Gut Feelings, Intuition, and Emotions: An Exploratory Study

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ABSTRACT

Objective: Investigate whether the gut feelings of one person, as measured with an electrogastrogram (EGG), respond to the emotions of a distant person.

Design: In a double blind protocol, EGG activity was recorded in an individual relaxing in a heavily shielded chamber while, at a distance, a second person periodically viewed the live video image of the first person along with stimuli designed to evoke positive, negative, calming, or neutral emotions.

Subjects: Twenty-six (26) pairs of healthy adult volunteers.

Outcome measures: EGG maximum values recorded while the distant person was exposed to emotional stimuli were compared to similar values recorded during exposure to neutral stimuli.

Results: EGG maximums were significantly larger on average when the distant person was experiencing positive ($p = 0.006$) and negative ($p = 0.0009$) emotions, as compared to neutral emotions. Nonparametric bootstrap procedures were employed to evaluate these differences, and the results survive correction for multiple analyses.

Conclusions: EGG activity increases in response to the emotions of a distant person, beyond the influence of ordinary sensory interactions. Relationships commonly reported between gut feelings and intuitive hunches may share a common, poorly understood, perceptive origin.

INTRODUCTION

Ideally, medical decisions should be based on the outcomes of clinical trials, laboratory tests, and scientific experiments. In practice, given uncertain diagnoses, scores of therapeutic alternatives, idiosyncratic differences, and unpredictable daily crises, practitioners must also rely on their intuition. Discussions about the role of intuition in healing can be found throughout the medical literature; such papers are especially conspicuous in nursing journals (Kerfoot, 2003; King and Clark, 2002; Kosowski and Roberts, 2003; Rew et al., 2000; Ruth-Sahd, 2003; Truman, 2003).

Many intuitive hunches can be attributed to factors such as forgotten expertise, subliminal cues, and unconscious somatic influences (Damasio, 1994; Torff and Sternberg, 2001). However, there is growing evidence that such conventional explanations may not account for all intuitive impressions. Sometimes intuition appears to provide accurate information about future, noninferable events (Hams, 2000; McCraty et al., 2004a, 2004b; Radin, 1997a, 1997b, 2004a; Spottiswoode and May, 2003), and about the intentions, attentions, and emotions of people at a distance (Braud, 2003; Schlitz, 1996; Schmidt et al., 2004).

The present study investigated whether gut feelings—commonly reported visceral sensations that are virtually synonymous with intuitive hunches—may involve information gained by nonordinary means. Because of the close relationship between gut feelings and emotions (Houghton et al., 2002; Katkin et al., 2001; Mayer et al., 2000; Muth et al., 1999; Sadler and Orten, 1968), we specifically tested whether a person's gut feelings might respond to the emotions of a distant person.

Previous studies have focused on how one person's (the receiver, or R) autonomic nervous system is affected while a distant person (the sender, or S) is instructed to direct their thoughts towards R.* The principal measures in these stud-

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*These terms are used for ease of exposition; they do not imply explanatory mechanisms.

ies have been electrodermal and peripheral vascular responses (Braud and Schlitz, 1989, 1991; Dean and Nash, 1967). Event-related changes in R's electroencephalogram have also been studied (Radin, 2004b; Standish et al, 2004; Wackermann et al., 2003). Meta-analyses of these studies suggest that people can mentally influence each other's physiologic states in ways that transcend conventional models of human interaction (Schlitz and Braud, 1997; Schmidt et al., 2004; Wackermann, 2004).

METHODS

To explore the relationship between gut feelings and intuition, we used cutaneous electrogastrography (EGG) as the physiologic variable of interest. The EGG is a noninvasive way to monitor the gut's myoelectrical behavior (Stern et al., 2001). EGG frequencies and amplitudes closely correlate with stomach contractile activity measured with invasive electrodes (Muth et al., 1999; Stern et al., 2001).

Receiver

Volunteers were recruited in pairs; a minimum of 25 pairs were prespecified for this study. Each pair signed an informed consent and then mutually decided who would take the role of S and R. R was asked to relax in a reclining chair in an electromagnetically and acoustically heavily shielded room (a Lindgren/ETS [Glendale Heights, IL] double steel-walled chamber, with acoustic shielding on the walls and ceiling, and a vibration damping floor). All signals in and out of the chamber were transmitted through fiber optics to maintain the electrical isolation of the shielded room. (Fig. 1).

