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Title: A Markov Chain Analysis of Emotional Exchange in Voice-to-Voice Communication: Testing for the Mimicry Hypothesis of Emotional Contagion

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Abstract

Mimicry is a central plank of the emotional contagion theory, however it was only tested with facial and postural emotional stimuli. This study explores the existence of mimicry in voice-to-voice communication by analyzing 8747 sequences of emotional displays between customers and employees in a call-center context. We listened live to 967 telephone interactions, registered the sequences of emotional displays and analyzed them with a Markov chain. We also explored other propositions of the emotional contagion theory that were yet to be tested in vocal contexts. Results supported that mimicry is significantly present at all levels. Our findings fill an important gap in the emotional contagion theory; have practical implications regarding voice-to-voice interactions, and open doors for future vocal mimicry research.

Keywords: *emotional contagion theory, vocal mimicry hypothesis, naturalistic observation, voice-to-voice interactions, sequential analysis, Markov chain.*

The emotional contagion theory (Hatfield, Cacioppo, & Rapson, 1994) proposes that individuals automatically mimic the vocal, facial and postural nonverbal cues of emotions of others and, through a process of afferent feedback, converge emotionally. Although the mimicry proposition was empirically tested in several studies for the facial and postural hypothesis, the vocal mimicry premise remains untested.

The present study aims to explore the occurrence of vocal mimicry in a natural setting. To test this proposition is central, since it represents a fundamental part of the emotional contagion theory that, although never empirically tested, served as the theoretical foundation for many studies (e.g., studies to test the vocal feedback hypothesis). To explore this phenomenon is also important for several areas where vocal communication prevails and where the understanding of its dynamics is basal, such as telephone sales, political speeches, and counseling. Research has shown that emotional contagion is present in nearly all types of communication interactions, from groups to dyads, in both directions regarding power hierarchy, and in professional as well as in personal relations (e..g, Barsade, 2002; Cherulnik, Donley, Wiewel, & Miller, 2001; Hennig-Thurau, Groth, & Grembler, 2006; Thompson & Bolger, 1999). Emotional contagion is one of the most important processes that lead to the interpersonal influence and exchange of emotions in communication and for this reason its unexplored dimensions urge to be scrutinized.

THEORETICAL BACKGROUND

The emotional contagion theory, as discussed by Hatfield et al., (1994) refers to how individuals' emotional states are influenced by the verbal and non-verbal emotional cues of others. It is described as the basic block of social interactions and comprises a set of psychophysiological, social and behavioral processes. The phenomenon of emotional convergence between people started to be studied following a 'group mind' perspective and

later as a form of pathological mass behavior (Le Bon, 1896). James (1890) proposed that physical expressions and movements antecede emotions and might even cause them. Both appraisal theorists (e.g. Scherer, 1999) and non-cognitive scholars (e.g., Izard, 1993) agree that emotional states are automatic and easily changeable, and that the processes that precede and define emotions are rapid and unconscious. Several studies have supported this theory in diverse areas of research, from child psychology (e.g, Pfeifer, Lacoboni, Mazziotta, & Dapretto, 2008; Thompson, 1987) to organizational research (Barger & Grandey, 2006; Dallimore, Sparks, & Butcher, 2007).

The theory of primitive emotional contagion describes the process whereby one catches and synchronizes with others' emotions as happening in two main phases: 1) *Mimicry*: individuals tend to synchronize their movements with others' emotional displays (such as facial expressions, postures, voices, movements and instrumental behaviors) with the function of facilitating interactions (e.g., Meltzhoff & Moore, 1992), and 2) *Feedback*: the feedback proposition states that after mimicking others' emotions, one actually experiences an emotional state that is congruent with the message that was sent through the process of afferent feedback, i.e., the process by which information from the peripheral nerves is sent to the brain.

The emotional contagion theory states that contagion happens through the synchronization of facial, postural, and vocal signs of emotion. Both the facial and postural hypotheses have been supported within a variety of studies that were focused on the two above-mentioned phases of contagion (mimicry and feedback). For example, the facial mimicry and feedback hypotheses have been supported in a vast array of both laboratory and natural contexts. Studies that measured facial expressions with electromyography supported the mimicry proposition by finding that people reproduce the subtlest moment-to-moment

alterations in the facial expressions of others (e.g., Wild, Erb, Eyb, Bartels, & Grodd, 2003). This phenomenon was found in infants, young children, adolescents and adults (Hurley & Chater, 2005).

There is also evidence that facial feedback leads to emotional convergence (the feedback hypothesis). In a classic experiment conducted by Laird and Bresler (1992), researchers told participants they were studying facial musculature and attached silver cup electrodes to strategic areas of their faces, which surreptitiously manipulated their facial expressions. They found that participants in the 'smile' condition reported significantly higher levels of happiness than the ones in the 'frown' condition'. More recent studies also supported the facial feedback hypothesis both in laboratory and natural contexts (e.g., Barger & Grandey, 2006; Hennig-Thurau, Groth, Paul, & Gremler, 2006).

Regarding the postural mimicry and feedback propositions, there is a vast amount of research that supports the automatic tendency to mimic other people's postures and the consequent emotional tuning between individuals. For example, a pioneer study conducted by Condon and Ogston (1966) with university students found that, when interacting, people tend to synchronize movements and postures within 21 milliseconds. This predisposition, also called microsynchrony, was found to cause afferent feedback in a variety of investigations (for a review see Hatfield et al., 1994).

The importance of postural feedback for the emotional experience was also acclaimed by the theatre theorist Konstantin Stanislavski, who argued that "Emotional memory stores our past experiences; to relive them, actors must execute indispensable, logical physical actions in the given circumstances. There are as many nuances of emotions as there are physical actions" (in Moore, 1984, pp. 52–53). In fact, since Darwin's (1872/1965) proposal that the

activation of skeletal musculature should, in part, affect one's emotional experience, various works have tried, with success, to verify the facial and postural hypotheses.

