Trends in Cognitive Sciences

Review

On Cuteness: Unlocking the Parental Brain and Beyond

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Cuteness in offspring is a potent protective mechanism that ensures survival for otherwise completely dependent infants. Previous research has linked cuteness to early ethological ideas of a 'Kindchenschema' (infant schema) where infant facial features serve as 'innate releasing mechanisms' for instinctual caregiving behaviours. We propose extending the concept of cuteness beyond visual features to include positive infant sounds and smells. Evidence from behavioural and neuroimaging studies links this extended concept of cuteness to simple 'instinctual' behaviours and to caregiving, protection, and complex emotions. We review how cuteness supports key parental capacities by igniting fast privileged neural activity followed by slower processing in large brain networks also involved in play, empathy, and perhaps even higher-order moral emotions.

Trends

The parent–infant relation is fundamental to infant survival and development.

Cuteness has emerged as an important factor for attracting caregiver attention and affection.

Cuteness is not limited to visual infant features, but is also found in positive sounds and smells.

Neuroimaging has started to identify how survival-related infant-positive and negative stimuli elicit core affective brain activity through fast attentional biasing and slow appraisal processes.

Beyond caregiving, cuteness has a key role in facilitating social relations, pleasure, and well-being, as well as increasing empathy and compassion.

Cuteness for Caregiving, Empathy, and Beyond

What is it about the sight of an infant that makes almost everyone crack a smile? Big eyes, chubby cheeks, and a button nose? An infectious laugh, soft skin, and a captivating smell? These characteristics contribute to 'cuteness' and propel our caregiving behaviours, which is vital because infants need our constant attention to survive and thrive. Infants attract us through all our senses, which helps make cuteness one of the most basic and powerful forces shaping our behaviour.

The prevailing view of cuteness came from the founding fathers of ethology, Nobel prizewinners Konrad Lorenz and Niko Tinbergen. They proposed that the cute facial features of infants form a 'Kindchenschema' (infant schema), a prime example of an 'innate releasing mechanism' that unlocks instinctual behaviours [1]. This hypothesis was part of their larger ethological program to define the biological study of behaviour. The program included at least four goals, namely, to define the physiology, survival value, evolution, and development of behaviour [2,3]. These goals are still relevant, but subsequent research has questioned some of their initial propositions, such as 'innate releasers', and the whole idea of 'instincts' [4–6]. The tools of modern neuroscience have provided the basis for a broader understanding and precise dissection of brain networks that process survival-related stimuli [7] and have clarified the impact of biologically relevant stimuli on brain networks related to motivation, pleasure, and learning [8].

Here, we propose to extend the concept of cuteness beyond the morphological features of the infant face to include positive auditory and olfactory features that attract parental caregiving. Infant laughs and babbles are examples of what has been called 'auditory cuteness' [9], where the infant's well-stretched vibrating vocal membrane produces mostly high frequency and pure tone-like sounds that attract caregivers across many bird and mammalian species [10]. Most existing neuroscientific research has not defined such auditory features as cute, but here we synthesize the existing research on stimuli belonging to our extended notion of cuteness and

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propose that the impact of cuteness on emotions and behavior is broader than suggested by the idea of 'instincts'. Cuteness is linked to the helplessness of human infants as a key (but not the sole) elicitor of complex parental caregiving [11]. It works on both fast and slow timescales; it elicits core affective brain activity through fast attentional biasing and slow appraisal processes. Our synthesis also indicates that there is a need to rethink the role of cuteness: It is a powerful positive stimulus and even non-infant stimuli can be cute. Beyond caregiving, cuteness appears to have a key role in facilitating social relations, pleasure, and well-being. As such, we speculate that cuteness may even go beyond eliciting caregiving to facilitate complex social relations by triggering empathy and compassion [12].

Here, we first discuss the existing behavioural and neuroimaging evidence for the fast processing of infant and infant-like cute stimuli. We investigate how our extended concept of cuteness helps to unlock complex caregiving even in adults who are not parents. This caregiving cannot be reduced to mere instinctual behaviour, but instead requires 'expertise' that takes time to acquire, and this slow acquisition changes the caregiver's brain. We present evidence suggesting that cuteness can also facilitate slow, complex behaviours that are also involved in caregiving. We discuss the implications of how problems for parents, such as **postnatal (postpartum) depression** (PND; see Glossary), and for infants, such as cleft-lip, alter the processing of infant stimuli and disrupt natural caregiving. We speculate that the modulatory effect of cuteness on brain networks could be linked to mechanisms for privileged access to consciousness. As such, we suggest that cuteness might usefully be construed as a potential candidate for expanding the '**moral circle**' [99] of entities worthy of moral consideration by increasing empathy and compassion.

Fast Responses to Infants

Cute infants attract our attention, and they also capture it quickly. Here, we extend the concept of infant cuteness to be a biologically significant, positive multimodal stimulus that, through sight, sound, or smell, elicits fast selective attentional processing that facilitates caregiving and other complex emotional behaviours. Other biologically significant negative stimuli, such as the infant cry, also elicit fast selective attentional processing [13–15]. These abilities enable infants to quickly affect people's, both parents and nonparents, brains and minds, which opens the possibility for complex caregiving and the promotion of sociality [1,16]. Cuteness, then, displays both instantaneous impacts and gradual effects that aid infants' evolutionary aim of survival, perhaps linked to both proximate and ultimate evolutionary functions [17].