Three pre-gelled, disposable electrodes (Ag/AgCl, Biopac EL503) were used to monitor R's EGG (Biopac Systems, Inc., Goleta, CA). The signal electrode was placed between the umbilicus and the xiphoid process; the reference was placed in the upper right quadrant just below the costal margin, approximately 8 cm right of the midline; and the ground was placed in the left upper quadrant approximately 8 cm to the left of R's midline. The signals were amplified by a Biopac EGG100C EGG amplifier (set to 1000 gain, low pass filter at 0.1 Hz, high pass filter at 0.005 Hz) and digitized by a Biopac MP150 physiologic monitor recording at a 125 Hz sample rate.

After confirming that R's physiologic signals were recording properly, the experimenter (E) focused a video camera on R's face, and R was asked to relax while attempting to maintain a "mental connection" with S. R knew that S would be watching him or her periodically over closed circuit video, but R did not know the timing, length, or frequency of these periods. R listened to a meditative tone on headphones to encourage relaxation and to provide additional acoustic masking.

To encourage a shared state of connection, R and S were asked to exchange a personal, meaningful item, like a watch or ring. They each held this item in their right hand during the experimental session. Then S was led to a room about 15 meters away.

Sender

To verify that S's emotions were successfully manipulated, S's electrocardiogram was monitored with a Biopac EMG100C electromyogram amplifier.[†] Instantaneous heart rate was calculated offline using a cardiotachometer feature within Biopac's Acqknowledge 3.7.1 data acquisition and analysis software.

S sat in front of 2 video monitors and wore a set of active noise-canceling headphones (Bose QuietComfort™). One monitor periodically displayed R's live image; the other displayed a sequence of pictures. The stimulus pictures were selected from the International Affective Picture System (IAPS; Lang et al., 1993), a standardized pool of color digital photographs with preassessed ratings for emotional arousal and valence. Music was selected from popular songs and movie soundtracks to evoke emotions, as described below.

Stimulus procedure

Digitized signals from the R & S Biopac systems were transmitted over a local area network to 2 separate Windows-based personal computers (PCs). The experiment was controlled by a third PC. When the experimental program was launched, it randomly selected 1 of 2 counterbalanced sequences of emotional conditions.[‡] Each sequence consisted of a 30-second interepoch rest period followed by a 2-minute epoch presenting 1 of 4 emotions: positive, negative, calming, or neutral. After 4 epochs were presented, the same sequence was repeated using new pictures and sound for the positive and negative conditions, and the same pictures and sound for the calm and neutral conditions.

To avoid psychological and physiological habituation (Bradley et al., 1996; Weisenberg et al,, 1998), S viewed a series of 20 different pictures during each sending epoch. Each picture was displayed for 6 seconds, and each picture within a given epoch was selected to have approximately the same IAPS-standard valence and arousal level.

At the beginning of each epoch, the computer switched R's video image to 1 monitor in S's room, sent electrical markers to the R and S Biopac systems to synchronize the 2 sets of physiological recordings, started playing to S mu-

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[†]A Biopac EL503 signal electrode was placed beneath the center of S's right collarbone, the reference on the left side below the last floating rib, and the ground about 3 inches below the reference.

