

Review

Contamination sensitivity and the development of disease-avoidant behaviour

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Owing to their developing cognitive abilities and their limited knowledge about the biological basis of illness, children often have less expertise at disease avoidance than adults. However, affective reactions to contaminants through the acquisition of disgust and the social and cultural transmissions of knowledge about contamination and contagion provide impetus for children to learn effective disease-avoidant behaviours early in their development. In this article, we review the ontogenetic development of knowledge about contamination and contagion with particular attention to the role of socialization and culture. Together with their emerging cognitive abilities and affective reactions to contaminants, informal and formal cultural learning shape children's knowledge about disease. Through this process, the perceptual cues of contamination are linked to threats of disease outcomes and can act as determinants of disease-avoidant behaviours.

Keywords: children; contamination; disgust; disease avoidance

1. INTRODUCTION

Cleanliness and order are not matters of instinct; they are matters of education, and like most great things, you must cultivate a taste for them.

(Benjamin Disraeli)

Immense challenges to human fitness and survival require children at an early age to learn about strategies to avoid disease. Above all, since the act of ingestion is of primary importance to health and survival, children need to focus on the edible–inedible distinction in recognizing that substances appearing good to ingest may in reality be harmful. Research carried out in Western countries and in Japan has shown that even at an early age children are attentive to information concerning whether food or liquids can be consumed. Moreover, they have considerable understanding of the life and death consequences of ingestion. In this article, we examine children's knowledge about hygiene and illness and the consequences for disease-avoidant behaviour.

2. KNOWLEDGE OF CONTAMINATION AND CONTAGION IN RELATION TO BIOLOGICAL CONCEPTS

Research has long documented the early sensitivity of young children in countries such as America and Australia, to the possibility that food can be contaminated [1–5]. By the age of 4–5 years, children recognize that dissolving substances remain in liquids and that food or juice that has been in contact even momentarily with a contaminant such as a cockroach will remain

harmful—or at least has been transformed—even though evidence of the contaminant is no longer visible. They even show a strong associational contamination reaction in which a substance that has been in proximity to a contaminant such as cockroaches is avoided, even though it has not been in direct contact [6].

In a particularly innovative study, Kalish [7] found that young American children between 3 and 5 years are able to distinguish between mental and bodily reactions to contamination. In particular, they are aware that knowledge of contamination determined mental reactions to contamination, while physical contact determines bodily reactions. However, although preschoolers do distinguish between physical and mental reactions to contamination, they can have a weak understanding of the actual bodily processes involved in illness. When questioned about the particulars of reactions to illness, many preschoolers did not realize that illness takes time to develop. Indeed, instead of identifying germs as living organisms that multiply, American children aged 4–7 years appear to maintain that germs are not alive and that colds are as likely to be transmitted by poisons or by irritants such as pepper as by germs. They may also claim that germs grow like tumours but do not reproduce inside the body and do not eat or die [8].

Therefore, it might be concluded that young children make judgements about the role of germs in illness without considering biological causality at all. They may regard illness as simply owing to contact with noxious or poisonous substances rather than as the outcome of microscopic infection by germs. If so, they simply are reproducing a learned fact ('colds come from being close to someone else who is germy with a cold') rather than embedding their knowledge of illness within a biological theory. However, as Kalish [7] has remarked, 'Poisons and other chemical/physical entities

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can be viewed as mechanisms of contagion and contamination. Poison is clearly a contaminant. If one contacts poison one may become ill. Poison may also be a vehicle for contagion. For example, if someone gets a particularly virulent poison on his hand and then touches someone else, that second person may come to show the effects of the poison as well. The transfer of materials (and the effects of the materials) represents a coherent model of physical infection '...Germs function like poisons, as physical agents of contamination'. This type of theory of illness fits well with children's notions of death as involving finality in the material sense and the cessation of biological functions [9], even though children may not be clear as to what these biological functions may be [10]. As in other areas of scientific reasoning [11–13], a physical theory of illness may simply serve as a 'placeholder' for a full biological understanding that may not be understood until adolescence or adulthood, if at all.