However, the vocal hypothesis did not attract the same degree of attention. Only a very small number of pioneer studies attempted to investigate the existence of emotional contagion through vocal communication. The original vocal feedback hypothesis (Hatfield, Hsee, Costello, Weisman, & Denney, 1995), for example, was based on a single series of studies conducted by Zajonc, Murphy, and Inglehart (1989). In this series, researchers asked participants to produce sounds that required them to make a facial expression that was related to an emotion. For example, individuals were asked to make a long 'e' in 'cheese' (and consequently make a smiling expression) or the German 'u' (disgust expression). Results showed that participants tended to experience emotions that were congruent with the faces they pulled while making the sounds. However, these results were tightly linked with the feedback from facial expressions alone, disregarding a) the feedback from vocal cues of emotion instead of facial expressions, and b) the mimicry hypothesis, i.e., the tendency do automatically copy other's verbal cues of emotions.

Based on this study, Hatfield and colleagues (1995) attempted to test and develop the vocal feedback hypothesis of emotional contagion, which posits that when individuals vocalize sounds and words that correspond to certain emotions, they converge emotionally. To achieve this, the authors conducted two experiments. In the first, participants had to read a sad, angry, loving or joyous script. Their ensuing emotional experience was assessed through their facial expressions and through a self-report measure of emotion. In the second experiment, participants had to reproduce one of six sound patterns pre-recorded on a tape. One was a neutral control and the other sounds corresponded to love/tenderness, fear, anger, sadness and joy. The participants' emotional experience was assessed through a self-report

measure of emotion. In both experiments, the authors found that individuals were emotionally affected by the type of sound they were asked to reproduce. The vocal feedback hypothesis of the emotional contagion theory was deemed to be supported. However, the vocal mimicry hypothesis remained unexplored, since the isolated vocal mimicry phenomenon was not tested. Since mimicry is one of the foundations of emotional contagion, it is extremely important to test its occurrence in vocal contexts in order to ascertain whether the vocal emotional contagion proposition is supported.

DEVELOPMENT OF HYPOTHESES

One of the most well-known and accepted definitions of emotional contagion is that it is the 'tendency to automatically mimic and synchronize facial expressions, vocalizations and movements with those of another person and, consequently, to converge emotionally' (Hatfield et al., 1992, pp. 153-154). The first stage of the emotional contagion process implies the automatic and involuntary mimicry of the external signs of emotions expressed by others. Mimicry is an innate predisposition to replicate mannerisms, facial expressions, verbal and non-verbal behaviors (Gueguen, Jacon, & Martin, 2009), and it is a phenomenon inherent to several species, from humans to primates (e.g., Want & Harris, 2002), grey parrots (Moore, 1992) and even butterflies (Mallet, 1995).

The mimicry phenomenon serves several adaptive functions. Want and Harris (2002) stated that mimicking others' behaviors facilitates learning in the early stages in life. An experiment conducted by Bailenson and Yee (2005) tested the influence of mimicry in persuasion, by exploring the interaction of participants with a virtual agent in two conditions: in one condition, the agent presented a persuasive argument while mimicking the participants' head movements (with a delay of 4 seconds); in the other condition, the agent provided a persuasive argument without mimicking the participants' movements. Results

showed that in the mimicking condition, the agent was more persuasive than in the non-mimicking condition. Other experimental studies supported the influence of mimicry in several affiliative functions such as empathy (Chartrand & Bargh, 1999; Maurer & Tindall, 1983), rapport (Lafrance, 1979; Lakin & Chartrand, 2003), and spontaneous helping behavior (Van Baaren, Holland, Kawakami, & Van Knippenberg, 2004). Despite the evidence-supported importance of mimicry in human functioning, no experiment has directly tested whether mimicry of vocal emotional displays occurred in the development of the vocal mimicry hypothesis of emotional contagion. In studies so far carried out, there has only been one person involved (the participant) and the mimicry phenomenon was 'imposed' since researchers asked individuals to read emotionally charged sentences or to imitate pre-recorded sounds. What was tested was the *impact* of vocal mimicry on participants, and not the *occurrence* of vocal mimicry alone. Thus it is still not known whether people automatically tend to copy the vocal emotional expressions of others as they do with facial and postural expressions, or not.

Since previous research supported the human tendency to mimic both facial and postural cues of emotion (e.g. Schulte-Rüther, Markowitsch, Fink, & Piefke, 2007; Yabar, Johnston, Miles, & Piles, 2006) and also some vocal dimensions of speech like rate (Webb, 1972), rhythm (Cappella & Panalp, 1981), laughter (Bush, Barr, McHugo, & Lanzetta, 1989; Provine, 1992) and even the accent of the counterpart (Giles & Powesland, 1975), we predict that:

H1: The probability of individuals mimicking the vocal emotional valences of others will be statistically significant.

Moreover, some previous studies supported that negative emotions are more easily recognized and transferred than positive ones (Joiner, 1994; Tickle-Degnan & Puccinelli,

1999). Hatfield and colleagues (1995), for instance, while testing the vocal feedback hypothesis found that negative emotions were more powerfully affected by vocal feedback than positive ones. A possible explanation is that, as most researchers studying emotion agree, negative emotions are normally externalized more strongly and are thus more easily recognized than positive emotions (e.g., Hatfield et al., 1995). A cross-cultural experimental study conducted by Scherer, Banse, and Wallbott (2001) explored whether there were cultural differences in the recognition of vocal changes produced by five different emotions (sadness, anger, joy, fear and disgust). Judges from nine countries from three continents listened to pre-recorded vocal stimuli and were asked to rate the emotion that was being expressed. The positive emotion (joy) was inferred with much less precision (48%) than the negative emotions (ranging from 74% to 88%). The authors found that the positive emotion was frequently confused with neutral stimuli, a phenomenon that was also supported in earlier research (e.g., Scherer, 1991). Based on this phenomenon, we predict that:

H2: The mimicry of negative vocal emotional displays will be significantly higher than the mimicry of positive ones.