[‡]The Microsoft Visual Basic 6.0 pseudorandom algorithm, seeded with the computer's system clock time at the beginning of each session, was used to generate the random order.
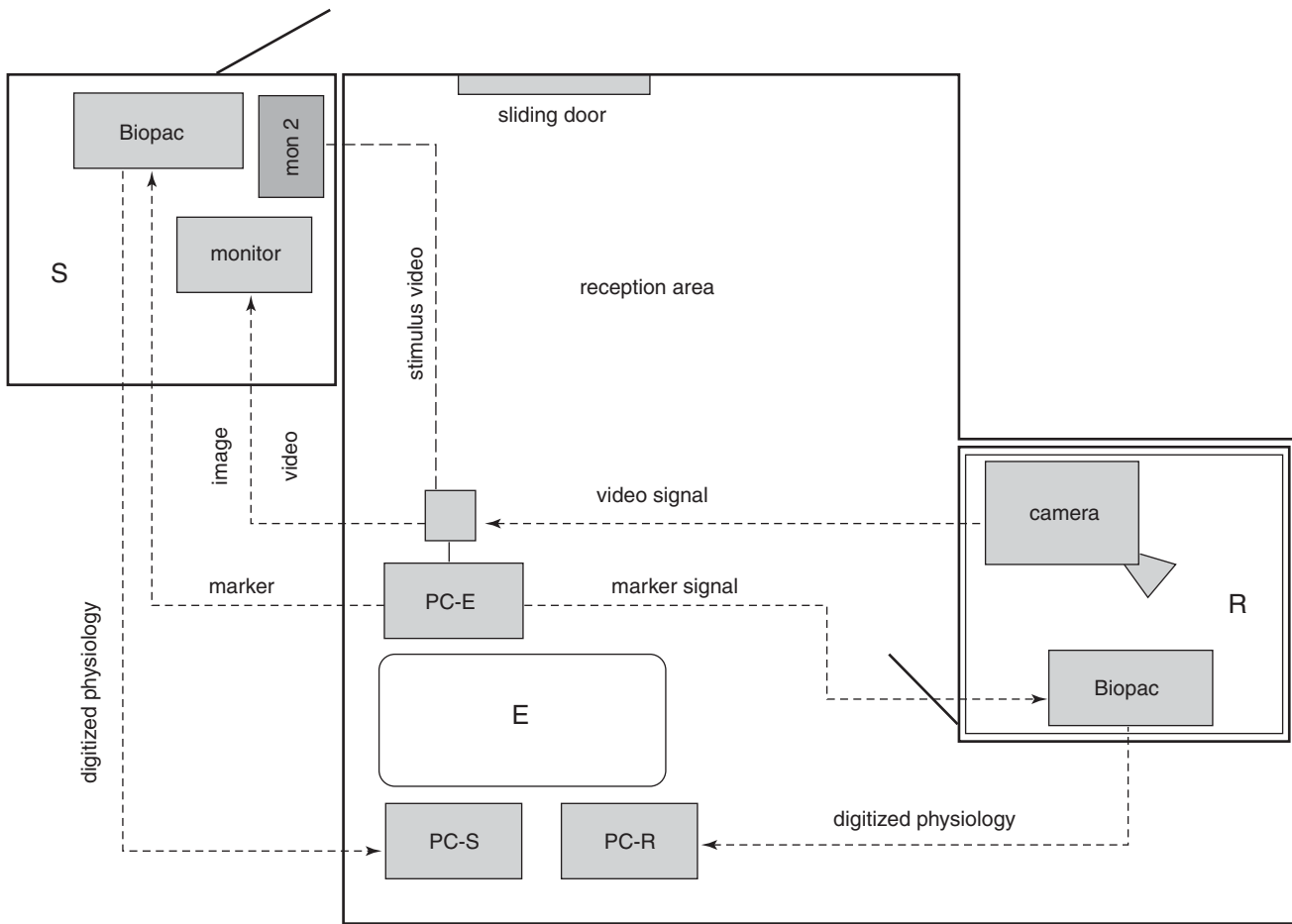
FIG. 1. Laboratory layout and infrastructure. The experimenter's workstation (E) consisted of 3 computers: 2 recorded the physiological data from the sender (PC-S) and receiver (PC-R) Biopac systems; the third (PC-E) controlled the timing and generation of the stimuli and a video switch. The receiver (R) was in an electromagnetically and acoustically shielded room; the sender (S) was in a distant room behind two doors and a double wall.

sic appropriate to the emotional condition, and also displayed to S the stimulus pictures on the other monitor. During the interepoch rest periods, 1 monitor was black and the other presented the word "relax" in green on a black background.

Positive emotion stimuli included photos of smiling babies and kittens. Positive epoch 1 was accompanied by the Beatles' rendition of *Twist and Shout*, and positive epoch 2 by Little Richard's song, *Long Tall Sally*. The negative emotion epochs included a sad theme with pictures such as a graveyard, accompanied by Samuel Barber's *Adagio for Strings*, and an angry theme with pictures such as an atomic bomb explosion, accompanied by the song, *Feuer Frei*, by the heavy metal rock band Rammstein. The calming epoch consisted of low-arousal IAPS pictures transformed into gray-scale images, accompanied by the song, *May it Be*, by Enya. The neutral epoch pictures were all gray-hued rectangles accompanied by pink noise. The interepoch rest periods were accompanied by the same pink noise.

