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Making Sense of Infants' Differential Responses to Incongruity

Gina C. Mireault, Ph.D.¹ and Vasudevi Reddy²

¹Northern Vermont University-Johnson

Johnson, VT

USA

²University of Portsmouth

Portsmouth, England

UK

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Corresponding author: Gina Mireault, Ph.D., Department of Behavioral Sciences, 337

College Hill, Northern Vermont University-Johnson, Johnson, VT 05656.

Tel: 802-249-7235 (mobile) or 802-635-1320 (dept front desk)

E-mail: gina.mireault@northernvermont.edu

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1 Abstract

2 Infants show strikingly different reactions to incongruity: looking (Baillargeon, 1998) or
3 smiling (Mireault & Reddy, 2016). The former occurs in response to magical events and
4 the latter to humorous events. We argue that these reactions depend largely on the
5 respective experimental methodologies employed, including the popular Violation of
6 Expectation (VOE) paradigm. Although both types of studies involve infants' reactions to
7 incongruity, their literatures have yet to confront each other and researchers in each
8 domain are drawing strikingly different conclusions regarding infants' understanding of
9 the world. Here, we argue that infants are sensitive to and constrained by several
10 contextual differences in the methodologies employed by incongruity researchers that
11 afford one or the other reaction. We apply De Jaegher & Di Paolo's (2007) Participatory
12 Sense Making framework to further understand what infants are sensitive to in these
13 paradigms. Understanding infants' reactions to incongruity (i.e., VOE) is necessary to
14 clear up claims regarding the sophistication of their knowledge of physical and social
15 phenomena. Attention to several simple methodological details is recommended.

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1 Making Sense of Infants' Differential Responses to Incongruity

2 The Puzzle

3 Within the first 6-months of life, infants show two very different reactions to
4 phenomena involving incongruity: looking (Baillargeon, 1994, 1998, 2004) or smiling
5 (Mireault & Reddy, 2016). The question explored here is, why? Incongruous events that
6 elicit looking are often described as “magical” and involving “tricks” (Walden, Kim,
7 McCoy, & Karrass, 2007, p. 654), while those that prompt smiling are often described as
8 “humorous” (Pien & Rothbart, 1976). However, both types of incongruous events share
9 key qualities. For example, both involve novelty, captivating infants' attention by
10 violating their expectations. Both are also nonthreatening, inconsequential, and not
11 unpleasant (Warren & McGraw, 2016). What is it therefore that infants are sensitive to
12 that predictably elicits these different responses? Is it due to differences in the nature of
13 the events themselves, or something peripheral to the events, or other unintended aspects
14 of the experimental procedures? Dissecting the ways in which these incongruities differ
15 should give us important insights into infants' responses to and experiences of the
16 physical and social world.

17 **Unpacking Incongruity**

18 Let's begin with the meaning of the word “incongruity”, which refers to a
19 disharmony, discordance, or inconsistency between two juxtaposed events or stimuli. For
20 example, hearing a large muscled man speak in a high squeaky voice, seeing the sun
21 floating in a night sky, or observing an object vanish before one's eyes are all
22 incongruous events. The developmental literature commonly refers to these incongruous
23 events as “violations of expectations” (VOE), meaning the discrepancy exists between

1 what one *expects* to happen vs. what one *experiences* (Charles & Rivera, 2009). The
2 word “incongruity” is used to describe both magical and humorous events in studies
3 investigating infants’ reactions to them. For example, researchers exploring magical
4 incongruities, typically referred to as VOE studies, have used the term as follows:
5 “...even 2-year-olds’ reasoning may be limited to recognizing after-the-fact incongruent
6 events...” (Keen, 2003, p. 82), “...Experiment 4 revealed no significant increase in the
7 strength of the incongruity preference...” (Powell & Spelke, 2018, p. 44), and “Seeing a
8 hand carry an object out of the display did not prevent infants from detecting the
9 incongruity of the result revealed behind the screen...” (Wynn & Chiang, 1998, p. 453).
10 Similarly, those investigating humorous incongruities have employed the term:
11 “Resolved incongruity, in addition to pure incongruity, may be appreciated even by
12 infants” (Pien & Rothbart, 1976, p. 970), “...we would speculate that the infant laughs on
13 those trials when the incongruity is fully processed...” (Sroufe & Wunsch, 1972, p.
14 1341), and “...infants ...copy incongruous actions paired with laughter...” (Esseilly, Rat-
15 Fischer, Somogyi, O’Regan, & Fagard, 2016, p. 818). Therefore, the same experience –
16 that of incongruity – leads puzzlingly to very different responses in infants.

