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SHORT COMMUNICATION

Listening to infant distress vocalizations enhances effortful motor performance

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There are few sounds that carry as much biological clout as the cries of a distressed infant. Consider a crying infant on a plane: the sound is as unpleasant as it is difficult to ignore, even amongst a host of other environmental noises. A distressed infant's cry, characterized by high and variable pitch, elicits autonomic arousal in the listener as measured by heart rate, blood pressure, skin conductance [for review, see (1,2)] or hand grip force (3). The physiological arousal seen in response to infant cries may reflect a 'high-alert' state which prepares an adult to react rapidly to the infant's distress (4).

We examined whether the reported physiological change in response to infant cries translates into measurable differences in adults' ability to move in a concerted and accurate manner. To this end, we played a series of infant cries and other sounds to a group of adults and measured subsequent performance on an effortful motor speed and dexterity task, in the form of a miniature version of the classic arcade game, 'Whack-a-mole'. This game is brief but engaging and requires participants to press down on a target button (indicated by a light), with a predetermined amount of force, in order to score points. Within the same individuals, we compared performance on this task after listening to infant distress vocalizations, adult distress vocalizations and non-distressed, but high-pitched bird vocalizations. An individual's overall score on the task reflected their success in pressing target buttons quickly enough and with sufficient force. An additional, subtle measure of change in performance was obtained in the form of effort exerted by participants, by measuring the pressure applied to target buttons during the game. Similar measures such as hand-grip force in humans (5) or lever pressing in animal models have been taken as an index of behavioural activation or motivation to act (6).

Forty adults (20 men), ranging in age from 19 to 59 years took part ($M = 26.5$, $SD = 8.2$). Three participants were parents, but none had young children. All participants had normal hearing and normal vision or vision corrected to normal.

The task, a small-scale version of 'Whack-a-mole' (Fig. 1A, 'Whack it', USB version), requires participants to press one of nine buttons, whose location varies randomly across the game. As the game progresses, the speed of change in location of the target button increases. The game was mounted on top of electronic scales (Salter 1036 BKDR), which were used to gauge the amount of effort participants exerted to push the buttons by measuring peak weight (in grams; minimum, maximum and average weights were recorded by videotaping the scales for the duration of the experiment). The amount of effort participants needed to apply to a target button in order to score was measured on the scales as approximately 350 g.

After playing three 30 sec practice rounds, each participant listened to 4.5 min of one of the sound categories and then immediately replayed the game for 60 sec. This was repeated for each of the sound categories, with the order in which participants heard each sound category counterbalanced across participants. Each sound category consisted of 15 sounds, clipped to 1500 msec, free from background noise and matched to have linear rise and fall times of 150 msec and comparable average root mean square intensity. The sounds were presented at 70 dBFS above each participant's absolute hearing threshold using Sony In-Ear earphones (MDR-EX77LP). The three categories of sound