The 8 epochs presented in each session could appear in one of two orders: Order I consisted of calm, negative-sad,

neutral, positive 2, calm, negative-angry, neutral, and positive 1. Order II was the reverse of Order I. The order assigned to a given session was determined randomly by the controlling program. Two orders were provided to keep both
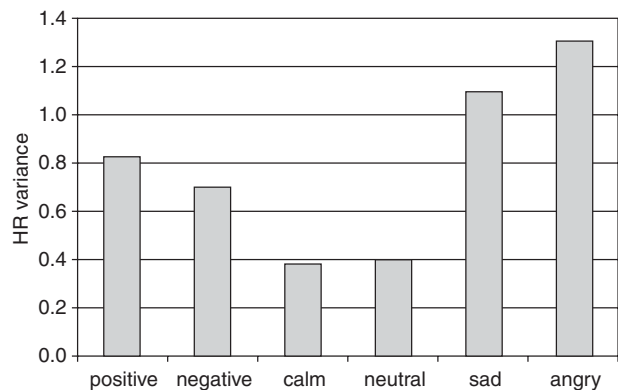

FIG. 2. Heart rate (HR) variance in senders during emotional and neutral epochs.
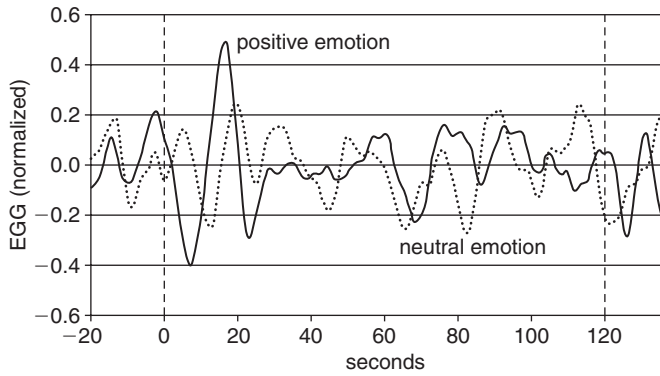
FIG. 3. Electrogastrogram (EGG) averaged across all positive and neutral conditions, minus 20 seconds before stimulus onset and plus 20 seconds after stimulus offset.

E and R blind to the emotional condition sequence during each recording session, and to allow an assessment of potential EGG baseline drifts. Each experimental session thus consisted of 8 2-minute sending epochs, each separated by a 30-second rest period, plus a 2-minute cooldown period before the session began, for a total of 22 minutes. R and S were allowed to relax with the electrodes in place for about 10 minutes before the session began.

During sending epochs, S was instructed to periodically gaze at R with intention to send the emotions evoked by the stimuli. Between epochs, S was instructed to withdraw attention from R and relax. To check that R could not inadvertently pick up sensory cues from S, prior audio tests were conducted from S's location using a horn that issued a 1000 Hz tone at 100 dB. Quantitative audio level tests indicated that those extremely loud tones were indistinguishable from background noise inside R's shielded chamber.

Analysis

EGG maximum amplitudes observed during positive, negative, and calm epochs were compared to the same measures during neutral epochs. A secondary analysis split the negative emotional epochs into the subgroups of sad and angry versus neutral. We assumed that changes in R's EGG would be synchronized with S's emotions, thus the strategy of the bootstrap technique was to examine differences between EGG signals in emotional versus neutral conditions, as compared to differences observed when those same signals were desynchronized in time.

Raw EGG data was downsampled from 125 Hz to 25 Hz; at 120 seconds per epoch and 25 samples/second, each sending epoch consisted of 3000 samples. Data 20 seconds before and after each epoch were also retrieved, thus each analyzed epoch consisted of 4000 samples: 1 to 500 corresponding to prior to stimulus onset, 501 to 3500 to the sending period, and 3501 to 4000 to after stimulus offset. The following 7 steps were then followed:

1. Find the mean (μ_j) and standard deviation (σ_j) of EGG samples x_{ij}, where $i = 1$ to 4000 in each epoch j.
2. Normalize each sample as $s_{ij} = (x_{ij} - \mu_j)/\sigma_j$ for each sample i = 1 to 4000 and epoch j.
3. Determine the average normalized epoch for the emotional condition e, as $\bar{s}_{ie} = \sum_{ij} s_{ij} / N_{ij}$ where $i = 1$ to 4000, j is the number of epochs in each emotional condition, and e refers to the data subsets for positive, negative, calm, neutral, sad, and angry epochs.
4. Calculate the maximum value of $\bar{s}_{ie}$ for samples $i = 500$ to 3500 for each condition e. Call these values max_e. Because epochs are normalized in step 2, the mean value per epoch will be close to zero, so only maximum values are considered. Normalization also ensures that when EGG samples are combined across sessions, in step 3, that each epoch has equal weight.
5. For each normalized epoch in step 2, select a sample r_i randomly between $i = 1$ to 4000, call that sample 1 and shift the remaining samples accordingly (i.e., rotate the vector) to form a new epoch, maintaining the same amplitudes and autocorrelational structure as the original signals, but desynchronized in time with respect to the original stimulus onset and offset.
6. Using these randomly time-shifted epochs, recalculate steps 3 and 4 to determine max_{er}, where r indicates random permutation.
7. Repeat steps 5 to 6 10000 times, each time recalculating max_{er} to build up a distribution of possible values. These distributions are used to determine the standard deviations of the randomly time-shifted maximum EGG values for each emotional condition; call these values σ_{max_er}.
8. Determine $z_{max\ e} = (max_e - max_n)/\sqrt{\sigma_{max\_er}^2 + \sigma_{max\_nr}^2}$, where max_e represents the original average maximum value for emotion e, max_n represents the original average maximum value for the neutral emotion, σ_{max_er} is the standard deviation for the maximum values of the randomly desynchronized emotion e, and σ_{max_nr} is likewise for the neutral emotion.
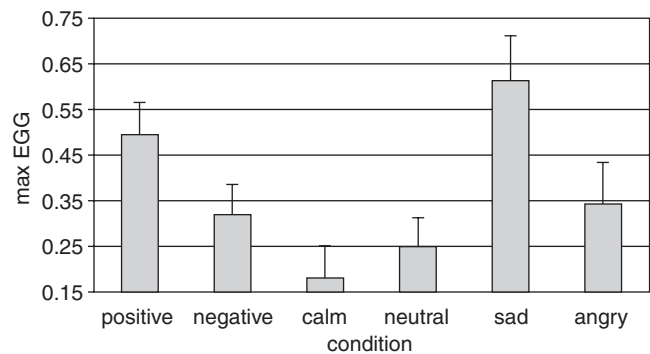

FIG. 4. Electrogastrogram (EGG) mean maximum measurements, with 1 standard error bar as determined by the bootstrap analysis, for the four primary emotional conditions, and for the sad and angry components of the negative emotion.

TABLE 1. STATISTICAL RESULTS COMPARING AVERAGE MAXIMUM ELECTROGASTROGRAM VALUES FOR POSITIVE, NEGATIVE, AND CALM EMOTIONAL CONDITIONS VERSUS THE NEUTRAL CONDITION

	z_{max}	p
Positive	2.54	0.006
Negative	0.80	0.21
Calm	−0.71	0.76
Sad	3.13	0.0009
Angry	0.85	0.20

The gut feelings hypothesis predicts that R's EGG would be modulated by S's emotions; thus $z_{max(positive)}$ and $z_{max(negative)}$ were predicted to be positive and $z_{max(calm)}$ was predicted to be negative. To avoid statistical inflation due to multiple testing, a Bonferroni correction factor was employed (i.e., $p = 0.05/5 = 0.01$), providing an adjusted significance threshold of $z = 2.33$.

RESULTS

Participants

A total of 26 sessions were conducted, resulting in a total of 208 epochs, 52 in each of the 4 emotional conditions. Five (5) epochs were partially recorded due to equipment failures, resulting in 52 positive, 51 negative, 51 neutral, and 49 calm usable epochs. Among Rs there were 5 males and 21 females (mean age 45; age range, 24–83), and among Ss there were 12 males and 14 females (mean age 44; age range, 24–83). Participants in all cases knew each other, some as friends and others as long-term partners. Two pairs were run twice with the S/R roles reversed, and 2 individuals participated in 4 sessions, each taking S and R roles twice.