17 The historical origins of the notion of incongruity – or of its earlier form,
18 bisociation - might provide a starting point to explain this diversity of response. Koestler
19 (1964/1975) coined the term bisociation to distinguish between routine thinking, which
20 occurs in a single frame of reference and creative thinking that involves more than one
21 frame of reference. Two important points in the notion of bisociation are relevant here.
22 First bisociation, which Koestler linked to humor, is not limited to humor. It occurs in
23 science and art too, working differently in each case and bringing about different

1 cognitive and emotional by-products. In science, bisociated frames of reference merge in
2 a new synthesis, leading to progress in scientific discovery. In art, bisociated frames of
3 reference are continuously juxtaposed, which is key to the perception of art. In humor,
4 the juxtaposed frames of reference may be linked at one point (as in the sound of the
5 word in a pun) and then suddenly switched to reveal a punch line. The second relevant
6 point is that bisociation creates inherent instability - a cognitive/emotional disturbance –
7 in the individual who experiences it. This cognitive/emotional disequilibrium is inherent
8 in bisociation, which is to say, it is inherent in incongruity.

9 In sum, the nature of the incongruity or bisociation varies in different contexts and
10 domains, as does the emotional experience of the disturbance. Studies of magical and
11 humorous incongruities may represent these types of differences, affording different
12 cognitive and emotional experiences. We therefore need to look at the details of both
13 types of studies in order to understand what infants make of incongruities presented in
14 these different experimental traditions and what might lead to their varying responses.
15 Conclusions based on grouping together large numbers of studies that ignore the
16 contextual specifics are likely to involve superficial explanatory glosses and will bump
17 into problems sooner or later. Contextual factors such as local affordances or
18 developmental histories may influence the infant’s behavior, and we propose that it is in
19 these details of the contexts where we can gain the most insight regarding what
20 incongruity means to infants. Notably, Walden and Baxter (1989) credit Graziano (1987)
21 for remarking that the “lack of understanding of the effect of contextual variations on
22 behavior is one of the largest single obstacles blocking our understanding of complex

1 social processes” (p. 1511). This observation remains relevant and requires exploration of
2 the specific research contexts of magical and humorous incongruities.

3 **Magical Incongruities**

4 Baillargeon, Spelke, and Wasserman (1985) are generally credited with the paradigm-
5 shifting VOE design which they first employed to examine whether very young infants
6 had access to object permanence (Charles & Rivera, 2009). The VOE paradigm,
7 however, quickly became a means for discovering how infants respond to events that
8 violate a range of natural laws (e.g., gravity, continuity, solidity, etc.), appearing to be
9 physically impossible or magical events. VOE experiments involve presenting infants
10 with events such as screens that appear to pass through solid objects (Baillargeon et al.,
11 1985), containers that appear to be impossibly placed in and occluded by smaller or
12 transparent containers (Baillargeon & Wang, 2002; Hespos & Baillargeon, 2001; Wang,
13 Baillargeon, & Brueckner, 2004), balls appearing to fall or roll through solid objects
14 (Spelke, Breinlinger, Macomber & Jacobson, 1992), and objects appearing to roll along
15 unsupported paths (Spelke et al., 1992), for example.

16 The VOE usually begins with a habituation phase to familiarize infants with the
17 event, which occurs on a display in front of them, repeating the same trial until a pre-
18 determined reduction in looking has been reached (e.g., a 50% reduction in looking
19 time) or a fixed number of trials has been completed (Charles & Rivera, 2009).
20 Following habituation there are a series of test trials in which equal numbers of
21 “possible” (i.e., consistent with natural laws, nonmagical) and “impossible” (i.e.,
22 inconsistent with natural laws, magical) events are presented, both of which are iterations
23 of the initial habituated event. VOE studies generally adhere to the technique as described

1 by Baillargeon et al. (1985) in their seminal experiment:

2 “... a box was placed on a surface behind a wooden screen. The screen initially
3 lay flat, so that the box was clearly visible. The screen was then raised, in the
4 manner of a drawbridge, thus hiding the box from view. Infants were shown two
5 test events: a possible event and an impossible event. In the possible event, the
6 screen moved until it reached the occluded box, stopped, and then returned to its
7 initial position... In the impossible event, the screen moved until it reached the
8 occluded box-and then kept on going as though the box were no longer there! The
9 screen completed a full 180-degree arc before it reversed direction and returned
10 to its initial position, revealing the box standing intact in the same location as
11 before.” (p. 195)

12
13 To know whether infants detect a difference between possible and impossible
14 events, their looking times are compared based on the “...commonly-held assumption that
15 infants react to novel or surprising events with prolonged attention...” (Baillargeon et al.,
16 1985, p. 196). Such studies, which tend to occur under tightly controlled laboratory
17 conditions, have consistently shown that infants as young as 3^{1/2} months **look** longer at
18 events that break natural laws including those involving gravity, continuity, and solidity,
19 and indicating that infants have detected the incongruity (Keen, 2003). Researchers have
20 interpreted this to mean that infants have some knowledge regarding the behavior of
21 objects in accordance with natural laws such as gravity (Walden et al., 2007). Baillargeon
22 has sometimes described these events – and infants’ **prolonged looking at** them – as akin
23 to the impossibilities observed in magic shows.

24 “Babies look longer at events they view as unexpected. It is a 'whoa' look - a state
25 of heightened attention. It's like it is in everyday life. You expect something and
26 then when it's not what it should be, you tend to look longer, as when we watch a
27 magic show. It's the wow of the unexpected.” (Baillargeon, 2005 from
28 <https://news.illinois.edu/view/6367/207318>)

29

30 **Humorous Incongruities**

31 Another line of research has investigated infants’ responses to incongruous social or
32 behavioral events. The latter can also be characterized as VOEs (Sroufe & Wunsch,

1 1972) as they involve violations of social or behavioral norms. Like Baillargeon et al.'s
2 (1985) initial study that set out to explore whether very young infants were aware of
3 object permanence, these studies set out to explore whether very young infants were able
4 to engage in social referencing. To do so, researchers explored whether infants rely on
5 parental emotional signals (i.e., laughing and smiling) to interpret an incongruous event
6 as amusing (e.g., Mireault, Crockenberg, Sparrow, Pettinato, Woodard, & Malzac, 2014).

7 These studies tend to involve infants as young as 4-months observing an emotionally
8 neutral experimenter present familiar household objects to caregivers in ordinary (e.g.,
9 rolling a ball) and unexpected (e.g., wearing the ball as a clown nose) ways (Mireault,
10 Crockenberg, Sparrow, Cousineau, Pettinato, & Woodard, 2015; Mireault et al., 2014).
11 Caregivers are instructed either to show positive affect (laugh and smile) toward the
12 event or to remain neutral toward it. Habituation trials are not required since the events
13 and objects are within the ordinary experience of infants, and because the randomized,
14 repeated-measures design controls for extraneous variables that might affect infants'
15 responses. These experiments generally adhere to the technique as described by Mireault,
16 Crockenberg, Heilman, Sparrow, Cousineau, & Rainville (2018):

17 *“Infants watched while a research assistant showed parents two ordinary events*
18 *(narration of playing with a ball or drinking from a cup, or read a book) and two*
19 *absurd events (ball worn as a clown nose and continuously poked while saying*
20 *‘beep’, book or cup worn like hat and continuously raised and lowered while*
21 *saying ‘zoop’), in a within-subjects randomized design. Each absurd event was*
22 *presented twice: once with parents exhibiting neutral affect and once with parents*
23 *exhibiting positive affect towards the event (i.e., smiling and laughing). Except for*
24 *parental affect (neutral and positive), which was counter-balanced for the absurd*
25 *events, the absurd events were identical. Parental affect was not manipulated*
26 *during ordinary events in order to preserve their ordinary nature. Thus, there*
27 *were six randomized conditions each lasting 45 s: two ordinary events, two*
28 *absurd-neutral events, and two absurd-positive events. The absurd-neutral*
29 *and absurd-positive events were identical with the exception of parental affect.*
30 *All events were performed for the parent by an experimenter who remained*