Previous studies found differences in emotional contagion regarding the sex of the sender. Results showed that the negative expressions of males were more easily perceived than those of women (Goos & Silverman, 2002), that both sexes were more prone to recognize negative expressions displayed by men (Rotter & Rotter, 1988), that negative expressions in men were identified at longer distances than other expressions (Hagar & Ekman, 1979; Kirouac & Doré, 1984) and that men were more expressive in the context of negative emotions (Kring & Emmons, 1990). There are both physiological and social explanations for this. Physiologically, for example, the higher testosterone levels in men were found to be associated with the stronger displays of negative expressions (e.g. Honk et al., 1999; Kimura,

1999, Goos & Silverman, 2002). Sociologically, men tend to follow to a lesser extent the social rules that are generally associated with women, like faking positive emotions or hiding negative ones (Simpson & Stroh, 2004), and they are given a higher status by both men and women (Rafaeli, 1990). This greater tendency to express more negative emotions, and to express them more overtly and more expressively than women, leads us to propositions 3 and 4.

H3: Regarding the sex of the sender, male senders will generate significantly higher levels of negative vocal mimicry than positive vocal mimicry.

H4: Regarding the sex of the sender, when the senders are male the levels of negative vocal mimicry will be significantly higher than when the senders are women.

Regarding the sex of the receiver, there is clear evidence from a variety of studies that women are more susceptible to emotional contagion than men. For example, in a study conducted by Doherty, Orimoto, Singelis, Hatfield, and Hebb (1995) judges rated women as being more able to share senders' emotions and also as exhibiting more emotional contagion. Moreover, recent studies resorted to the electromyography technique to test for such differences and found that women respond to emotional stimuli with more pronounced facial electromyography intensity (Lundqvist, 2008). Women revealed an increase in emotional responses from subliminal (spontaneous) to supraliminal (emotionally regulated) stimuli, whereas men did not, and also demonstrated a greater correspondence between their facial responses and their verbally reported emotional contagion (Sonnby-Borgström, Jönsson, & Svenson, 2008).

Women's greater sensitivity with regard to recognizing emotions in others is, to a great extent, a perceptual ability based on adaptive mechanisms (Goos & Silverman, 2002). Some authors have related it to the gender-role stereotype of women since, from an early age, they

are socially expected and motivated to emotionally relate more to others, which might result in a more accurate ability to identify and converge with others' expressions and emotions (e.g., Broverman, Vogel, Broverman, Clarkson, & Rosenkrantz, 1972; Hall, 1978). It has also been suggested that women's competency with regard to reading others' emotions is a consequence of the higher status attributed to men (e.g., Rafaeli, 1990), as women had to develop a stronger sensitivity to nonverbal cues in order to 'read better the wishes of the more powerful ones' (Hall, 1978, p. 854). There is also an evolutionary explanation for this phenomenon, which states that this capacity to read and synchronize with others' emotions is innate and stronger in women in order to: 1) facilitate an accurate response to the needs of their progeny and 2) to detect the emotional signs of other adults in order to enhance the survival chances of descendants (Hall, 1978).

Whatever the underlying reason, the fact that a vast array of empirical studies found that women are more likely to copy the postural and facial expressions of others led us to predict that:

H5: Women, as receivers, will have a greater tendency to mimic both positive and negative vocal emotional displays than men.

METHOD

Participants

The individuals who took part in the study were 41 full-time workers from an inbound call center. 76% (N=31) were female. From the total number of analyzed phone calls (N = 967), 78% (N = 754) answered by women.

The mean age was 31.5 years (SD=7.38) and ranged from 22 to 54 years. Their mean organizational tenure was 4.52 years (SD=4.14), ranging from 1 to 12 years. Regarding education, 29% of participants had a university degree and 71% had a high school certificate.

Setting

The participants worked in an in-bound call center owned and operated by a large private highway company. Participants answered calls from this company's customers. Their job tasks were to provide information, deal with complaints and to solve billing and other customers' problems. As part of their job, the agents followed a predefined script to elicit important information in order to effectively deal with customers' requests. They were instructed by the company to act neutrally and efficiently, to be unperturbed by customers' emotions and to maintain an automatic and composed tone of voice. Employees sat at desks separated from each other. Every time one call ended, another was immediately assigned in a mechanical and automatic manner, which the employees had no control over.

Data Collection Procedures

In a private room at an inbound call center, two trained researchers listened randomly to 967 live phone calls (the average number of the total calls answered per worker was 25) between customers and employees, during a period of 10 working days. Participants were aware that a study was being conducted and gave their informed consent so we could listen to their calls. They did not, however, know on what specific day and at what time their conversations would be listened to. The use of these data carefully respected ethical conventions and agreements by also ensuring the anonymity of the callers and the privacy of their personal information.

Measures

Voice-to-voice communication is a very complex mode of interaction that encompasses much more emotional information than written or electronic communication (e.g., Barry & Crant, 2000; Goldberg & Grandey, 2007). In accordance with most emotional contagion studies, the unit of analysis of the present research was the emotional valence (e.g., Hennig-

Thurau et al., 2006) that better characterized each interactant's turn-at-talk (see, e.g., Courtright, 2014). Each turn to talk represented an event that was either coded as positive, negative or neutral. We opted to use each turn to talk as a unit because we were interested in the overall emotional valence being displayed sequentially and in the consequent mimicry probability. As so, analyzing turns to talk provided a more accurate and comprehensive measure for our research questions than using, for example, thought units. As mentioned by Courtright, (2014, p. 27): 'If an interspeaker sequential analysis is to be conducted (…) multiple thoughts within a turn can be problematic, because a speaker is antecedent to herself'.