Sender heart rate

At the end of each session, E asked whether the emotional stimuli provoked the desired effects in S; all replied in the affirmative. To help confirm those reports, the variance of each S's instantaneous (i.e., beat-to-beat) heart rate was determined for each epoch, and then averaged across similar emotional conditions to produce an average variance for each emotion. Results indicated that the stimuli produced changes in heart rate in alignment with the planned emotional manipulations (Fig. 2). Specifically, positive and negative emotions produced larger changes in heart rate than the neutral or calm emotions.

Receiver EGG

Figure 3 shows EGG averaged across all positive and neutral epochs. Comparison of the emotional, calm, and neutral conditions reveals (see Figure 4 and Table 1), as predicted, that with respect to average maximum EGG amplitudes during the neutral condition, the positive emotion was significantly larger ($z_{positive} = 2.54$, $p = 0.006$), negative was larger (nonsignificantly), and calm was smaller (nonsignificantly). When the negative emotion epochs were partitioned into their sad and angry components, sad was found to be significantly larger than neutral ($z_{sad} = 3.13$, $p = 0.0009$).

DISCUSSION

The results appear to support the hypothesis that one person's gut feelings can respond to a distant person's positive and sad emotions. What alternative explanations might account for these results? The leading conventional candidates include chance, inappropriate statistics, sensory cues, expectation biases, and physiological drift.

Chance: Results in 2 conditions exceeded the Bonferroni criterion in the predicted directions, thus chance seems implausible.

Inappropriate statistics: A nonparametric bootstrap technique was used to avoid violating any parametric assumptions.

Sensory cues: The laboratory environment was designed and tested to block potential electromagnetic, acoustic, or vibratory signals passing between R and S, thus sensory leakage is not a viable explanation.

Expectation biases: Could R have modulated his or her physiological state to match S's emotional conditions? The order, timing, number, and precise nature of the stimuli were unknown to most Rs. A few Ss who switched roles with Rs would have known the length of each emotional epoch and the nature of the stimuli, but not when each session began nor the order of the stimuli. So this explanation seems implausible.

Physiological drift: Could observed results be due to drifts in EGG baselines? Each epoch was independently nor-
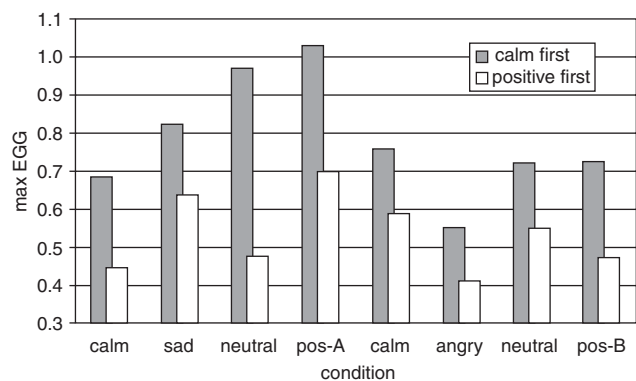

FIG. 5. Mean maximum electrogastrogram (EGG) for calm-first order, shown from left to right, and positive-first order, shown right to left. The correlation between the two conditions is r = 0.67, $p = 0.068$ (two-tailed), suggesting that the EGG values did not depend on the order in which the conditions were presented.

malized, so this should not be a viable explanation. However, to explore this question in more detail, Figure 5 shows the average EGG maximum values according to the emotional condition. Order I is shown left to right and Order II is shown in reverse, so that the same emotional sequences can be directly compared. The gut feelings hypothesis predicts that EGG values are influenced by S's emotional state regardless of the order in which the emotions took place; a positive correlation is predicted, thus a one-tailed probability is employed. The observed correlation confirms the prediction, $r = 0.67$, t (6df) $= 2.22$, $p = 0.034$.

CONCLUSIONS

This experiment suggests that some somatic feelings may be associated with perceptions transcending ordinary sensory capabilities. Of course, it would be imprudent to assume that all gut feelings necessarily contain intuitive information, as on occasion visceral sensations reflect little more than a bad burrito. But assuming that future studies can successfully replicate the present results, it may turn out that the "belly brain" is more perceptive than previously suspected, and that common reports of gut feelings having special intuitive qualities may have a basis in fact.

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