1 *affectively neutral, and each event was separated by 10 s.*” (p. 5)
2

3 To know whether infants detect a difference between incongruous and ordinary events,
4 researchers focus on infants’ rates of smiling and laughing, although they also measure
5 looking times. Such studies, which tend to occur under naturalistic conditions in infants’
6 homes, have consistently shown that infants as young as 5-months smile and laugh more
7 at incongruous events, indicating that they have detected the incongruity (Mireault et al.,
8 2018; Sroufe & Wunsch, 1972). Since they smile and laugh towards the incongruous
9 events even when parents are emotionally neutral, infants are not simply mimicking
10 parental laughter nor relying on parental affect to interpret the incongruity as amusing.
11 Looking times tend to reveal inconsistent results depending on the measure employed
12 (i.e., frequency, duration, latency to look away, etc.), and thus do not provide as stable a
13 metric as smiling and laughing. However, looking times have confirmed infants’ ability
14 to detect these social and behavioral incongruities, with 6-month-olds taking longer to
15 look away, for example, although 4-month-olds do not differ significantly in their looking
16 times (Mireault et al., 2018). Since infants smile and laugh at such incongruities
17 beginning at 5-months, researchers have applied the same inference used in the VOE
18 literature (Walden et al., 2007) interpreting infants’ detection of and reaction to
19 incongruity to mean that they have some knowledge regarding social norms. For
20 example, in considering why infants often find their mirrored reflections humorous,
21 Addyman speculated:

22 *“Conversation and social interaction involve turn-taking, but the person in the*
23 *mirror is breaking these conventions by doing everything at the same time.”*
24 (Addyman, 2014 from [https://www.dailymail.co.uk/health/article-2580540/Why-](https://www.dailymail.co.uk/health/article-2580540/Why-babies-laugh-That-scientist-set-learn-tantalising-results.html)
25 babies-laugh-That-scientist-set-learn-tantalising-results.html)
26

1 In sum, both types of incongruity share some central features. Both involve an
2 event that is outside of infants' expectations and that is therefore initially captivating.
3 Both are harmless, nonthreatening, inconsequential (Warren & McGraw, 2016) and not
4 specifically unpleasant (Walden et al. 2007). However, these incongruities also differ in
5 important ways that may provide insight into infants' social-emotional and cognitive
6 processes and reveal what they are sensitive to.

7 **Differences Between 'Magical' and 'Humorous' Incongruity Studies**

8 **The possibility of events.** In both magical and humorous incongruity studies
9 there is a violation of some sort of expectancy. In the former it is a violation of natural
10 laws, such that the event appears to be physically impossible. In the latter, the violations
11 involve social practices, such that the event does not entertain impossibility. In the
12 simplest comparison, one set of events is impossible and therefore no sense can be made
13 of them, leading to longer looking, while the other set of events is merely odd, allowing
14 more sense to be made of them and leading to other reactions, like smiling. Could the
15 disparity in infants' reactions be due to this striking difference in the events as VOE
16 researchers contend? Even were this the case, privileging infants with knowledge of the
17 laws of physics still does not explain the difference in responses. For example, why
18 should longer looking be the response rather than distress? Why respond to the possible-
19 but-odd with smiling, and conversely why *not* respond to the impossible with laughter?
20 Does the physically impossible somehow directly elicit a more fundamental shock?

21 There are reasons to suggest that this may not be the case. First, infants have also
22 been observed to look longer at physically-possible-but-socially-unexpected events. For
23 instance, Fantasia, Markova, Fasulo, Costall, & Reddy, (2016) reported that 3-month-olds

1 reacted with more frequent gaze shifts to a violation of expectancy. Mothers were
2 instructed to reach for their babies and then stop with arms out-stretched before actually
3 picking up the baby. In another study (Fantasia, Fasulo, Costall, & Lopez, 2014), mothers
4 were instructed to sing/play one of their customary action rhymes to their babies, but to
5 do so either without sound or without gesture. Infants reacted with stunned expressions
6 (wide open eyes), body stilling, and more frequent looking away when confronted by
7 those incongruities, which cannot be accounted for by the ‘impossibility’ explanation as
8 these actions by the mother were certainly physically possible. Similarly, infant body
9 stilling has been reported in still face studies (Tronick, Adamson, Als, & Brazelton,
10 1975) at the onset of the mother’s still face, also not fitting within the impossibility
11 explanation. These findings show that social incongruities, like physical incongruities,
12 can also evoke longer looking, and further indicates that the two types of events are
13 reasonable to compare.