Before starting the data collection, we conducted a pilot study in which we, together with two supervisors, listened to 72 calls in order to ascertain the most common types of emotional behaviors displayed within each emotional valence (positive, negative or neutral) and to practice identifying them quickly and accurately. Some specific and recurrent emotional behaviors were identified as category systems (see, e.g., Hewes, 1979) that were later grouped within the three dimensions of emotional displays. For example, emotional behaviors like shouting or speaking aggressively were coded as negative emotional displays, while friendly greetings, compliments or the acclaimed '*smile in the voice',* were all coded as positive emotional displays. Behaviors like following the script or speaking calmly and monotonically were coded as neutral behaviors. Based on the results of this pilot study, we built a grid to register the sequence of emotional displays of customers and employees for each telephone interaction. We listened to the phone calls live, as they were happening, and registered in the grid the type of emotional valence (events) that was being displayed by each interactant (customers and employees) in his/her turn-at-talk. We also identified the sex of each interactant (male or female). The sex of speakers was easily distinguished by listening to

their voices, names, and also by the way employees referred to them (in Latin languages men and women are approached with different determinants and suffixes).

Each researcher registered the displays independently and, when the phone call ended, the grids were compared. Both researchers knew they were coding the same events because these conversations only integrated two speakers that, in most cases, intervened timely and respecting the other interactant's turn to talk. The dyads that were considered as unclear or problematic for classification purposes were discarded (22 in total). In all, we registered and analyzed a sequence of 8747 events (emotional displays), from 967 conversations that lasted a total of 52 hours and 18 minutes comprising the interaction between 41 employees and 967 callers (customers). In order to test our hypotheses we also registered the role of each interactant (customer and employee) and their sex, for each interaction.

ANALYSIS

Markov Chain Sequential Data Analysis

Data was analyzed sequentially; more specifically, we designed a Markov Chain and performed transitional probabilities analysis to explore the pattern of emotional mimicry between the two organizational actors (customers and employees). Transitional probabilities provide the likelihood that an event will follow another within a chain of events in sequence. In sum, it specifies the chances that an event (called the *given* event) will predict another (called the *target* event).

One of the advantages of analyzing data sequentially is that the variables in study are not considered as isolated elements, independent of one another. Instead, they are analyzed within the network of prior and posterior cases, and patterns of occurrence can be explored (for a review on sequential analysis see Abbott, 1995). In the present study, the word *sequence* refers to a temporal order of *events*, which were the turns-to-talk of each interactant.

More specifically, the events were positive, negative and neutral vocal emotional behaviors displayed by customers and employees during these telephone interactions (we considered all the 8747 events recorded). We analyzed *recurrent sequences*, as events repeated themselves within each wave of data collection, in contrast to *nonrecurrent sequences* where events cannot repeat and therefore the magnitude of events cannot exceed that of the whole. The transitional probability between successive events is represented by the formula:

$$p(y \vee x) = \frac{freq(xy)}{freq(x)}$$

It describes the probability that a specific behavior (*x*) will be followed by another (*y*). More precisely, the probability that x is followed by y, or p (y | x) is given by the frequency of occurrence of the pair *xy* divided by the frequency of the occurrence of x. The value of this coefficient provides the power of the forward relations between each given dyad *xy*.

To test our hypotheses, we first calculated the transitional probabilities and computed the *z* scores for each possible event pairing to identify the transitional probabilities that were significantly higher or lower than expected. At the same time, we considered the differences between observed and relative frequencies of both target and given events (Bakeman & Quera, 2011; Jeong, 2003). We used a critical *z* score of 1.96 at $p < .05$. When the hypothesis required statistical comparison tests, we followed the recommendations of Bakeman & Quera (2011) not to use the product of transitional probabilities, as they are not comparable with standard statistical techniques. Instead, we tallied the raw replies elicited by the variables of interest and used them to conduct the appropriate tests. Moreover, instead of analyzing each dyad individually, we nested data by employees. This was because, theoretically, a transitional probability table cannot be designed with less than 30 frequencies, and the average number of frequencies for each isolated dyad was 9. This reduced number of 'turn to talk' frequencies is a consequence of to the rapid nature of this type of conversations in this

specific context, where employees are pressured to respond to the maximum number of calls each day.

Markov Chain Assumptions

Preliminarily, Markov chain assumption tests were conducted. Due to the above-mentioned short duration of each call, stationarity tests were discarded.

We started by testing for order. Although mimicry is involuntary, rapid and automatic, and does not involve cognitive processes that could lead to more complex higher order models (being this absence of cognition what distinguishes emotional contagion from other phenomena, like empathy), theoretical claims have to imperatively be tested. Moreover, if a second order was to be found, the vocal mimicry hypothesis of emotional contagion would have to be discarded. Order tests ascertain how many previous events are needed to attain prediction. Both Pearson X^2 and the Likelihood ratio (LRX^2) indicated that the order of our Markov chain was first order or higher (X^2 = 2999.31, df = 4, p < .001; LRX^2 = 2315.81, df = 4, p < .001), since Pearson X^2 and the Likelihood ratio (LRX^2) values of the second order test yielded lower results (X^2 = 514.42, df = 12, p < .001; LRX^2 = 422.40, df = 12, p < .001). However, because second order results were still significant, we conducted effect size and power analysis. Cohen's effect size value for the first order Markov chain suggests a moderate effect size (d = 0.20), while the value for the second order Markov chain suggests only a small effect size (d = 0.007). Moreover, power analysis revealed that while for the first order Markov chain we need at least 221 subjects and a critical X^2 value of 9.48 in order to achieve the desired level of the α (0.05) and β (0.95) error, for the second order model we need at least a sample of 5278 and a critical X^2 value of 21.023, indicating that the chi-square results for the second order model were largely inflated by the sample size (see, e.g., Bakeman & Gottman, 1997; Cohen, 1977; Courtright, 2014).