Behavioural data demonstrate the salience and attentional prioritisation of infant cues, such as a cute face, on which most research has concentrated. The visual features that make infant faces cute include large, round eyes, a head 'too large' for the body, high eyebrows, full cheeks, and a small chin [1,18] (Figure 1A). Adults prefer to look at cuter infant faces [19–21] and even prefer them to adult faces [14,22]. The impact of cuteness transcends in-group versus out-group distinctions and cultural familiarity [23]. Infants and children also prefer to look at cuter infant faces [24,25]. The power of cuteness to capture attention may diminish as a child develops: both adults and children pay more attention to infants' faces than to older children's faces [26], suggesting that the power of cuteness in young children's faces fades as children mature. Crucially, cuteness does not operate alone, and may be influenced by experience. This influence is easily demonstrated in a simple computerised 'baby social reward task', where learning about an infant's easy or difficult temperament shifts subsequent cuteness ratings [27].

Infant cues spur us to action: both men and women will expend extra effort to look longer at cute infant faces [22,28] (for putative sex differences, see Box 1). When presented with cute and less-cute infants, adults prefer to give a toy to, or even adopt, the cuter one [29]. Adults who see an infant face before a simple task have faster reaction times and sustain their engagement in the task [30].

Glossary

Bifurcation: an abrupt qualitative change in the dynamics of the system when one or more parameter pass through critical values, for instance the loss of stability and appearance of sustained oscillations.

Connectome: the complete description of the structural connections between elements of a nervous system.

Hopf bifurcation: in nonlinear dynamics, a Hopf bifurcation is a local bifurcation in which an initially stable fixed point of a dynamical system loses its stability in an oscillatory fashion.

Global neuronal workspace model: a model that proposes that conscious access occurs once a stimulus gains access through ignition to a global neuronal workspace, where information is broadly shared and broadcasts it to many other processors.

Magnetoencephalography (MEG): a method of measuring brain activity by detecting minute perturbations in the extracranial magnetic field that are generated by the electrical activity of neuronal populations.

Metastability: in dynamical systems refers to a state that falls outside the natural equilibrium state of the system but persists for an extended period of time.

Monotropy: the concept according to Bowlby that infants have an innate and inborn capacity to attach primarily to a single caregiver.

Moral circle: the circle of entities worthy of moral consideration (i.e., the in-group of entities to whom kindness is extended).

Postnatal (postpartum) depression (PND): depression after birth associated with impairments in parent–infant interactions, as well as longer-term disruption of emotional and cognitive development of the infant.

Temporal discounting: the phenomenon whereby people typically devalue rewards as a function of the delay to their delivery.