14 Second, children and adults do laugh at magical and seemingly impossible events as
15 evidenced by the popularity and ‘fun’ of magic shows, suggesting that amusement is a
16 complex emotional response not simply attained by the nature of the stimulus. It could be
17 argued that these types of mis-expected actions by mothers do in fact constitute a social
18 impossibility for the infants and thus lead to longer looking. What then are the factors
19 that distinguish them from social incongruities that lead to smiling? Perhaps a more
20 graded consideration of what constitutes the impossible is needed, as well as attention to
21 the greater complexity in infants’ understanding of social actions and practices.

22 **Familiarity of context.** As Sroufe and Wusnsch (1972) observed in infants’
23 differential reactions to stimuli, “...context and stimulus may be inseparable” (p. 1340).

1 The studies of magical incongruities are traditionally carried out in carefully controlled
2 laboratory settings that might be described as “familiar-context deprived” in which the
3 infant watches objects moving across a display. The standardized set-up controls the
4 potential effects of an experimenter’s presence, minimizes the distraction of an
5 experimenter, and maximizes the infant’s attention to the events. These qualities are in
6 part why studies of physical incongruities include habituation trials, to ensure infants
7 acclimate to these highly unusual situations. That is, the infant has no history with events
8 in which objects behave in unusual ways; the habituation trials provide the infant with
9 that experience. Studies of humorous incongruities, by contrast, are often carried out in
10 infants’ homes in an attempt to minimize the distraction of a novel laboratory
11 environment and to preserve the setting in which infants are likely to encounter humorous
12 events (Mireault et al., 2015; Sroufe & Wunsch, 1972). They might be described as
13 “familiar-context rich”. Of relevance is Walden & Baxter’s (1989) note that infants smile
14 less when studies are conducted in laboratory settings than in the familiar context of the
15 home. Thus, the laboratory context of VOE studies narrows the possibility of infants’
16 smile response even if researchers were attending to it as a dependent variable.

17 **Social embodiedness and embeddedness.** Relatedly, one key difference between the
18 two sets of studies may lie in the extent to which the incongruities presented are socially
19 embodied and embedded. In studies of magical incongruities, objects appear to be
20 behaving independently as disembodied entities, i.e., there is no one acting on the objects
21 or performing the events. As explained by Spelke et al., (1992),

22 *“...The infant viewed the display from a reclineable seat surrounded by a*
23 *curtain...” (p. 612) and “...a hand entered the display & removed the ball...” (p.*
24 *610) and “...the presenter disappeared behind the display... lowered the screen*

1 *and presented the ball in her right hand ... while introducing her left hand*
2 *through the bottom opening...*” (p. 612)

3
4 The complete absence of people or the involvement of partially occluded people
5 performing the events also makes it strangely “disembedded”, depriving the event of any
6 social context that might aid the infant in making sense of it. In studies of humorous
7 incongruities, by contrast, the events involve a person who manipulates an object, such
8 that objects do not appear to be behaving independently – or behaving at all; instead, the
9 event is the experimenter’s behavior *with* the object. Further, infants are in the presence
10 of a parent and an experimenter who presents or performs the event. Even in studies in
11 which parents and experimenters do not engage with the infant, both social partners are
12 wholly visible. The incongruity is both socially embodied and socially embedded. As
13 described by Mireault et al. (2014),

14 *“Infants were seated in a high chair between the researcher and the parent ...*
15 *seating arrangement allowed the infant to see both the parent and the event*
16 *presented by the researcher... The effect of this configuration was to place the*
17 *infant in the role of observing the event and the parent’s reaction to it” and “The*
18 *researcher presented three events with each of two objects (ball and book) to*
19 *parents while infants observed” and “...the opened book was repeatedly placed*
20 *upside down on the researcher’s head while she said ‘joop joop’; the ball was*
21 *worn as a clown nose and poked with her finger while she said ‘beep beep’...*” (p.
22 539).

23
24 **Repetition and duration of events.** Another key feature that may explain infants’
25 different reactions to these incongruities is that, unlike magical events, humorous events
26 are of longer duration and are presented with repetition (Mireault Sparrow, Poutre,
27 Perdue, & Macke, 2012; Mireault et al., 2014, 2015; Sroufe & Wunsch, 1972). Duration
28 may well be crucial, as infants initially look at novelty before smiling or laughing. Their
29 latency to smile may reflect the time it takes for them to make sense of the incongruity

1 with the available social information and challenges the snapshot approach to measuring
2 meaningful infant reactions.