Moreover, we conducted a homogeneity test among the individual first order transition matrices of all 41 participants. Results of X^2 yielded a significant result for homogeneity, meaning that the difference between dimensions amongst participants is statistically significant, i.e., their exhibited patterns were not the same ($X^2 = 875.291$, $df = 6$, $p = > .05$).

RESULTS

First, to explore what possible variables could influence homogeneity, we employed a weighted least-squares regression that was first introduced by Grizzle, Starmer, and Koch (1969) and has subsequently been called simply the "GSK approach."

GSK is based in the rationale of the general linear model (GLM) however it "applies the methods of weighted least squares to a set of response probabilities that have been obtained by classifying (into a vector) or cross-classifying (into a contingency table) one or more categorical variables" (Courtright, 2014, pp. 304). The objective is to understand and recognize underlying patterns and to test statistically the differences between subpopulations, dyads or combinations of variables. Such variables represent possible predictors of heterogeneity, and therefore are treated as dependent variables. In our case we compared the sample in terms of (1) shift (morning or afternoon), (2) sex of the client, (3) sex of the worker, and (4) day of the research (1 to 10). This information was gathered from our registers and was transformed in nominal data. To test for the differences we used the SAS procedure CATMODE, being the GSK procedure as follows:

$$\mathbf{f} \quad = \quad \mathbf{X} \quad \mathbf{b}$$

$$(u \text{ x } 1) \qquad (u \text{ x } v)\ (v \text{ x } 1)$$

where **X** is the design matrix, coded nominally; **b** is a column vector whose regression values are unidentified, and **f** is the vector that includes the functions of probabilities of responses that are created by the researcher (for more information refer to Courtright, 2014). GSK results yielded a significant interaction between days and sex of the worker ($X^2 = 70.68$, $df = 48$, $p < 0.05$). In a general way, we found some interesting differences that are worthy of consideration. Regarding the probabilities of positive mimicry to occur for the women group, they were markedly lower on both Fridays (day 5 and day 10, probabilities: 36.36 and 50, respectively), when the interact was initiated by employees. In a similar fashion, we noted that, for the men group, the higher probability of an event occurring was negative mimicry initiated by the employee, on a Friday too (probability: 77.78). This contradicts many studies on the affective fluctuations in the course of the week that support that positive affectivity increases as the weekend is closer and negative affect is higher in the beginning of the week (e.g., Robins & Judge, 2005; Watson, 2000). We also found that men (both employees and customers) showed visibly lower probabilities of initiating positive interactions when compared to their probabilities of initiating negative ones, which is related to hypothesis 3 (regarding the sex of the sender, male senders will generate significantly higher levels of negative vocal mimicry than positive vocal mimicry). In fact, when considering the analysis of all types of interactions and variables, the higher probabilities obtained were for the negative mimicry in the men group (either the interact was started by customers or employees), which reached values higher than 70. We also found that mimicry probabilities ranged in a much more homogeneous way on the women group than on the men group. On the women group, independently of who initiated the event and of its valence, probabilities ranged from 36.36 to 69.23. On the male group, probabilities oscillated to a much greater

extend, from 0 to 77.78. These findings will be discussed further on the "Discussion" section of this paper.

In Table 1 we show the overall transitional probabilities between the events (positive, negative and neutral emotional displays). Each cell has the transitional probability for each possible combination of given (rows) and target (columns) events. For instance, positive displays were followed 46% of the time by positive displays, 50% by neutral displays and 4% by negative displays ($p < .05$). These probabilities were calculated from a total of 1025 target events (replies) to the observed 1025 given positive displays. Because these data represent dyadic interactions, the response ratio (1025 targets to 1025 given) to any given behavior was 1. The transitional probabilities of the interactions *positive–positive*, *neutral–neutral*, and *negative–negative* were all significantly higher than expected (36.16, 33.69 and 42.16, $p < .05$, respectively). All other possible event pairings were significantly lower than expected ($p < .05$).

INSERT TABLE 1 ABOUT HERE

To verify if mimicry occurred we also calculated the transitional probabilities with the speaker identified. This analysis is crucial because, being mimicry an involuntary and automatic behavior, both interactants (customers and employees) need to show statistically significant probabilities of mimicking the behavior of their counterparts for mimic to occur (e.g., Courtright, 2014; Hewes, 1979). As reported in detail in Table 2 both interactants have higher than expected probabilities of displaying the same behavior of their counterparts. This table reads as Table 1, this is, each cell provides the transitional probability for each possible combination of given (rows) and target (columns) events, for employees and for customers. There are two submatrices that contain no values for the obvious reason that "when turns-at-

talk are used as the coding unit, a speakers' communication behavior cannot be followed by another behavior by the same speaker" (Courtright, 2014, pp. 332). The transitional probabilities of the interactions *positive–positive*, *neutral–neutral*, and *negative–negative* were all significantly higher than expected both for employees as speakers (42.60, 65.31 and 46.96, $p < .05$, respectively) and for customers as speakers (39.94, 62.97 and 46.93, $p < .05$, respectively).

These results suggest that mimicry occurs, as the probability of both interactants copying the previous emotional display is significantly higher than the probability of displaying another type of emotional valence.

These results supported hypothesis 1 (the probability of individuals mimicking the vocal emotional valences of others will be statistically significant).

INSERT TABLE 2 ABOUT HERE

Regarding hypothesis 2 (the mimicry of negative vocal emotional displays will be significantly higher than the mimicry of positive ones), transitional probabilities indicated that negative mimicry was more prevalent than positive mimicry (negative = 55%, positive = 46%, $p < .05$). To verify whether this difference was statistically significant, we conducted a Mann-Whitney U test using the 1025 raw replies to positive target emotions, and the 1635 raw replies to negative target emotions. Results showed that the difference between positive and negative mimicry was statistically significant ($U = 758350$, $p < .001$) therefore hypothesis 2 was supported.