Recently, children's contamination sensitivity has been investigated as part of their more general knowledge about illness, contamination and contagion. Raman & Gelman [14] have reported that American preschoolers not only have knowledge of contamination but they also recognize that not all disorders are transmitted exclusively through germ contagion. In particular, the children in Raman & Gelman's study selectively focused on appropriate and relevant cues in grasping that certain disorders, like allergies, are transmitted by parents at birth so they are not the result of contagious illnesses conveyed through germs. As their knowledge of illness transmission might reflect previous experiences of contagious illnesses such as colds rather than the expression of a genuine recognition of biological mechanisms, Raman & Gelman also explored how children infer the origin of fictitious illnesses. Children tended to rely on descriptions of the length of such illnesses, judging permanent diseases to be genetic and temporary diseases as more likely to be transmitted by contagion. Their pattern of responses mirrors that of adults who conceive of permanent disorders as being little influenced by environmental factors and temporary illnesses as emerging from the effect of transitory external conditions (i.e. contact with an ill person). According to these results, even preschoolers demonstrate a rather advanced biological understanding of illness in terms of causation that may be owing to genetic or environmental factors.

In a follow-up study, Raman & Gelman [15] sought to determine the extent to which young children are influenced by non-biological mechanisms, such as psychosocial relatedness, when asked to judge the likelihood of transmission of injuries and contagious illnesses. Children were asked to consider a range of social relationships (for example, family membership, or positive, neutral or negative relationship with acquaintances). They judged that a family or positive relationship would decrease the likelihood of contracting an illness from that person. Moreover, negative relationships produced heightened disgust reactions to contagion in contrast to contagion emanating from a family member or liked person. However, children's use of psychosocial information in judging the causes of illness was not part of an overall response

bias but it was limited to the domain of contagious illnesses. In fact, regardless of the type of relationship, even preschoolers maintained that injuries are not contagious.

Legare *et al.* [16] further examined children's explanations and predictions for contamination. Preschoolers and adults heard vignettes concerning contamination and they were asked to predict or to provide an explanation of the specific outcome. Even very young American preschoolers gave explanations based on contamination sensitivity. Most of them proposed an invisible mechanism, such as germs, as a possible explanatory mechanism for contamination. Children were significantly more accurate with their explanations than with their predictions when reasoning in the domain of everyday biology, which according to Legare *et al.* suggests a crucial role for explanations in children's process of learning about causal knowledge. As explanations involve theoretically unobservable elements to explain the phenomenon of contamination, they engage children in the important interplay between data and theory that leads to theory change and provides an important base for further learning.

Taking together, the results of the studies described so far delineate a quite effective early sense of contagion and contamination in typically developing Western preschool children. This understanding is in part a product of socialization influences concerning contamination and contagion [17]. These prompt children to behave according to an understanding of the basic categories of illness.

In Western countries and Japan, carers are normally very concerned to ensure that infants and young children exercise caution in ingesting substances. In this respect, social considerations, as well as conceptions of physical and biological processes, can influence judgements of foods as inedible. For example, people sometimes drop food at mealtimes and, once dropped, the food becomes dirty and avoided even without physical contact with contaminants, especially in some social contexts such as when eating in restaurants. Therefore, how people judge contamination might be influenced not only by the physical properties of the substances but also by the social context, which is characterized by specific and often implicit rules about appropriate food behaviour. This phenomenon is termed 'socially mediated rejection' in referring to the power of social context to determine whether food might be perceived as edible or inedible.