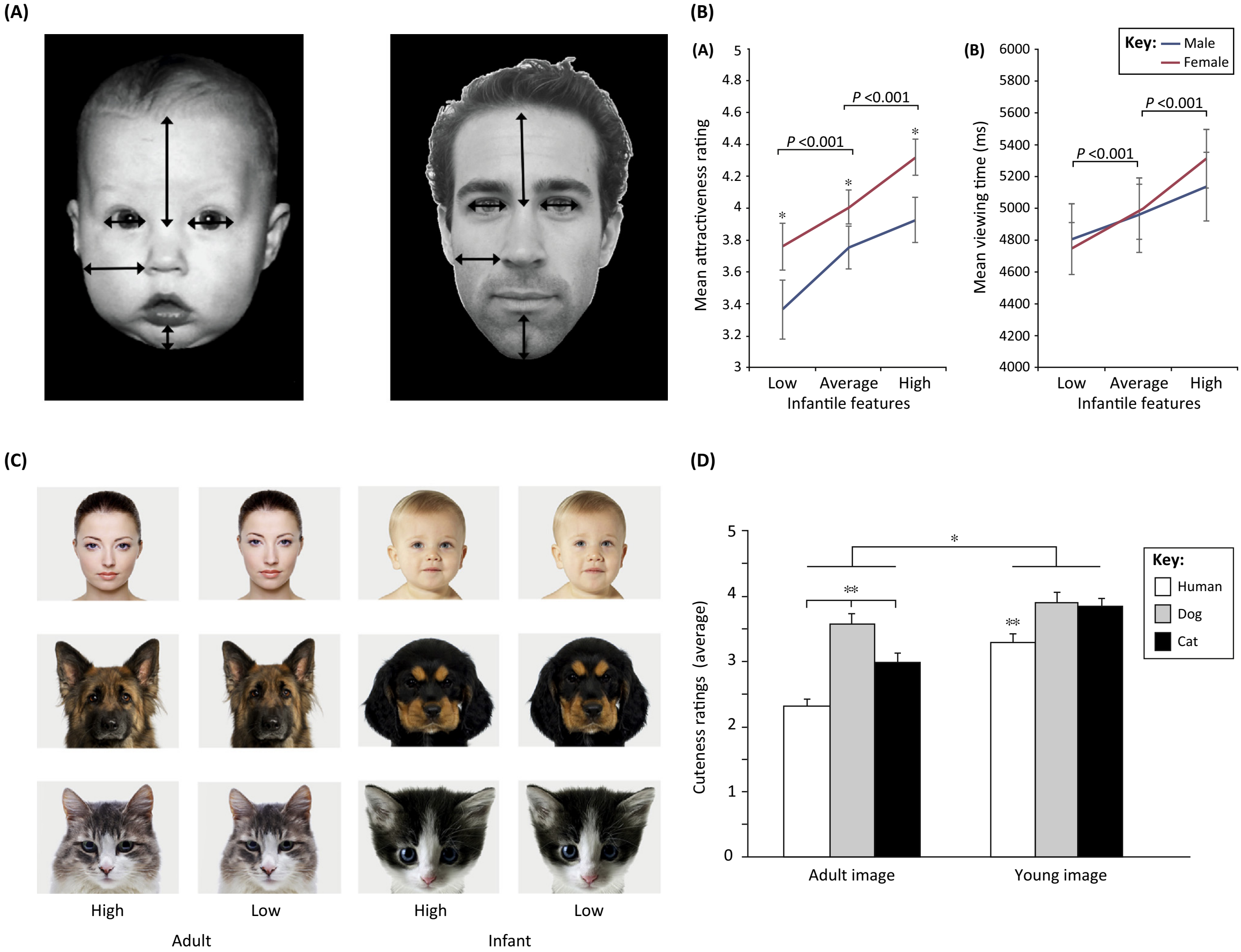

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Figure 1. Behavioural Measures of Cuteness of Faces across Species. (A) The proportions of features of a face can be used to provide objective measurements of cuteness in infant and adults [20]. (B) Adult men and women (who are not yet parents) differ in their liking ratings but not in the amount of effort they expend on viewing natural images of infants with varying levels of objective cuteness [22]. (C) Artificially changing the proportions of the faces of humans, dogs and cats can change their perceived cuteness, although questions have been raised over the ecological validity of such nonecological image manipulations. (D) Five year old children find the young significantly cuter than the adult of different species [24]. (C,D) Reproduced from [24].

Therefore, cuteness is a fundamental mechanism that helps to elicit caregiving. As mentioned above, cuteness is not limited to visual cues, but works through the other senses: infant laughter and babbling [31,32] and even smell [33]. When we have oriented to and recognised an infant, which cuteness helps to secure, slower and more complex behaviours can begin, starting with ‘intuitive parenting’ [34], and leading to higher-order capacities, such as intersubjectivity, attachment, and cognitive functions [35].

It is interesting to compare the positive, cute infant stimulus to the negative, aversive stimulus of, for example, an infant distress cry. Analogous to the effect of seeing an infant face or hearing infant laughter, adults also increase their effort in simple motor tasks after hearing the ‘biological siren’ of an infant cry [36]. Both positive and negative infant cues provide evidence that they take a ‘fast’ pathway in the brain. Our brains are equipped to respond quickly to a baby cry, whether

Box 1. Gender and Cuteness

Sexual dimorphism in responsiveness to cute infant cues is an important area of research to understand how cuteness affects us. Yet, a focus upon a **monotropy** in terms of infant–parent relations has led to an inequity within the literature, with mothers favoured at the expense of fathers [105]. These ideas may have recourse to the work of the founding father of attachment theory, John Bowlby [16], who initially proposed that children are born with a biological predisposition to form one exclusive attachment relation. Bowlby attributed this unique relation to the mother, proposing that a single maternal relation was enough to aid survival. We propose an end to this monotropy, and a renewed focus in parenting research upon both male and female responsiveness to multimodal infant cues. This includes homosexual fathers as primary caregivers, in addition to fathers as secondary caregivers [106].

What we do know exemplifies the importance of studying behavioural data relating affective response to action. The first step in understanding gendered caregiving behaviour is to explore the motivational salience of cute infant cues. Here, results have been mixed. Women have been found to display greater overt positive appraisals of infant facial features compared with significantly lower attractiveness ratings in men (Figure 1B, main text) [22,107,108]. Yet, any hedonic response involves both a 'liking' and a 'wanting' component [8], and results showing gender discrepancy have principally focused upon explicit evaluations of liking. When given a key press task conferring control over the viewing time of infant stimuli, men have shown similar incentive salience to women (Figure 1B, main text) [22] (although see [28]). Such findings suggest that men are less conscious of, or less willing to admit to, the compelling nature of infant cues. Furthermore, these responses can be modulated by expertise in both parents as shown by fathers exhibiting similar brain activity to mothers in regions relating to salience, reward, and empathy, among others, when watching footage of themselves interacting with their infant [106]. In addition, another cross-sectional study has shown that parenthood may lead mothers to become more sensitive to infant's emotions, while fathers become less sensitive [109]. Yet, clearly the field needs longitudinal research into the development of parental responsiveness in both sexes to infant cues, combining neuroimaging and behavioural responsiveness measures.

we are female or male, parents or nonparents. That is, even nulliparous adults display fast brain responses to both auditory [37,38] and visual [15,39] infant cues. Important general differences between negative aversive stimuli, such as crying, and positive inviting stimuli, such as cute babbling and laughter, are found in the parental behaviour that follows them. Whereas crying initiates less flexible, more stereotyped behaviour to prevent or terminate the noise, cuteness promotes sociality, smiling, laughter, and more complex interactions designed to continue the interaction [40]. Cuteness clearly facilitates caregiving, and the cuteness response is not limited to instincts, but is characterised by complex interactions.

Neuroimaging data provide evidence of rapid, intuitive responses to infant cues followed later by processing in several brain regions [15,39,41]. **Magnetoencephalography** (MEG) has shown that men and women, parents and nonparents all have rapid (within 140 ms) selective neural responses to infant faces [15] (Figure 2A). This rapid activity is found in the orbitofrontal cortex when participants look at infant faces, but not at adult faces or infant faces with a craniofacial abnormality that disrupts the typical cute facial composition [39]. The orbitofrontal cortex has been implicated in representing salient stimuli on multiple timescales [42–45] possibly to coordinate the resources of the brain for further action and sociality [46]. Experience also has a role here, because parents' brains respond to their own, rather than to unfamiliar, infants with stronger activity in reward-related regions [47–49].

Of course, other stimuli can be cute; we raise animals, such as puppies and kittens, to look cute (Figure 1C). Children and adults have given similar cuteness ratings to animal and infant pictures [24,50]. Adults find young cats and dogs cuter than adult cats and dogs, although pet owners show higher cuteness ratings for human infants, suggesting that expertise has a role [51]. Cartoon characters such as Mickey Mouse have become 'cuter' and more baby-like over time [52]. Cuteness has been transferred to inanimate objects, such as cars and toys [53]. The iconic children's toy, the teddy bear, has gradually changed to become more baby-like, which may have evolved through a process of artificial selection whereby consumers chose ever-cuter bears [53].