Concerning hypothesis 3 (regarding the sex of the sender, male senders will generate significantly higher levels of negative vocal mimicry than positive vocal mimicry), transitional probability results indicated that male senders had higher probabilities of negative mimicry (57%, $p < .05$) than positive (45%, $p < .05$). We conducted a sign test using the raw

total of replies generated by each positive (526) and negative (978) target emotions within the male senders' group. Sign test results showed that the difference between the negative and positive mimicry was significant, with the occurrence of negative mimicry being significantly higher than positive mimicry ($Z = 3.20$, $p = 0.02$, result is significant at $p < 0.05$). Hypothesis 3 was supported.

Considering hypothesis 4 (regarding the sex of the sender, when the senders are male the levels of negative vocal mimicry will be significantly higher than when the senders are women), transitional probabilities indicated that the probability of negative mimicry was lower for women (53%, $p < .05$) than for men (57%, $p < .05$). We conducted a Mann-Whitney test with the raw scores of the negative replies (women: 657, men: 284). Results indicated that the occurrence of negative mimicry was not significantly different when considering the sex of the sender ($U = 92219$, $p = .745$)

Regarding hypothesis 5 (women, as receivers, will have a greater tendency to mimic both positive and negative vocal emotional displays than men) the transitional probability results were as predicted (probability of mimicking positive emotions: women 46%, $p < .05$, men 31%, $p < .05$; probability of mimicking negative emotions: women 53%, $p < .05$; men 47%, $p < .05$). We performed a Mann-Whitney test using the number of raw replies elicited by each positive and negative emotion for each sex (positive emotions: women = 908, men = 117; negative emotions: women = 1380, men = 255). Results showed that the differences in the mimicking of positive emotions was significant between sexes ($U = 44073$, $p < .001$, sig < .05), and that the sex differences in the mimicking of negative emotions was also significant ($U = 158663$, $p = .004$, sig < .05). Hypothesis 5 was supported.

DISCUSSION

The main goal of this study was to test the vocal mimicry hypothesis of the emotional contagion theory. More specifically, we analyzed real vocal interactions between people in a real and natural setting, in order to verify whether the tendency to mimic others' external signs of emotions was also prevalent in voice-to-voice communication.

When testing Markov chain assumptions, we found that the sample was heterogeneous. We conducted GSK tests to address questions as to what variables could be accountable for such discrepancies and found a main interaction effect between sex of the worker and day of the research. More precisely, we found that the probability of men exhibiting more negative than positive emotional behaviors (which is consistent with our third hypothesis), was moderated by the day of the research, reaching significant higher values on Fridays. In a similar way, women showed lower probabilities of initiating positive mimicry on Fridays. This data is important and represents other approach to understand differences on daily emotional interactions and to predict its fluctuations with day-specific measures. We found that for both sexes some days are more important than others. Regarding negative mimicry (or less positive mimicry), Friday was a significant day.

Some theorists found controversial results regarding affective experience and weekdays, and mainly regarded differences on days of the week by splitting them on weekdays and weekend days (See, e.g. Clark & Watson, 1988; Kennedy-Moore, Greenberg, Newman, & Stone, 1992; Stone, Hedges, Neale, & Satin, 1985), finding greater positive affect on weekend days. More recent studies found that, whereas in the beginning of the week the experience of negative affect tends to be higher, positive affect starts to increase on Wednesdays and normally keeps increasing till the weekend, where the occurrence of negative events tends to be lower and the occurrence of positive ones tends to be higher (e.g., Robins & Judge, 2005; Watson, 2000). Although we did not test for emotional exchanges on

weekend days, our results contradicted this view since there was more negative emotional mimicry (for men) and less positive emotional mimicry (for women) at the end of the week, more precisely on Fridays. This is probability related to employees' fatigue impacting on their ability to follow the organizational display rules of emotional labor, this is, the requirement to fake positive emotions and suppress negative ones (e.g. Grandey, 2000). Some previous studies found that negative affect has a type of carryover effect over the days, this is, negative emotions experienced before leave "residues" to the following days (e.g. Marco & Suls, 1993; Sheldon, Ryan, & Reis, 1996). Therefore, we may argue that Friday, being the last day of the week, concentrates in itself the remains of all negative emotional exchanges experienced during the week, being a day where the occurrence of negative mimicry (for the male group) or the diminishing of positive mimicry (for the women group) is more preeminent.

We also found that the mimicry probabilities, either positive or negative, ranged in a more homogeneous way in the women group (36.36 to 69.23) than in the men group (0 to 77.78). We may argue that both sexes are cognitively equally prepared to understand what the other is feeling and to engage in tuned emotional exchanges (see, e.g., Hoffman, 1977). However, when one considers the automatic and involuntary ability to tune with other's emotional expressions without a cognitive element involved (which is what distinguished emotional contagion from empathy), there is evidence that women are more prepared than men. Previous research supported that women have a higher propensity to congruently respond to emotional stimuli, a phenomenon that was verified in laboratory studies, resorting to facial expressions of emotion (Lundqvist, 2008; Sonnby-Borgström, Jönsson, & Svenson, 2008). In our study we found that this tendency also prevailed with vocal stimuli, since the tendency to mimic the other was more prevalent and constant in the women group than in the men group,

where probabilities were sometimes as low as 0. This tendency to tune with others may be due to adaptive mechanisms related with gender-role stereotype, since women are more socially expected to emotionally relate with others than men, who have to follow less the social rules that are related with the regulation of emotions (e.g., Broverman, et al., 1972; Goos & Silverman, 2002; Simpson and Stroh, 2004).

