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Show Me You Care:
Trait Empathy, Linguistic Style and Mimicry on Facebook

JAHNA OTTERBACHER, Open University of Cyprus
CHEE SIANG ANG, University of Kent
MARINA LITVAK, Shamoon College of Engineering
DAVID ATKINS, University of Kent

Linguistic mimicry, the adoption of another's language patterns, is a subconscious behavior with pro-social benefits. However, some professions advocate its conscious use in empathic communication. This involves mutual mimicry; effective communicators mimic their interlocutors, who also mimic them back. Since mimicry has often been studied in face-to-face contexts, we ask whether individuals with empathic dispositions have unique communication styles and/or elicit mimicry in mediated communication on Facebook. Participants completed Davis' Interpersonal Reactivity Index and provided access to Facebook activity. We confirm that dispositional empathy is correlated to the use of particular stylistic features. In addition, we identify four empathy profiles and find correlations to writing style. When a linguistic feature is used, this often "triggers" use by friends. However, the presence of particular features, rather than participant disposition, best predicts mimicry. This suggests that machine-human communications could be enhanced based on recently used features, without extensive user profiling.

1. INTRODUCTION

> "If you talk to a man in a language he understands, that goes to his head. If you talk to him in his language, that goes to his heart." –Nelson Mandela

The above words were spoken by Nelson Mandela during negotiations in the Apartheid era. Mandela was referring, of course, to the difference in response a negotiator might expect when engaging an interlocutor in a lingua franca versus her native language. He reminds us that language is not simply a means to encode and share information; it is very much an embodiment of our culture, beliefs and personalities. In short, the manner in which we use language also conveys our social connection to - or disconnection from - others.

Even when speaking the same language, there are subtle ways in which communicators convey pro-social intentions. Linguistic or verbal mimicry (also referred to as

coordination or accommodation [Giles et al. 1991] or linguistic alignment [Pickering and Garrod 2004]), adapting one's own language behavior to that of another, is one such mechanism. A fascinating body of research in social psychology has shown that while mimicry is a subconscious phenomenon, it likely serves as a kind of social glue. For example, researchers have found that people who are mimicked by a specific interlocutor report liking him or her more [Lakin et al. 2003]. Mimicry may also promote more generalized pro-social behaviors not specifically directed toward one's interlocutor. In one experiment, after having been mimicked by someone else, participants then went on to place themselves in closer physical proximity to others as compared to those who had not been mimicked by anyone [Chartrand and Van Baaren 2009]. Others have found that being mimicked leads one to report feeling an enhanced sense of interpersonal closeness to humankind [Stel and Vonk 2010].

Mimicry is also believed to enhance persuasion and/or collaboration. In one study, restaurant servers who mimicked their customers' verbal patterns received better tips as compared to tips received from customers they had not mimicked [Van Baaren et al. 2003a]. Similarly, linguistic mimicry between partners assigned to work on a collaborative task correlates to better performance [Fusaroli et al. 2012]. Researchers have postulated that mimicry fosters development of a common language through which collaborators can jointly direct their attention. In short, mimicry is a way to show that we can speak one another's language.

1.1. Mimicry in Computer-Mediated Communication

While much of what we know about linguistic mimicry and its role in social cohesion has been learned from studies conducted in face-to-face settings, linguistic mimicry has proven to be pervasive in computer-mediated communication (CMC) including social media [Danescu-Niculescu-Mizil et al. 2012]. Indeed, the rise of social media has had a significant impact on how we stay informed about the world, how we educate ourselves and crucially, how we communicate with our friends and loved ones. As social technologies continue to mature, their use is increasingly and intricately woven into the social fabric of our physical life. As we spend more time in these technology-mediated environments, we leave digital traces of our interactions that can reveal much about who we are as people.

In CMC, linguistic mimicry is again viewed as a social strategy that plays a role in acceptance as well as in building rapport. Scissors and colleagues [Scissors et al. 2008] asked pairs of individuals to collaborate on a task remotely via instant messaging. They found that pairs who reported trusting one another showed more linguistic mimicry as compared to those who reported low levels of trust. Danescu-Niculescu-Mizil and colleagues found linguistic mimicry to be pervasive in an online community of gourmet beer drinkers [Danescu-Niculescu-Mizil et al. 2013]. Here, they found a fascinating correlation between one's connection to the community and the mimicking of others' style. In fact, they were able to predict a participant's life cycle in online community participation based on her degree of mimicry (i.e., a decrease signaled a loss of interest in the community and thus, a likely exit).