Similarly, the Japanese term 'Kawaii' is often translated into English as cute, although its etymological roots are in the ancient word 'kawa-hayu-shi', which literally means face (kawa-) flushing (hayu-shi) [23,40], as demonstrated in an experiment using thermography to show an increase of facial temperature in adults when viewing infant faces [23]. Kawaii objects share many of the cute-infant-schema features and viewing Kawaii images has also demonstrated behavioural task improvements and a narrowed attentional focus [40].

Facilitation of Parental Capacities for Caregiving

Empirical evidence suggests that cuteness has a key role in facilitating the parent–infant relation, which is a highly dynamic and intensely social template of all later human relations. For infants, this dynamic starts with basic orienting and recognition processes and culminates in attaining higher socioemotional and cognitive capacities [35,54,55]. This slow process is shaped by social interactions with primary caregivers, typically parents, who in turn rely on infant signals to guide their interactions [56,57]. Becoming a parent can be daunting at first, but parent–infant interactions are full of reciprocal influences and each party comes to the task well equipped. Just as infants have excellent competences, such as cuteness and crying, that elicit attention and care, parents have capacities that facilitate optimal care.

To be able to provide this care, at least three ‘parental capacities’ have to develop: (i) a focus of attention on the infant and an associated contingent responsiveness; (ii) emotional scaffolding, especially when the infant is distressed; and (iii) behavioural sensitivity to attachment cues and mentalisation (i.e., the capacity to treat an infant as a psychological agent) [46]. The antecedents to these capacities, particularly attentional focus, are even found in the brain processes of nonparents [15,58].

A key question for immediate future work in this area is how parental ‘expertise’ develops and whether our perceptions of cuteness change over time or with experience. Despite the fundamental capacity to orient and respond to infants, their care requires a complex and demanding array of skills (e.g., emotional scaffolding and mentalisation) that parents must acquire and hone. There is a wealth of longitudinal, cross-cultural behavioural data on parenting [55,59], but a dearth of neuroimaging data on longitudinal changes in the parental brain. Except for two recent studies that investigated structural changes in grey matter in parents at two time points postpartum [60,61], all previous neuroimaging work has been cross-sectional studies of parents and nonparents [46,57]. However, we are in the process of carrying out the first longitudinal combined functional and structural neuroimaging study of the parental brain before conception, immediately after birth, and 12 months later.

What has emerged from the cross-sectional studies of the parental brain is the engagement of brain networks known to have roles in emotion, pleasure, social interactions, mentalisation, and embodied simulation [57,62,63]. Important hubs in these emotional networks include the orbitofrontal cortex, anterior cingulate cortex, anterior insula, amygdala, and supplementary motor area [64]. As shown earlier, the orbitofrontal cortex in particular appears to be crucial for recognising infant cues as salient, tagging them for fast processing, and orchestrating slower subsequent appraisal behaviours [46]. These findings have led to the hypothesis that the orbitofrontal cortex is a key brain region that changes as parental expertise develops.

In overview, none of these brain networks appears to be unique to caregiving behaviour. Although they are recruited by both positive and negative infant-related stimuli, these networks are also recruited in other prosocial contexts. The evolutionary importance of infant survival means that infant-related stimuli are extremely salient and able to sustain metabolically expensive behaviours, such as parental caregiving, over longer timescales. Both negative and positive infant stimuli are important for the fast responses involved in caregiving [14,37]. Negative stimuli, such as crying, have been intensively investigated for their role in rapidly instigating and sustaining caregiving [37,58,65]. Positive stimuli, such as cute smiling infant faces and babbling, are equally able to incite