Given that carers spend a lot of time in teaching to very young children the edible–inedible distinction, Toyama [18], in a Japanese study, investigated how mothers and teachers explain to the children why fallen food is inedible. Under the assumption that, while the social rules are very clear and emotionally relevant for adults, they might be less clear and less salient for children compared with the physical principles of contamination, Toyama investigated whether adults mainly refer to physical principles or to social rules when teaching children to reject food dropped from the table. To examine this process of socially mediated rejection, children aged between 1 and 4 years were observed in two contexts, at home and at school during meal time, and mothers' and teachers' talk about dropped food was

analysed. Even 2 year-olds reacted differently to fallen food at home, where they almost always ate the food, and at school, where they seldom ate the food after it touched the floor. When asked to predict a story character's bodily and emotional reactions to eating fallen food, children by the age of 4 years were able to specify that physically contaminated food would cause bodily harm and that social contexts do not determine bodily reactions to food and germs. This was in spite of adults who acted in a manner that contradicts a strictly material causal explanation for food contamination. For example, if a child intentionally dropped food that was disliked, some mothers and teachers often told them to eat it, as a form of 'punishment'. Given such mixed information about edible–inedible distinction from caretakers, Japanese preschoolers' sophisticated understanding of physical contamination is quite surprising. It challenges the hypothesis that children acquire these beliefs solely from exposure to explicit information in the social world and points to the receptiveness of children to implicit information about the edible–inedible distinction. Thus, young children seem not to be totally ignorant of socially mediated rejection, even though the specific reasons for this kind of rejection may be implicit and unclear.

At the same time, Stevenson *et al.* [19] have highlighted the importance of parental influences in the development of a sense of disgust that accompanies acute contamination sensitivity. Australian children aged 2 and 16 years were exposed alone and with their parents to a range of elicitors. Self-reports, with behavioural and facial expression data were obtained along with measures of contagion, conservation and contamination. Evidence for parent–child transmission was also observed, with parents of younger children emoting more disgust to their offspring and with these children showing greater behavioural avoidance of potential contaminants. Moreover, child reactivity to animal and socio-moral elicitors and contamination correlated with parental responsiveness. Indeed, children as young as 12 months old are influenced in their object preferences by disgust reactions exhibited by their mothers [20], and slightly older children (14–18 months old) search less for objects associated with disgust reactions in strangers (experimenters) than for objects associated with happy emotional displays [21].

The ease at which typically developing children in Western countries and Japan display concern for the edible–inedible distinction seems to benefit from an early preparedness or receptiveness to information about food contamination. However, children with autism who are inattentive to speech and conversation, and thus do not benefit from socialization influences concerning contamination and contagion, lack contamination sensitivity compared with typically developing controls and to children with Down syndrome [22,23]. Thus, clearly the translation from 'awareness' to 'action' in young children is not automatic, but is mediated by cognitive, affective and socio-cultural processes. Specific cognitive abilities, like categorization and the understanding of causal relations, predispose individuals to recognize and remember perceptual cues that indicate the presence of a contaminant in the environment and to

link these with the biological concepts that connote disease [24]. Affective reactions to contaminants belong mainly to the domain of disgust. Responses involving disgust are acquired relatively early to promote avoidance of pathogens and these seem to trigger the behaviour of individuals in the direction of avoiding contamination and contagion [25,26]. Although arising relatively early in development, an initial delay in disgust reactions in young children may actually facilitate the learning of the edible–inedible distinction by not precluding *a priori* any particular food choices. Given that feral children show no signs of disgust reactions [27], learning about disgust is facilitated by an early preparedness [19] but still requires observational and cultural learning.

Of particular importance in children may be the extent to which disgust is directed outwards towards elicitors or inwards towards the self. Self-disgust in adults has been found to be an important determinant of mood and behaviour, consisting as it does of two subcomponents, disgust at one's 'self' and disgust at one's 'ways' or actions [28]. Although self-disgust has not been studied directly in children, self-conscious emotions seem to be present in the second year of life, as evidenced by the presence of pride [29] and shame [30] responses in children of that age: the presence of shame is particularly important in the present context as shame is closely related to self-disgust [28]. Disgust elicitors themselves are likely to repel a child and cause them to *avoid* a contaminated item. However, self-disgust, engendered by a real or imagined encounter with a contaminated item, is likely to affect a child's propensity to *approach* a contaminated item, through a negative appraisal of the actions that led (or might lead) to the encounter with the item and a negative evaluation of the self that resulted. In this way, disgust can be seen as an affective mechanism that protects the child from harm by influencing all aspects of the motivation to encounter or re-encounter a potentially harmful item.