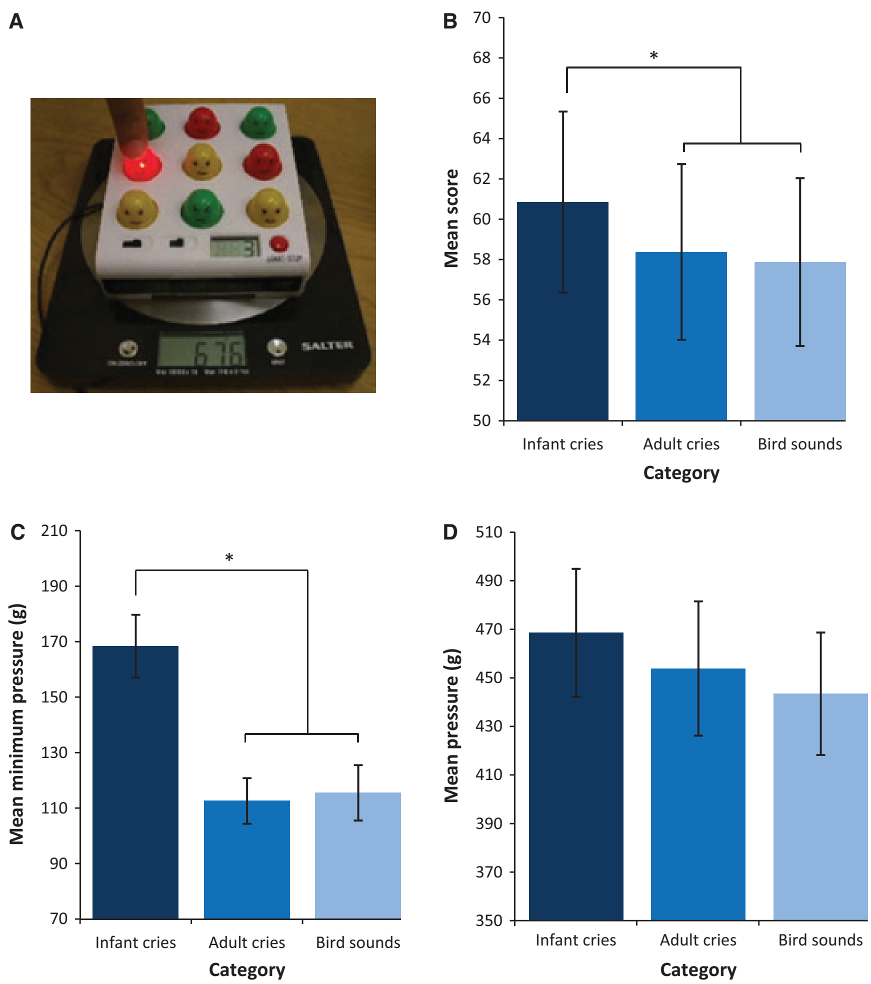

Figure 1 The 'Whack it' game and participant performance after listening to the different sound categories: (A) task and scales (B) mean scores across categories, (C) mean minimum pressure scores, (D) mean pressure scores. Error bars represent the mean ± standard error, *significance.

stimuli were obtained from video recordings, and the human sounds were independently rated as unambiguously communicating distress.

Scores on the game were significantly higher after listening to the infant cries compared with the other sounds [Fig. 1B; $F(1, 38) = 5.47$, $p = 0.02$, $r = 0.35$]. Men and women had similar scores overall [$F(1, 38) = 0.13$, $p = 0.72$, $r = 0.05$] and the interaction between gender and sound category was not significant [$F(1, 38) = 2.87$, $p = 0.09$, $r = 0.26$]. The minimum pressure that the participants applied to the buttons was significantly greater after listening to the infant cries compared with the other sounds [$F(1, 38) = 32.44$, $p < 0.001$, $r = 0.68$, Fig. 1C]. No significant effects of gender or sound category × gender interaction emerged for any of the pressure score data. Participants applied similar average pressure [$F(1, 38) = 3.18$, $p = 0.08$, $r = 0.28$, Fig. 1D] and similar maximum pressure [$F(1, 38) = 1.27$, $p = 0.27$, $r = 0.18$] to the target buttons after listening to each sound category. The higher minimum pressure scores after listening to infant cries suggest that, in this condition, participants were consistently attempting to hit the target buttons with close to the amount of force necessary to score a point. This finding, in keeping with studies of the 'wanting' component of reward processing which take analogous pressure measures in animals (6), suggests that infant cries can motivate people to act. Average and maximum pressure scores after all three sound categories were substantially higher than the amount of force required and therefore did not reflect relative success on the task.

Here, we report novel evidence to show that infant distress cries can elicit immediate improvements in adults' motor performance, as indexed by rapid, co-ordinated effortful movements. These improvements were not simply a consequence of listening to a high-pitched sound, or a distressed human vocalization. The specificity of this effect suggests that infant crying is a privileged category of human emotional vocalization that can have a unique impact upon adults' behaviour. Crying is metabolically costly for the infant, but when it occurs as a result of transient distress, it is highly likely to elicit parental care (7). It is not hard to imagine how faster, more accurate intentional movements could facilitate such caregiving.

Listening to infant cries has been shown to adversely affect performance on simple cognitive tasks when compared with other noisy environmental sounds (8). In this study, we demonstrate a positive consequence of hearing distressed infants: improvements in speed and accuracy in intentional movements. Such improvements in accurate effortful movements may reflect an adaptive physiological response that takes effect when an immediate reaction to a distressed infant is required.

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