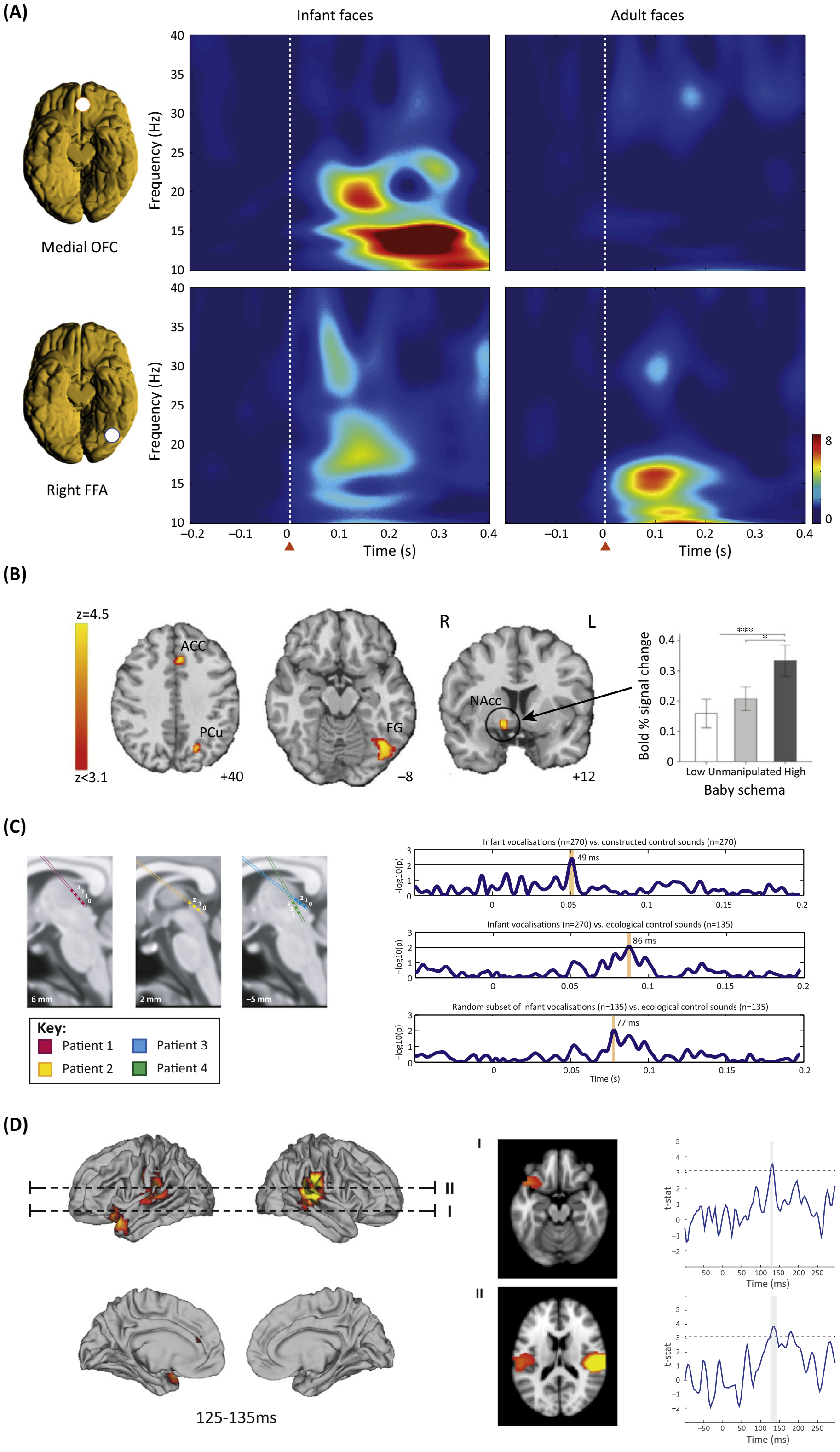

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Figure 2. Cuteness Elicits Fast Responses in the Human Brain. (A) Infant faces are examples of cute stimuli that have been shown to elicit fast brain responses in the orbitofrontal cortex (OFC, ~130 ms) at the same time as responses in

(Figure legend continued on the bottom of the next page.)

fast brain responses [14,15,37]. There is some evidence of kinship-related cuteness (i.e., of differences in parents' prioritisation of own versus other's infants in terms of attentional [66] and emotional [67,68] processing). However, cute stimuli in general also engage other slower prosocial behaviours, such as play and empathy [12,69].

Difficulties in Prioritising Attentional Resources to Cute Stimuli

Neuroscientific research is helping to explicate parental and infant capacities, which is important because difficulties in the parent–infant relation present a major challenge, since early childhood often proves crucial for long-term well-being [54]. A better understanding of problems in the parent–infant relation affords unique opportunities to invest in prevention, an exceedingly efficient societal strategy [70].

Disruption in parental sensitivity to infant cues is commonly found in parental PND (e.g., [71]), which affects substantial numbers of both mothers and fathers, typically 10–15% in high-income countries [72,73] and up to 30% of mothers in low- and middle-income countries [74]. PND can affect parenting in many ways. It has been associated with altered parent–infant interactions [75,76], including, as mentioned, disruptions in parental sensitivity to infant cues (e.g., [71]). It can particularly affect cognitive processes, such as attention and motivation, which are vital for developing parenting capabilities. In terms of responsiveness to infant signals, for example, both mothers with PND [77,78] and adults with depression [38,79] exhibit disrupted sensitivity to negative stimuli, such as distress in infant cries and faces. PND has also been associated with increased risk for childhood cognitive and socioemotional problems [80,81].

Changes in infants' appearance and signals can have significant long-term adverse effects on their development because such changes compromise cuteness. The most-studied example is cleft lip and palate, probably because it is one of the most common congenital conditions, occurring in 1 out of 700 live births in the UK [82]. Having cleft lip changes the typical 'cute' infant facial configuration (Figure 3) even though only a small proportion of the face is affected. This morphological change, in turn, is associated with adverse outcomes in child development, including cognitive problems. These problems can at least partly be attributed to early disruptions in mother–child interactions, specifically a lack of all-important maternal responsiveness [83]. Nonparents report finding infants with cleft lip less 'cute' than typical infants [84] and, when viewing cleft-lip infant faces, early activity in the orbitofrontal cortex is significantly diminished compared with viewing typical infant faces [39,84].

Developing effective interventions has traditionally relied on careful observations of behaviour, but is soon likely to be bolstered by a better understanding of the fundamental brain mechanisms associated with caregiving and how brain processing can be disrupted. Improving our understanding of the brain processes related to positive and negative infant signals could create opportunities for improving interventions. New learning paradigms derived from neuroscientific findings have already shown considerable promise [27,79]. For example, the 'baby-social-reward-task', which uses cute sounds and faces, mimics important aspects of caregiving and has been able to shift perceptions of infant temperament [27,85]. Musical training has also been implicated in sensitivity and empathy for infant distress [79,86], in that specific training has improved caregiver sensitivity. Such targeted behavioural paradigms based on neuroscientific

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the fusiform face region [15]. (B) Artificially manipulating the cuteness of infant faces has been shown to correlate with changes in the BOLD signal in the nucleus accumbens, part of the pleasure system [41]. (C) Very fast neural responses (~50 ms) are found in the human brainstem to both positive and negative infant vocalisations (babbling, laughter, and crying) [37]. (D) Similar to the fast brain response to cute visual stimuli, infant crying elicits activity in the OFC (~140 ms) at the same time as activity in primary sensory cortices [58]. (A) Reproduced from [15], (B) adapted from [41], (C) adapted from [37], and (D) adapted from [58].