While CMC researchers consider mimicry to show pro-social intentions, some have suggested that it is so pervasive that it has become merely a reflex [Danescu-Niculescu-Mizil and Lee 2011; Pickering and Garrod 2004]. After all, we all share an evolutionary, unconscious drive and need to foster relationships with others [Lakin et al. 2003]. However, mimicry does not happen all the time or by everyone. Factors such as gender and power differences between interlocutors likely affect who mimics whom [Bilous and Krauss 1988]. There is also reason to believe that personality and background play a role in this process. In particular, it has been found that individuals

with more "other-orientation," who perceive themselves in relation to others, are more likely to mimic and to be mimicked [Van Baaren et al. 2003b].

Therefore, we consider the possible mitigating role of trait (i.e., dispositional) empathy in this process. Bavelas and colleagues [Bavelas et al. 1986] describe mimicry as a mechanism that effectively tells one's interlocutor, "I show [you] how you feel." In other words, mimicry is described as a means to communicate empathy to another. As will be explained, effective communicators are able to elicit similar responses from their interlocutors. In other words, the ideal, pro-social interaction, is one in which both communicators mimic one another.

1.2. Contributions of the Current Work

Our work bridges a gap in the literatures on participant disposition, empathic communication and the phenomenon of linguistic mimicry in social media. CMC and social media researchers have extensively explored facets of personality and their connection to social media behaviors (see, for example, the survey of the state-of-the-art research in personality computing in [Vinciarelli and Mohammadi 2014] and available datasets and tools for personality recognition from multimedia and text data in [Celli et al. 2014]). However, most of this research has been carried out in the framework of the Big Five model (e.g., [Golbeck et al. 2011]; [Gou et al. 2014]; [Quercia et al. 2012]), which, while a reliable and valid way to measure personality [Nettle 2007] does not incorporate empathy. Our goal is to see if Facebook users with different empathy profiles (i.e., levels of self- and other-oriented empathy) communicate differently, and whether friends respond to them with a varying degree of empathic response via mimicry. We address the following research questions:

— What are the different empathy profiles among Facebook users? (RQ1)
— Is trait empathy correlated to the use of specific linguistic style features? (RQ2)
— Do more empathic individuals tend to elicit more linguistic mimicry from their friends? (RQ3)
— Is there a link between the linguistic characteristics of a post and the mimicry responses? (RQ4)

This work contributes to the growing body of literature that sheds light on the connections between our "offline" selves (i.e., our personality and dispositional traits as gauged by standardized measures) and our digital communication patterns. More specifically though, the results aim to inform the effective use of social media to foster the creation of interpersonal relations between communicators (human users or computer agents), by eliciting empathic responses from others. Furthermore, this could also prove useful in situations where communicators want to motivate others to "do good" by convincing them, for example, to donate to a worthy cause, or to adopt more healthy habits.

2. BACKGROUND

Since the advent of early social technologies such as bulletin boards and online forums, there have been significant scientific efforts to understand how humans communicate with each other in these virtual environments. Many of these studies also aim to translate these understandings to practical technology design with the hopes of enhancing human-computer (or agent) interactions and computer-mediated communication. Some of this work examined issues of non-verbal cues, social presence and identity to leverage a range of human emotions to improve technology-mediated interactions [Derks et al. 2008; Walther et al. 2011; Aragon 2010; Lo 2008; Sutcliffe et al. 2015], while others investigated perception of affect elicited by agents in order to implement realistic social interaction between humans and machines [Saerbeck and Bartneck

2010; Ho et al. 2008]. All this work shares a common underlying theme, which is to understand and recreate a wide range of human social and emotional capabilities in a digital environment with an ultimate aim to foster positive interpersonal relations.