3 The repetitious nature of humorous incongruities may allow another route for infants
4 to evaluate them as amusing for two reasons. One is anticipation (often credited for why
5 peekaboo is funny; Nomikou, Leonardi, Radkowska, Raczaszek- Leonardi, & Rohlfing,
6 2017). Another is that repetition may help infants understand the *intentionality* of the
7 behavior, a feature necessary for perceiving a joke (Hoicka & Gattis, 2008). Research
8 suggests that young infants may be able to infer others' intentions based on repetition
9 (Gergely & Csibra, 2003; Gergely, Nadasdy, Csibra, & Biro, 1995; Mireault et al., 2018;
10 Tauzin & Gergely, 2018). Repetition could also offer to infants in these situations a
11 preparedness, a readiness-to-interact and a readiness for emotional participation with
12 others (Di Paolo and De Jaegher, 2012) that allows for easier grasping of the incongruity.
13 Analyses that consider the standard 'action arcs' of humorous vs. magical interactions
14 specific to violations of timing, may shed further light on how infants distinguish
15 incongruities (Rossmanith, Costall, Reichelt, López, & Reddy, 2014).

16 Making Sense of Incongruity

17 How might the differences described above explain why, when confronted with some
18 sorts of incongruities infants look while towards others they smile? Our argument is that
19 infants are involved participants in these situations, actively seeking to make sense of the
20 incongruities with which they are confronted. They use not only a wider range of
21 information from the experimental contexts than is perhaps intended by the investigators,
22 but are also engaged in a dynamic process of sense-making revealed in their responses.
23 As De Jaegher and Di Paolo (2007) argue, sense-making is an active process:

1 *“Organisms do not passively receive information from their environments, which*
2 *they then translate into internal representations whose significant value is to be*
3 *added later. Natural cognitive systems are simply not in the business of accessing*
4 *their world in order to build accurate pictures of it. They actively participate in*
5 *the generation of meaning in what matters to them; they enact a world. Sense-*
6 *making is a relational and affect-laden process grounded in biological*
7 *organization.”* (p. 488).

8
9 Based on this, we propose that it is not simply the type of incongruous event that
10 leads infants to one or the other reaction. It is necessarily in the relation between infant
11 and event not only in the present moment but also in the infant’s history with objects and
12 with people – including their emotional expressions – that converge to create a given
13 context. Richer contexts must afford greater opportunity for sense-making resulting in
14 more ample and active emotional reactions like smiling and laughing, compared to
15 looking or stunned reactions when sense-making is hindered by an impoverishment of
16 relations. A more complete explanation, we suggest, comes from thinking about the role
17 that people and context play in the presentation of incongruities. To this point, in
18 replications of Baillargeon & Graber’s (1987), Wynn’s (1992), and Simon, Hespos, &
19 Rochat’s (1995) studies involving physical incongruities, Walden et al. (2007) and Dunn
20 & Bremner (2017) found that infants looked more frequently to caregivers’ faces (i.e.,
21 social looking) during unexpected or expectancy violating events than at expected or
22 simply novel events. They concluded that infants search the social environment for
23 information about unusual events, highlighting the important knowledge the social
24 context may or may not afford. This finding in particular emphasizes the significance of
25 the social context both for infants’ understanding of incongruities and for our
26 understanding of infants’ experience of them.

1 We are arguing that in one type of incongruity – those that are humorous - there is
2 information available for infants to “make sense” of it, while in the other – those that are
3 magical - the only information available is the incongruity itself. The inability to ‘make
4 sense’ of the incongruities may be the reason for longer looking times and stunned
5 expressions. Until the infant makes sense of the event, the only option is to just look at it.

6 Studies of humorous incongruities necessarily involve people as a central part of
7 the violation who– even when they don’t actually offer emotional information - alter the
8 context the infant is in. But what is it about people and context that enables sense-
9 making? The presence of involved others in an experimental situation could be
10 significant in different ways. Mere presence is not enough; the involved others seem to
11 need to be co-participants in order for infants to respond to incongruity with an emotion
12 instead of with simply looking. As co-participants, social partners – even when they are
13 emotionally neutral - jointly attend to the incongruity, and inadvertently invite
14 participatory sense-making in a reality that is necessarily shared. That infants search the
15 social environment when confronted with bizarre incongruous events (Dunn & Bremner,
16 2017; Walden et al, 2007) strongly supports the idea that they attempt, and in fact
17 prioritize, sense-making when the opportunity exists.