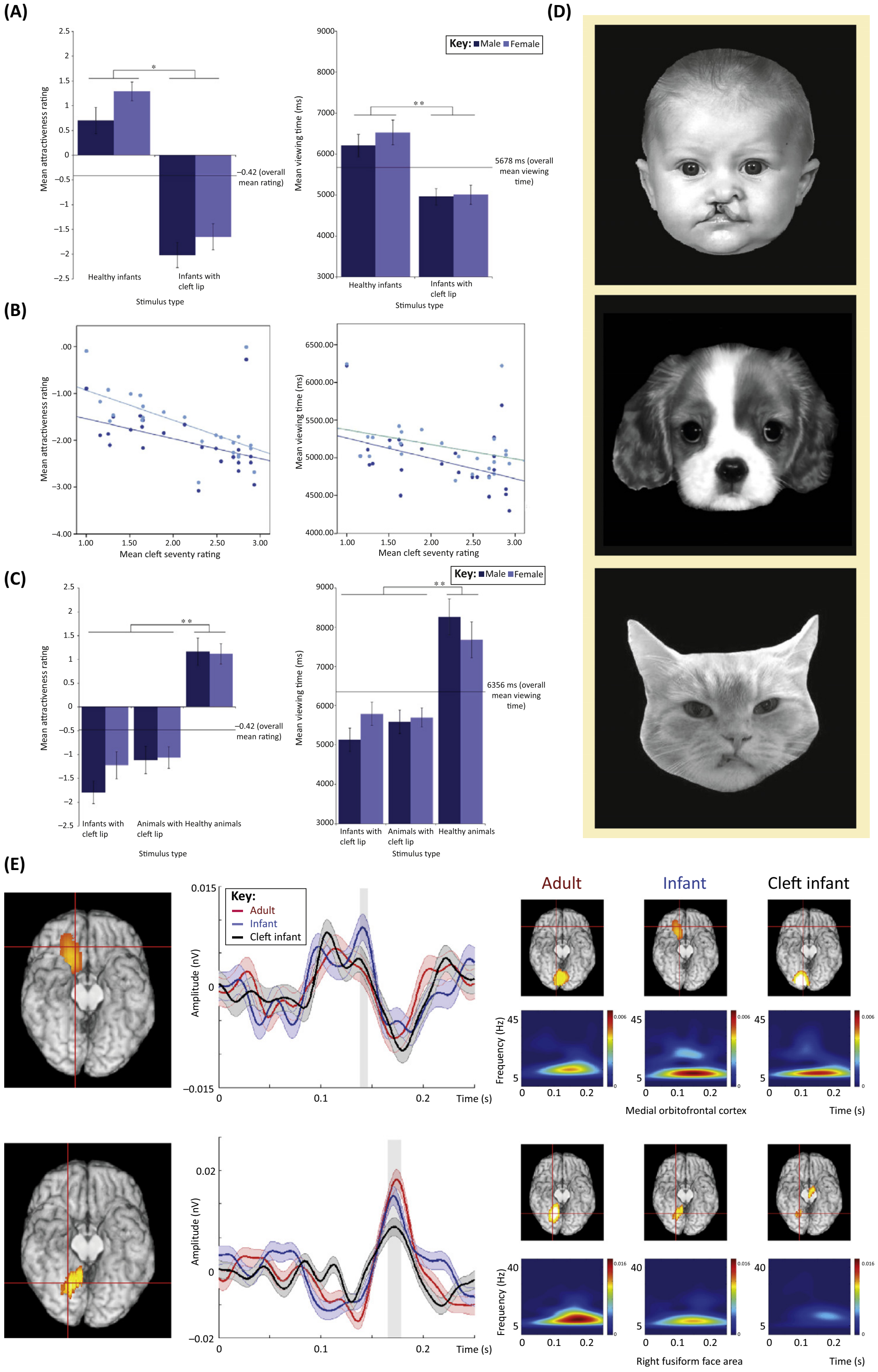

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Figure 3. Even Minor Facial Abnormalities Can Change Cuteness Perception. (A–D) Behavioural findings of responses to images of human and animal with cleft lips show significantly stronger liking and wanting of noncleft stimuli [84]. (E) Neuroimaging findings of significantly diminished fast processing (<140 ms) in orbitofrontal cortex (OFC) of cleft infant faces compared with cute infant faces in nonparents [39]. (A–C) Reproduced from [84] and (E) adapted from [39].

research may eventually help to increase caregivers' ability to properly interpret infant signals and provide appropriate responses.

Putative Brain Mechanisms of Cuteness

Cuteness has to be seen in the light of the evolutionary imperatives implying that for stimuli relevant to the survival of individuals and species (food, sex, and progeny) to easily gain access to consciousness, they must be prioritised over other, less-salient stimuli. Affective neuroscience has shown how positive and negative survival-related stimuli selectively capture attention, elicit core affects, and are available for conscious appraisal [87,88]. A large body of emotion research has identified brain networks where valenced stimuli are evaluated, based on the current state of the individual, for their reward value and then made available for future decision-making [64]. This processing is supported by the pleasure cycle, which comprises appetitive, consummatory, and satiety phases (Figure 4B). Dissociable brain mechanisms associated with the wanting, liking, and learning of rewards have also been linked to specific brain regions that govern phase transitions within the pleasure cycle (Figure 4A) [89]. The breakdown of any of these mechanisms leads to anhedonia, the lack of pleasure, which is a significant feature in neuropsychiatric disorders [90].

Here, we have argued that cuteness is an important, positive, infant-related signal that elicits both fast and slow brain activity linked to affiliative behaviours and that this cuteness is not limited to infants, but can be extended to other species and even inanimate objects. Survival-relevant positive cuteness as well as negative stimuli, such as infants' crying, have been shown to selectively bias our attention through rapid activity in the orbitofrontal cortex, which is then followed by slower, sustained processing in wider brain networks associated with emotion appraisal [14,15,58]. Importantly, significant progress has been made in understanding the dynamics of functional brain networks [91], in particular the state-dependent coupling that is fundamental to implementing flexible effective communication between different brain regions, without changing the fixed underlying structure of the brain [92].