In general, we found that mimicry was a natural and intrinsic part of vocal interactions. Results showed that the probability of copying the emotional valence of the sender was significantly higher than expected, independently of *who was saying what* (customer or employee) whereas the probability of responding with a different emotion was significantly lower than expected (hypothesis 1). This finding suggests that people do, indeed, tend to reproduce the emotional tone of the counterpart, regardless of whether they are asked to do so or not. This phenomenon goes beyond empathy, as it seems to be so rapid and automatic that it might even exclude any cognitive process. For example, in this specific work context employees were instructed to act neutrally. If cognitive processes were to be involved, they would not mimic the emotions displayed by customers so often, since the implicit organizational rule was to act neutrally towards the customer. This contradicts to some extent one of the propositions of the Communication Accommodation Theory (Giles & Coupland, 1991) that posits that while communicating, individuals transmit information about their social status and the most salient one dictates the tone of the conversation. We found instead that individuals from both higher and lower power statuses (customers and employees, respectively) had similar probabilities of mimicking their counterparts' emotional tones. This finding corroborates one of the mimic propositions of the emotional contagion theory that defends that the tendency to copying others non-verbal signs of emotions is "subtle,

automatic, quick and ubiquitous" (Doherty et al., 1995, pp. 355) being more related with a biological phenomenon of afferent feedback than with social comparison processes.

While we paid attention to both the verbal and non-verbal elements of communication as cues of the emotions being felt, we found that the tendency was not to copy *what* the other was saying, but rather *how* he/she said it. For instance, if customers were friendly the employees' tone of voice would be calm and pleasant. Similarly, although employees could not respond to an insulting customer with insulting words, they would automatically react with an aggravated or even irritated tone of voice. When a customer was impatient, employees would speak quickly and often without following the greeting parts of the script.

This finding opens doors for new research questions concerning the mimicking of vocal cues of emotion. For example, research could explore possible antecedents of mimicry, such as individual differences related with personality traits that were already found to correlate with the overall propensity for emotional contagion (e.g., sensitivity to others is positively correlated and alienation is negatively correlated, see Doherty, 1997). Moreover, although there is a considerable amount of research on the consequences of facial and postural mimicry, like social behavior and judgment (Gueguen et al., 2009) it is yet to be explored what the direct consequences of vocal mimicry are. A prolific research avenue would be to investigate such immediate impacts both on the individuals alone and on the dynamics of the dyad.

We also found that, consistent with some previous studies, mimicry of negative emotions was stronger than mimicry of positive ones (hypothesis 2). There are three possible explanations for this: first, when communicating verbally, the signs of negative emotions are easier to recognize than those of positive emotions. Negative emotions like anger often comprise strong verbal expressions like shouting, irritability or aggressiveness. The vocal

expression alters in both tone and amplitude, and the emotional valence is more easily detectable. Positive emotions, on the other hand, are often more subtle and difficult to recognize, particularly when there is no facial expression to interpret. They are frequently confused with neutral emotional displays since their main features, such as sounds with small amplitude changes and few harmonics are identical (Hatfield et al., 1995). Therefore, the stronger mimicry of negative emotions might be related to their more overt and identifiable vocal characteristics. Second, in this particular work context, employees got calls from customers who were normally not happy with the company. The expectancy theory (Vroom, 1964) proposes that one performs according to the expected outcome. If the outcome expectation is tightly connected to negative interactions, the performance efforts of employees should most definitely be shaped accordingly. So it might occur that employees, being prepared beforehand to engage in negative conversations would therefore respond automatically in a more negative way than in a positive one. Third, research supported that negative events stimulate cognitive, behavioral and emotional responses that are quicker and stronger than positive or neutral events (for a review see Cacioppo, Gardner, & Berntson, 1997). This also clarifies why mimicry was stronger for negative emotions.

Our results also suggested that regarding the sex of the sender, male senders would generate more negative vocal mimicry than positive (hypothesis 3). This, again, is probably related to how overtly the emotions are expressed. Research has shown that men display negative expressions of emotion more accurately than positive ones, which is related to both physical characteristics, like their low-pitched voices and large vocal folds (Thurman & Welch, 2000) and social norms, since men tend to conform less with norms associated with femininity like hiding negative emotions and faking positive ones. However, we did not find a significant difference between negative mimicry generated by male and female senders

(hypothesis 4). This might be related to two main factors: 1) *Status:* previous research suggested that men are given a higher status than women and for that reason generate more mimicry. However, in this specific context of service interactions the power relation imbalance is independent of the sex of the interactant. Both male and female customers have a higher status in the organizational hierarchy and both male and female employees have a lower status in the organizational hierarchy, regardless of their sex. Moreover, as described early in this section for the first hypothesis, status seemed to not play such an important role for defining mimicry probabilities as both customers and employees demonstrated a high propensity to mimic the emotional behaviors of one another. This might explain why sex differences between both are not significant; 2) the context, as the *leitmotif* for customers' (both men and women) calls was commonly related to complaints/ dissatisfaction.

Furthermore, we followed previous works that tested for differences regarding the sex of the receiver and found that, in voice-to-voice contexts, women are more prone to mimic both negative and positive emotions (hypothesis 5). Research supported that women are naturally more attentive and sensitive to subtle emotional expressions. They respond more rapidly and accurately, for example, to facial expressions of others and are particularly incisive in detecting emotions (e.g. Sonnby-Borgström et al., 2008). However, to our knowledge, this natural tendency had never before been tested in vocal interactions, in a natural context. Thus it would follow that our findings are particularly relevant as they arise from the observation of natural human behavior that has not been manipulated.

LIMITATIONS AND DIRECTIONS FOR FUTURE RESEARCH

One potential limitation of our study is the context in which it was conducted. We performed observations in a single organizational setting, in which the input of negative

emotions was more prevalent than positive ones. A possible way to overcome this would be to replicate the study in different contexts, either in positive contexts or where the flow of emotional valences would be more balanced. Having participants from different professional backgrounds could also yield different results. In this particular context, where they were exposed almost non-stop to customers' emotional displays, it can be hypothesized that employees did not have the chance to implement effective emotional and behavioral strategies to deal with customers' emotional displays.