2.1. Trait or Dispositional Empathy

Empathy is a multi-faceted interactional process, and there is no accepted standard definition of empathy in the literature. However, it is generally agreed that empathy is the ability to understand and/or experience what others feel without confusion between oneself and others. In other words, our empathic abilities help us understand the thoughts and feelings of others [Ickes 2009] and are crucial in the development of healthy interpersonal relationships [Blair 2005; Eisenberg and Miller 1987]. We recognize others' emotional experiences, and in turn experience similar emotions ourselves [Batson et al. 1981]. Over the past decades, a largely consistent body of research in philosophy and psychology has emerged [Preston and de Waal 2002], investigating numerous similar but discernible empathic notions, including emotional contagion, sympathy, compassion, and various conceptions of empathy as such empathic accuracy, cognitive and emotional empathy.

There is also significant research in cognitive neuroscience that attempts to unravel the neural processes involved in empathy, such as emotion sharing, perspective taking, and emotion regulation. More recently, researchers proposed a social neuro-scientific approach to studying empathy, by bridging different levels of analysis from the field of evolution, cognitive neuroscience and social psychology [Decety and Lamm 2006]. For instance, Preston and Hofelich [Preston and Hofelich 2012] proposed the perception-action model of empathy, in suggesting that empathy research is likely to benefit from the dissociation of the neural and subjective levels of self–other overlap.

In addition, empathy is often considered a key motivator [Decety and Grezes 2006] and the proximate mechanism [de Waal 2008] of altruism, in which we take actions to alleviate the suffering of others. Levenson and Ruef [Levenson and Ruef 1992] summarized these understandings and outlined three key components of empathy: "(a) knowing what another person is feeling [cognitive], (b) feeling what another person is feeling [emotional], and (c) responding compassionately to another person's distress [behavioral]." Given this third component, it is easy to see that empathy and communication are intimately linked.

Although early theorists saw empathy as a trait or characteristic which was stable and could be measured but not taught, later theorists have begun to view empathy as having both "trait" and "state" components. It is also important to note that neither "trait" or "state" was accepted as a defining attribute because empathy occurs regardless of whether it is a state or trait. In this study, we focus on empathy as trait, and investigate how this trait correlates to people's social media behavior.

2.2. Empathy in Professional Communication

Significant time and resources are invested in training professionals to be effective communicators. Physician-patient and employee-customer communication are two settings in which the role of empathic communication is stressed. In the medical literature, it is widely acknowledged that more empathic communication on behalf of physicians is correlated to positive outcomes, such as enhanced patient satisfaction and compliance [Kim et al. 2004], and reduced litigation [Beckman et al. 1994]. Similarly, employee empathy has long been considered key in customer relationship management [Aggarwal et al. 2005].

Encounters in these contexts are high-stake, and require that one effectively engages, rather than alienates, her interlocutor. For this reason, some have cited the need to better define the features of empathic communication, to facilitate the training

of professionals [Bylund and Makoul 2002]. As mentioned, while social psychologists have claimed that mimicry is subconscious, a good deal of professional communication literature actually suggests that one can consciously use mimicry to facilitate communication.

For example, Tanner and Chartrand [Tanner and Chartrand 2008] hypothesized that because mimicry induces pro-sociality, it might also enhance a salesperson's ability to persuade consumers. This was confirmed in their experiments involving dyadic interactions; consumers who were mimicked by salespersons reported more positive appraisals of a sport drink product, as well as greater consumption of the product. Likewise, Peterson and Limbu [Peterson and Limbu 2009] conducted an experiment in which they examined two types of training for salespersons: one focused more generally on empathic communication, and one focusing specifically on mimicry (i.e., "mirroring"). They compared the sales performance of participants assigned to one of four groups: no training, only empathy or mimicry training, and those having received both. Those that received both types of training significantly outperformed others.

The use of mimicry to enhance communication is also advocated in the medical field. In fact, the Accreditation Council for Graduate Medical Education's "teaching toolbox," a guide for developing physicians' interpersonal and communication skills, lists mimicry use as a desired competency [Rider and Keefer 2006]. Furthermore, the authors describe how mimicry is a means to express to patients that a physician is listening and following what he or she is saying.

The importance of the interlocutor's response is also highlighted. Specifically, effective communicators should be able to elicit a mimicry response from others; the optimal situation is one of mutual mimicry. In a sales setting, Wieseke and colleagues [Wieseke et al. 2012] describe the need to achieve a "customer-employee empathy symbiosis," involving mutual alignment of communication behaviors. Similarly, Bylund and Makoul [Bylund and Makoul 2002] describe how physicians and patients must create "empathic opportunities" during the course of interaction, stressing the transactional nature of communication in this context.