In terms of understanding the impact of cuteness-induced activity, the **global neuronal workspace model** is a possible account for how conscious access to stimuli is made possible by igniting activity in self-supporting, reverberating, metastable networks that broadcast information to the whole brain [93–96]. In this context, we speculate that cuteness (through its elemental, rapid, robust, and pervasive nature) could provide privileged, multimodal access to consciousness through global workspace mechanisms (Figure 4D). Of course, other potential mechanisms should also be evaluated. Furthermore, whole-brain computational modelling (Box 2) [97] can now be used to identify causal mechanisms of brain networks involved in the segregation and integration of information over the fast and slow timescales involved in caregiving [92,98].

Cuteness: Beyond Caregiving to Empathy?

Few things have the power to move us to action as the cuteness of infants. This proposition was powerfully demonstrated by the international reaction to the tragic drowning of a cute little 3-year-old Syrian refugee in the Mediterranean Sea in September 2015. The published photo caused moral outrage and a groundswell of sympathy for the plight of these refugees. The tragedy led to a surge in donations to charities and seemed to change moral concern for the Syrian refugees. Whereas previously the refugees were often treated with indifference and to a large extent 'dehumanised' as an out-group, they suddenly became part of the in-group and granted entry in large numbers (in contrast to, e.g., African boat migrants).

As noted above, cuteness is a general promoter of sociality acting through mentalisation, the ability to treat infants and even inanimate objects as psychological agents [12]. As such, cuteness may more generally serve to maximise moral concern by expanding the moral circle; that is, the boundary drawn around entities deemed worthy of moral consideration [99]. This