18 Additionally, these social partners must not create further barriers to sense
19 making. For example, Sroufe & Wunsch (1972) observed that a mechanical version of
20 peekaboo in which “items were presented in an automated fashion” elicited less laughter
21 from infants, raising questions about factors such as “spontaneity of the agent, uneven
22 cadence, and uncertain termination point” (p. 1337). The mechanical and automated
23 action seem to afford less possibility for rich emotional reactions by infants and indeed

1 by adults. This automated or mechanical quality may in fact also characterize the actions
2 of the mothers in the still face studies, or those instructed to reach for their infants
3 without completing the action of picking them up, or to perform a normal game without
4 sound as described above (Fantasia et al., 2014; Fantasia, Markova, Fasulo & Reddy,
5 2016; Tronick et al., 1975), and thus lead to an inability to make sense of the event.

6 The presence of involved others can open doors to emotional reactions,
7 particularly smiling, towards incongruity. Multiple studies with adults have shown that
8 for smiling and laughter to be expressed, social partners - and *not* humor, per se - are
9 requisite (Panksepp, 2000; Provine, 2004; Scott, Lavan, Chen & McGettigan, 2014).
10 LaFrance (2011) has even reported this effect in 10-month-olds who were less likely to
11 smile when alone than when in the presence of other people, and Addyman, Fogelquist,
12 Levakova, & Rees (2018) reported the same effect in toddlers watching cartoons. When
13 people are a central part of the context – as is the case in studies of humorous incongruity
14 - the infant relates to the event differently because the presence of another being with the
15 potential for evaluative reactions has opened up the infant’s own potential reactions to the
16 event, inviting emotional reactions from the infant of a more typical kind – like laughter,
17 for instance. Walden et al. (2007) and Dunn & Bremner (2017) validate this
18 interpretation having shown that infants look more frequently to their social partners
19 when presented with magically impossible incongruities that belong to the VOE tradition.

20 This approach of participatory sense-making questions the assumption that infants
21 passively perceive physical or humorous incongruities. The picture in both cases appears
22 more complex. Infants even in the early months certainly have experience with the laws
23 of physics and the patterns of behavioral practices and can detect violations of these. The

1 reactions to each, however, depend on the sense that can be made of them; the nature of
2 the contextual experience such as repetition, timing, familiarity, and the involvement of
3 other people, determine infants' responses to each. The deprivation or wealth of other
4 contextual factors is what must lead to looking or smiling, respectively. A rich context
5 allows richer emotional reactions – or more broadly - for emotional participation with
6 others and an emotional readiness to interact.

7 Future Directions to Make Sense of Infants Making Sense of Incongruity

8 Studies of infants' reactions to physical and social incongruities have existed as
9 separate lines of inquiry, finding that infants respond quite differently and leading to
10 different explanations regarding infants' understanding of the world. We suggest merging
11 these lines of research to discover why infants respond differently to the general
12 phenomenon of incongruity, and propose several variables that deserve further
13 investigation. For example, research should determine how infants' responses to magical
14 incongruities are altered by social context, something that could be easily tested by
15 having infants observe a social partner carry out impossible events (instead of a partially
16 occluded or videoed person). Whether infants react differently – potentially with smiling
17 instead of looking - to impossible events performed by a familiar other (e.g., sleight-of-
18 hand) is also worth examining given the rich social history infants and caregivers share.
19 Crucially, it is worth investigating whether infants' responses to impossible events are
20 influenced by repetition or duration and the opportunity to share the events with others,
21 common characteristics of events that evoke smiling. Ultimately, each of these variables
22 could maximize infants' opportunities for sense-making, manifested in reactions other

1 than looking, and shed further light on how infants come to understand unexpected and
2 expectancy-violating events.

3 Incongruity research has done much to reveal infants' sensitivity to the
4 unexpected, but it has yet to explain what it is precisely that infants are sensitive to –
5 whether it is their knowledge of simple physics or their use of social context. The
6 disparity in infants' reactions – primarily looking or smiling – likely has less to do with
7 whether an incongruity is physical or social, impossible or possible, magical or
8 humourous, unresolved or resolved – but instead more likely reflects contextual
9 variables that systematically differ between these two research paradigms and that either
10 deprive or provide infants with opportunities for sense-making.

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