3. CULTURE AND CONCEPTIONS OF ILLNESS

Another aspect of psychosocial conceptions of illness transmission has been investigated in classical Piagetian studies [31] and in a number of following studies [32,33] with reports that children aged 2–6 years have been seen to claim that illnesses is transmitted from the sun or trees or through magic or God [32]. In particular, they may believe that illness is the result of having been punished for naughty behaviour. They think that a child who transgresses by lying or stealing or by playing with prohibited objects will be more likely to develop disease than a child who behaves well. Thus, young children believe that illnesses such as colds are the result of punishment for misbehaviour. They have a belief in what Piaget termed 'immanent justice'—that justice is immanent in the transgression itself—similar to the 'divine retribution' orientation of the ancient Greeks that the gods will inevitably punish those who transgress. According to this view, children's conceptions of illness and their disease-avoidant behaviour need to undergo change to embrace an understanding of how

invisible microbial contamination and family genetic background can influence illness.

However, we now know that young children in Western countries and Japan generally do not endorse misbehaviour as a cause of illnesses that can be readily explained in terms of germ transmission. If asked to consider as a cause of colds either a child's naughtiness and/or his nearness to another child who coughs and sneezes, they choose the latter alternative [34]. Moreover, young children regard susceptibility to illness, rather than naughtiness, to be a likely cause of colds. For example, Inagaki & Hatano [35] showed cards to Japanese 5 year-olds illustrating two boys: boy A, who often hits and pinches his friend on the back but eats a lot at meals every day, or boy B, who is a good friend but eats only a little. When asked which boy is more likely to catch a cold from a child who has a cold and is coughing a lot, most children that they tested chose boy B. They placed more weight on the biological cause (insufficient nutrients) rather than misbehaviour.

However, although children often demonstrate an early incipient understanding of contamination and contagion that eschews immanent justice, conceptions of illness for both children and adults in Western as well as non-Western cultures are also strongly influenced by the 'laws of sympathetic magic' [36–38]. One of the laws, 'the magical law of contagion', states that persons or objects that have come into contact with each other continue to exert an influence on each other even after the physical contact has been severed ('once in contact, always in contact'). Any kind of properties might be transmitted, whether these are physical, moral or psychological in nature and harmful or beneficial in effect. The 'source' and the 'recipient' of contagion may come into direct or indirect contact (mediated by a 'vehicle') that may be brief or intimate. Transmission of properties occurs through the transmission of 'essence' believed to contain the essential unchanging properties of the source.

In magical contagion, the nature of the relationship between the source and the recipient determines whether contact has an impact upon the recipient's perceived well-being and what type of impact it will be. For example, Frazer [36] recorded that, for the Kai living in northern New Guinea, 'everything with which a man comes in contact retains something of his soul stuff'. Similarly, the Dowayo living in Cameroon believe that mountain water cannot be safe to drink unless offered by the owners and that uninvited drinking will result in disease [39]. One's enemy's character, or evil intent, could be absorbed into his clothing and passed on to the next person who is in contact with the garment. In Hindu Indians, children by the age of 8 years regard contamination of a drink through a stranger sipping as so severe that even boiling and cooling of the drink cannot reverse the effects of pollution that are seen as indelible [40]. Accordingly, disease avoidance has to do with staying away from bad people and ensuring that what is ingested is sourced from good people. Thus, in many non-Western countries, both children and adults who have a choice between polluted and purified water may prefer the former over the latter for reasons of tradition, social cohesion, taste

preferences, and familiarity in water supply and its perceived effects [41].