Nevertheless, we considered that this particular setting had some advantages, mainly related to the fact that employees were instructed to act neutrally. Since our primary goal was to test for mimicry, which is said to occur independently of one's will, the phenomenon is easier to verify if a person is supposed to act impartially but does not.

Moreover, the fact that we listened to the calls randomly did not allow us to control the number of calls per employee, nor to select them to suit our convenience, for example, by the sex of the customer. This fact also impeded us to have a sufficient number of events per dyad that would allow us to analyze each conversation independently as the minimum number of events required to build a transitional table is 30 (see, e.g., Bakeman & Quera, 2011). For this reason, other control variables as the length of calls had to be excluded. A possible avenue for further research would be to replicate this study in a controlled context where the characteristics of the interaction could be previously determined by the researcher according to the research questions. Moreover, future research could take this study further by investigating antecedents and consequences of emotional mimicry in vocal contexts. Such results would be fruitful for both academics and practitioners. Another possible research avenue was to test vocal mimicry when other sources of emotional contagion are present. For

example, exposure to others' facial expressions might moderate the mimicry intensity, especially if they are not congruent with the vocal message.

Furthermore, the observational nature of the study comprises the risk of subjectivity. To minimize this validity threat, two researchers collected the data and only the data that was interpreted in the same manner was used. Nevertheless, to collect data live, longitudinally and with such a large sample (of participants and events) is an advantage of this study.

PRACTICAL IMPLICATIONS

Besides the theoretical contribution it makes to the emotional contagion theory, our study brings practical implications since voice-to-voice interactions are becoming more and more frequent. In their daily lives, people are interacting more and more through vocal communication due, for example, to the massive access to mobile phones, which make everyone accessible everywhere and at any time. In organizations, customer contact via telephone is an ever-growing industry, employing millions of people across the globe. The vocal mimicry phenomenon could be used to the company's benefit by training employees to display positive emotions towards the consumers. This would influence factors like service satisfaction and positive appraisals, which have been shown to be boosted by the exchange of positive emotions in face-to-face contexts.

By contrast, if the mimicry of customers' emotional tone is not desirable (for example in in-bound call centers where customers call to make complaints) managers can take several actions. Role play video-taped training, for instance, where employees can see themselves mimicking the emotional expressions of others, could help them become more aware of the mimicking process. Awareness of the occurrence of vocal mimicry can also be an important

tool in other areas where communication is pivotal, like conflict resolution, sales, counseling, politics and leadership in general.

With regard to sex differences, the results of our study may provide fruitful insights on selection and training strategies. For example, training strategies involving role-play should be focused more on reducing the negative mimicry involving male customers, and emotional recognition techniques should be directed more towards men as receivers.

CONCLUSIONS

The findings of the study seem to support the occurrence of mimicry in vocal communication. As discussed early, vocal mimicry is one of the foundations of the emotional contagion theory. We verified its occurrence in a natural context where subjects were unaware that their conversations were being registered and also where one of the counterparts was requested to act neutrally towards the other.

We found that mimicry occurred despite this organizational demand. As earlier postulated in the emotional contagion theory, mimicry is ‘far too subtle, automatic, quick and ubiquitous’ (Doherty et al., 1995, pp. 355) to be organizationally controlled. It is indeed a central part of human communication that probably starts with a physiologic process (as mirror neurons) with the objective of promoting more affiliative and social processes, being another clue that human bodies work in search of a holistic harmony.

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Table 1

Transitional Probabilities of Observed Events

	Positive	Neutral	Negative	Targets	Observed	RSP Ratio	Given events
Positive	**.46** (*z*: 36.16)	.50 (*z*: -14.40)	.04 (*z*: -12.84)	1025	1025	1	12%
Neutral	.08 (*z*: -15.77)	**.81** (*z*: 33.69)	.11 (*z*: -26.75)	6085	6086	1	69%
Negative	.04 (*z*: -11.22)	.41 (*z*: -27.88)	**.55** (*z*: 42.16)	1635	1635	1	18%

Note: all values are significant at the $p < .05$ level. Results that are in bold correspond to the transitional probabilities that are higher than expected (z-score > 1.96, $p < .05$); results that are underlined represent the transitional probabilities that are lower than expected (z-score < 1.96, $p < .05$).

Table 2

Transitional Probabilities with Speaker Identified

Speaker	Employee Positive	Employee Neutral	Employee Negative	Customer Positive	Customer Neutral	Customer Negative
Employee				**0.57**	0.05*	<u>0.38</u>
Positive	----------	----------	----------	(z = 42.57)	(z = 1.81)	(z = -3.27)
Employee				**0.04**	**0.59**	**0.37**
Neutral	----------	----------	----------	(z = 7.52)	(z = 65.31)	(z = 5.06)

Employee				0.09	**0.12**	**0.79**
Negative Customer	---------- **0.46**	---------- **0.03**	---------- 0.50	(z = -3.20)	(z = 2.08)	(z = 46.96)
Positive Customer	(z = 39.94) **0.04**	(z = 7.75) **0.54**	(z = -4.84) **0.41**	----------	----------	----------
Neutral Customer	(z = 5.64) 0.08	(z = 62.97) **0.11**	(z = 3.66) **0.81**	----------	----------	----------
Negative	(z = -2.70)	(z = 4.48)	(z = 46.93)	----------	----------	----------

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Note: all values are significant at the $p < .05$ level, except the one marked with an asterisk. Results that are in bold correspond to the transitional probabilities that are higher than expected (z-score > 1.96, $p < .05$); results that are underlined represent the transitional probabilities that are lower than expected (z-score < 1.96, $p < .05$).