitz, J. S., Sawchuk, C., Lohr, J. M., & Elwood, L. S. (2007). The Disgust Scale: Item analysis, factor structure, and suggestions for refinement. *Psychological Assessment, 19,* 281–297.

Piaget, J., & Inhelder, B. (1974). From conservation to atomism. In J. Piaget & B. Inhelder (Eds.; A. J. Pomerans, Trans.), *The child's construction of quantities* (pp. 67–116). London: Routledge & Kegan.

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.

Rozin, P., & Fallon, A. (1987). A perspective on disgust. *Psychological Review, 94,* 23–41.

Rozin, P., Fallon, A., & Mandell, R. (1984). Family resemblance in attitudes to foods. *Developmental Psychology, 20,* 309–314.

Rozin, P., Haidt, J., McCauley, C., 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.

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

Rozin, P., & Millman, L. (1987). Family environment, not heredity, accounts for family resemblance in food preferences and attitudes. *Appetite, 8,* 125–134.

Rozin, P., Nemeroff, C., Horowitz, M., Gordon, B., & Voet, W. (1995). The borders of the self: Contamination sensitivity and potency of the body apertures and other body parts. *Journal of Research in Personality, 29,* 318–340.

Schaller, M., & Duncan, L. A. (2007). The behavioral immune system: Its evolution and social psychological implications. In J. P. Forgas, M. G. Haselton, & W. von Hippel (Eds.), *Evolution and the social mind: Evolutionary psychology and social cognition* (pp. 293–307). New York: Psychology Press.

Schnall, S., Haidt, J., Clore, G. L., & Jordan, A. H. (2008). Disgust as embodied moral judgment. *Personality and Social Psychology Bulletin, 34,* 1096–1109.

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

Simpson, J., Anthony, S. H., Schmeer, S., & Overton, P. G. (2007). Food-related contextual factors substantially modify the disgust response. *Food Quality and Preference, 18,* 183–189.

Solomon, G. E. A., & Cassimatis, N. L. (1999). On facts and conceptual systems: Young children's integration of their understandings of germs and contagion. *Developmental Psychology, 35,* 113–126.

Steiner, J. E. (1979). Human facial expressions in response to taste and smell stimulation. In H. Reese & L. Lipsitt (Eds.), *Advances in child development and behavior* (Vol. 13, pp. 257–295). New York: Academic Press.

Tomkins, S. (1963). *Affect, imagery and consciousness: Vol. 2. The negative affects.* New York: Springer.

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.

Young, A., Perrett, D., Calder, A., Sprengelmeyer, R., & Ekman, P. (2002). *Facial expressions of emotion: Stimuli and tests.* Suffolk, UK: Thames Valley Test Co.

Received July 24, 2008
Revision received April 24, 2009
Accepted May 5, 2009 ■