These beliefs are not inconsistent with those that we find in Western countries. According to Nemeroff & Rozin [42], for American adults, there are three different models of contagion: an association model (mere association in proximity between the contaminant such as a cockroach and the self or the substance to be ingested), a material essence model (transfer of physical properties, e.g. contamination of an edible substance through contact with a contaminant) and spiritual essence (transfer of non-material properties such as through contact with a stranger or 'impure person'). Thus, many Americans who feel vulnerable to disease express a desire to strive to avoid contact with those from a different ethnic group as these strangers can carry harmful pathogens [43]. Indeed, disease-avoidant conceptions and behaviour are subject to normative beliefs that reflect religious convictions and supernatural beliefs, even in Western countries [44,45]. In this connection, there are important differences even between English-speaking countries, such as the US and the UK, in religiosity that influence conceptions of basic scientific notions such as creationism [46]. American children are significantly more likely to ascribe to teleological explanations when compared with those in Britain [47], with implications for using spiritual essence in their reasoning about illness. Germs may be thought of as 'cute' or 'nasty' depending on their origin, with cute germs emanating from those who are loved and seen as too pure to carry harmful germs. By contrast, nasty germs emanate from those who are unloved and impure and thus especially likely to transmit harmful germs and infections [48]. In fact, for young children, a person portrayed as having been induced with purity from a loving religious source may be absolved of harmful intent to deceive others [49]. In the future, children's reasoning about illness is likely to be influenced by the widespread belief in the West and Japan that some bacteria are intrinsically 'good' or 'friendly': a conception that is widely reinforced through advertising. In the UK, some 3.5 million people take probiotics (containing the so-called friendly bacteria) every day [50]. It will be interesting to determine the extent to which these products, and the labels attached to them by advertisers, create cultural differences in development of ideas among children about the role of germs in disease.

In non-Western cultures such as in Africa where fire is critical to survival, children demonstrate an early mastery over fire use and control [51]. This process can be seen in terms of adaptive, domain-specific learning. By contrast, in such cultures, information from carers about contamination and contagion is often lacking and there may be little learning about disease-avoidant behaviours. Here, despite the extreme and often fatal risk of food and water contamination, efforts with adults to improve hygiene are not well understood by those who are targeted. For example, in Benin where there is often inadequate sanitation, latrines are uncommon. Even should parents of children want to have a latrine for use, it may be in order for convenience and comfort or to receive guests and to avoid shame or embarrassment. Safety from personal dangers such as encountering sorcery and dead spirits during the night

may also play a role in this desire. By contrast, the wish to avoid disease is at best a minor consideration [52].

4. CONCLUDING REMARKS

Cognitive development, affective reactions and opportunities for cultural learning are all essential ingredients in contributing to children's disease-avoidant behaviours. Thus for the most part, typically developing children in Western countries and Japan are well prepared by the age at which they enter school to have an elementary understanding of contamination and contagion. They can abide by the basics of hygiene in maintaining cleanliness and avoiding contaminants that lead to disease. By contrast, often children in Africa and in impoverished countries, such as Haiti and Myanmar, have little or no opportunity to gain information about the microscopic nature of contamination from their carers. Both children and their parents are at risk as they may possess less than adequate strategies for avoiding disease.

Conceptions of contamination and contagion develop on the basis of early culture-specific experiences. Through this process, the perceptual cues of contamination are linked to threats of disease outcomes that act as determinants of children's disease-avoidant behaviours. While the development of knowledge about contamination and contagion has been extensively studied, more attention needs to be devoted to the relation between such knowledge and the development of disease-avoidant behaviours. Although such behaviours might be more likely to occur in children with a mature knowledge of the biological mechanisms of contagion and contamination, an area that cries out for further investigation concerns translation from awareness to action. As contamination, pollution and water-borne diseases can jeopardize the health of children and their families everywhere, it is essential to determine what children in different cultures can and do know about contamination to formulate a scientific basis for intervention strategies that promote hygiene and disease avoidance.

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