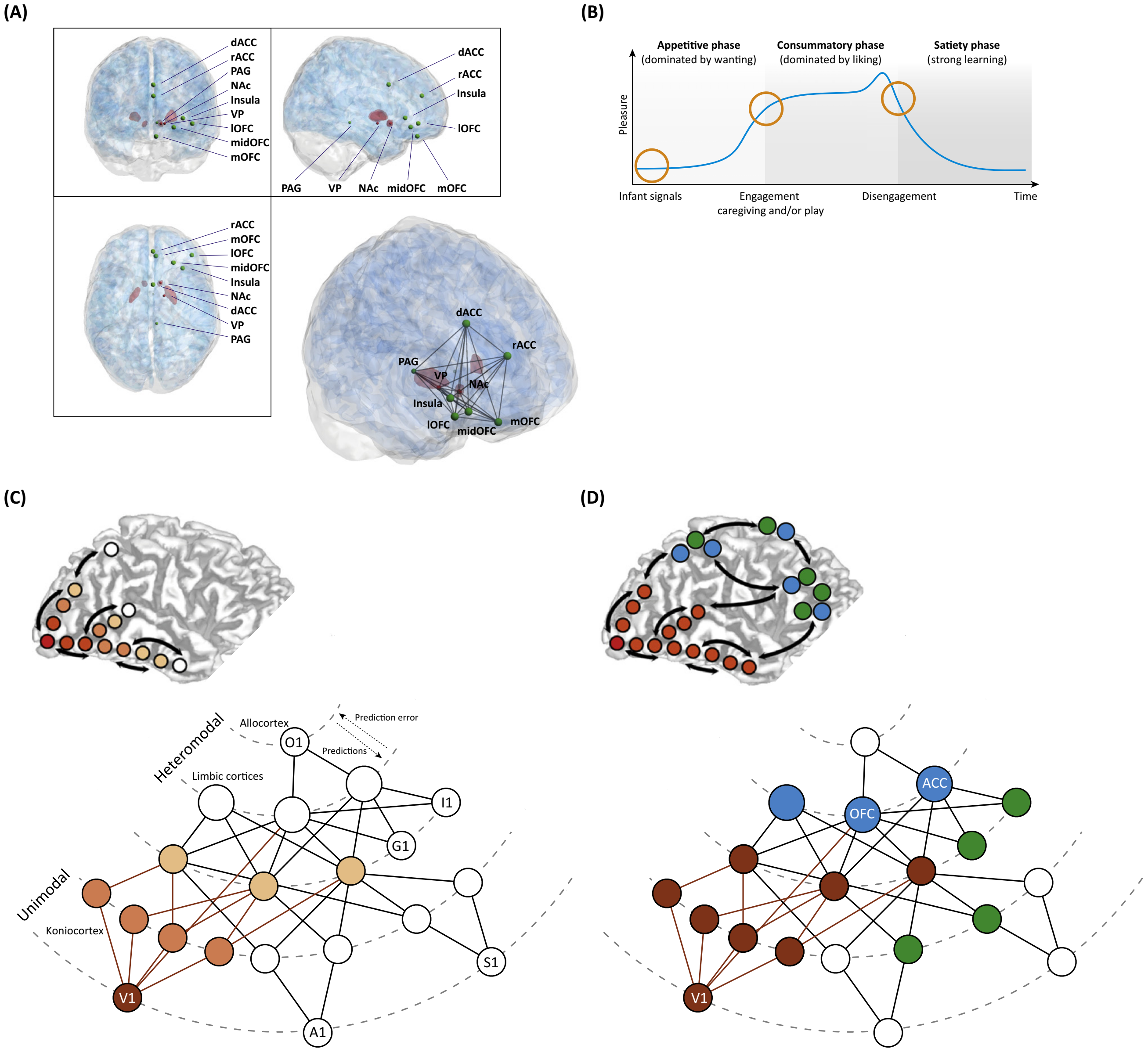

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Figure 4. Putative Brain Mechanisms of Cuteness and other Infant Survival-Relevant Stimuli Elicit Fast and Slow Affiliative Behaviours. (A) The core affect elicited by cuteness is generated by the pleasure network in the human brain (shown here in one hemisphere only) with the nucleus accumbens and ventral pallidum (in red) and other main pleasure-coding regions (in green). Clockwise views (from bottom left) are from the top, front, side, and 3D perspective. The connections indicate the tentative functional networks mediating hedonic 'liking' reactions and subjective pleasure ratings [64]. (B) The optimisation of resource allocation for survival depends on the engagement with rewards that act as motivational magnets to initiate, sustain, and switch state. Typically, the pleasure cycle comprises appetitive, consummation, and satiety phases, where wanting, liking, and learning mechanisms drive the phase transitions of the metastable brain states [102]. (C) Subliminally presented stimuli and nonsurvival-related stimuli often fail to provide ignition of activity that is made available for global access [103]. (D) Cuteness and other infant survival-relevant stimuli provide privileged routes to fast ignition of activity leading to global access providing the necessary slowness for prosocial caregiving and play behaviours [43,93,104]. Abbreviations: dACC, dorsal anterior cingulate cortex; lOFC, lateral orbitofrontal cortex; mOFC, medial orbitofrontal cortex; midOFC, mid-anterior orbitofrontal cortex; NAc, nucleus accumbens; PAG, periaqueductal grey; PBN, parabrachial nucleus; rACC, rostral anterior cingulate cortex; VP, ventral pallidum. (A) Reproduced from [64].

Box 2. Cuteness Computations, Time, and Metastability

Cuteness facilitates survival, which relies on time-critical neural computations [64] helping to optimise the resources used for exploration and exploitation of potential rewards ensuring long-term stability [110]. This balance between fast and slow processing is not easily struck [111] and humans are often relatively poor at **temporal discounting**, sometimes disastrously so [112].

Elucidating the networks underlying cuteness processing in the human brain requires more than just correlational neuroimaging. The use of whole-brain computational modelling combining structural **connectomes** with functional dynamics to explore and explain the emergence of resting-state and task-related networks mechanistically is starting to make significant progress in understanding the underlying brain networks for balancing fast and slow neural processing [91]. This computational modelling has started to be constrained by time-dependent activity, such as the **Hopf bifurcation** model [113,114], which captures the significant features of previously used asynchronous and oscillatory models [115]. These computational models provide evidence for the importance of **metastability** [116,117], which is a measure of how variable brain states are as a function of time (e.g., how the synchronisation between the different brain regions fluctuates across time). Furthermore, they have demonstrated how the healthy brain is maximally metastable, allowing for optimal exploration of the effective dynamical repertoire of patterns [92]. If the underlying structural connectivity is damaged, as found in many neuropsychiatric disorders, a more limited functional repertoire is available, leading to potentially severe behavioural and emotional consequences [97]. As such, these methods may help identify biomarkers of impaired brain processing related to cuteness, which in turn may help develop new effective interventions.

Outstanding Questions

What is the developmental trajectory of cuteness perception?

What are the brain mechanisms and networks linking the fast and slow cuteness responses?

How can cuteness best be used to improve caregiving in troubled parent–infant relations?

What is the relation between cute vocalisations and cute melodies?

How can we best harness cuteness to expand our moral circle and minimise dehumanisation?

proposal contrasts with disgust, which contracts the moral circle through contagion processes that extend disgust to categories beyond food stimuli (e.g., inanimate objects [100]). Out-group members are often seen in this way and dehumanised as a consequence.

Thus, disgust and cuteness would appear to regulate, albeit in opposite directions, the way people mentalise objects that are not already highly mentalised. Given that children are (in principle) universally forbidden targets of harm, cuteness could serve to expand the moral circle. Any cute infant is automatically granted membership to the moral circle and cuteness can then be extended to other people (or objects). As such, cuteness-triggered positive mentalising could instigate wider social engagement and perhaps even empathy and compassion [12].

Concluding Remarks

Here, we have proposed to extend the concept of cuteness to be a biologically significant, positive multimodal stimulus that, through sight, sound, or smell of infants, can help facilitate caregiving and perhaps promote other sophisticated emotional behaviours. We have presented established as well as emerging evidence that, as such, cuteness is a potent positive stimulus, which can elicit fast brain responses that prioritise infant signals in women and men, parents and nonparents. Cuteness helps infants to survive by eliciting caregiving, which cannot be reduced to simple, instinctual behaviours. Instead, caregiving involves a complex choreography of slow, careful, deliberate, and long-lasting prosocial behaviours, which ignite fundamental brain pleasure systems that are also engaged when eating food or listening to music [89], and always involve pleasant experiences.

We argued here that cuteness goes beyond an attention-grabbing evolutionary strategy that infants use to attract care and protection. Instead, like a Trojan horse, cuteness opens doors that might otherwise remain shut. In terms of mechanisms, we proposed that cuteness ignites activity in metastable brain networks, which provides a framework for sustaining the slowness inherent to prosocial behaviours [91]. Cuteness encourages caregiving and carefree playfulness. It is easily extended to other species, such as cats and dogs, and even cute inanimate objects, such as Mickey Mouse, Hello Kitty, and the teddy bears we treasure. Cuteness works through all our senses; thus, in addition to what we see, we are, for example, also drawn to cute babbling and cute melodies [101]. We speculate that the anthropomorphising that accompanies cuteness might serve to extend our moral circle, and counteract the dehumanisation and xenophobia all too common in our nature. Cuteness could be useful in designing novel interventions to strengthen troubled parent–infant relations. It could also be used to increase sympathy and empathy for those in the in-group and compassion toward those in the out-group. Perhaps cuteness is best thought of as a mirror to our nature and a powerful reminder of our inherent need for simple pleasures (see Outstanding Questions).

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