2.3. Empathy and Mimicry in Social Media

With few exceptions, which focus on very specific contexts (e.g., empathy in an online medical support group [Pfeil and Zaphiris 2007]; the relationship between empathy and trust [Feng et al. 2003]), empathic communication and its features in social media have not been studied as extensively as in face-to-face settings. However, it is clear that it is just as important in technology-mediated communication. In fact, Forbes describes empathy as being "the key to social media success" since social media requires one to effectively engage an audience that is no longer passive[1]. Similarly, those seeking to spread the adoption of an innovation in a social network have long known that the ideal change agents are empathic individuals, as they can more effectively diffuse information about something new, as well as influence others' views [Rogers 2010].

We aim to shed light on the relationship between disposition (specifically, trait empathy), the use of stylistic features of language, and the extent to which one elicits an empathic response, via linguistic mimicry, in an everyday social media setting, Facebook. As depicted in Figure 1, we study participants' cognitive, emotional and behavioral empathy. We first gauge their levels of trait empathy (cognitive and emotional dimensions) via a standardized test (Davis' Interpersonal Reactivity Index (IRI) [Davis 1983]). We then study their recent Facebook posts (behavioral dimension), to examine whether trait empathy correlates to the use of specific linguistic features when engag-

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[1]http://www.forbes.com/sites/sap/2011/08/22/social-media-success-is-just-about-one-thing-empathy/
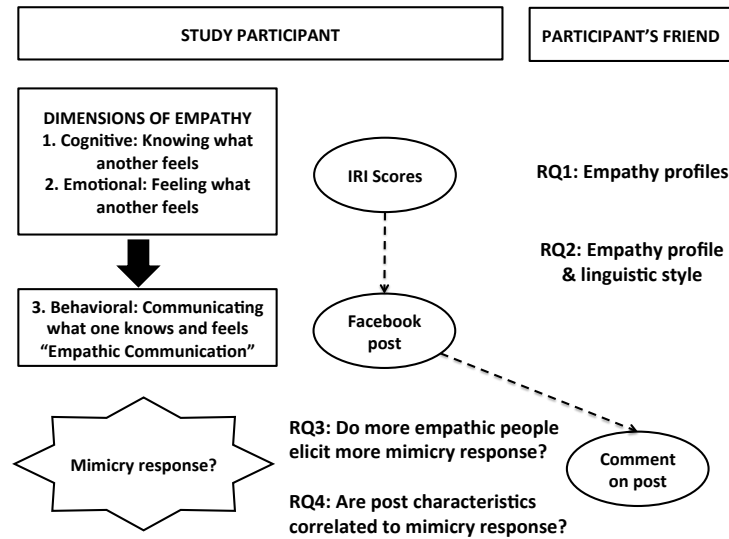
Fig. 1.   Research approach and questions.

ing friends. Finally, we consider friends' comments on participants' posts, in order to see if friends mimic the stylistic features observed in participants' posts.

2.4. Mimicry and Linguistic Style

Our study of mimicry focuses on participants' use of linguistic style features and their friends' potential responses. Before describing our methods, it should be noted that the concept of linguistic mimicry is very close to that of linguistic alignment. Pickering and Garrod [Pickering and Garrod 2004] studied linguistic alignment between interlocutors as a part of a mechanistic model of language processing in dialogue, the interactive alignment model. The model assumes that as dialogue proceeds, interlocutors come to align their linguistic representations at many levels ranging from the phonological to the syntactic and semantic. This interactive alignment process is automatic. The different levels of linguistic alignment, such as semantic, syntactic and lexical for written language, and phonological and phonetic for spoken language, were considered. The model assumes that alignment at one level promotes alignment at other levels including the level of the discourse model and hence acts as a mechanism to promote mutual understanding between interlocutors.

The notion of alignment was extended in [De Jong et al. 2008] to affective language use. Here, the researchers described a model for dynamically adapting the linguistic style of a virtual agent to the level of politeness formality detected in the user's own utterances. Another approach to linguistic alignment used by an Embodied Conversational Agent (ECA) in response to the user's utterances was presented in [Campano et al. 2015]. This work introduced a computational model of other-repetitions (ORs), conveying emotional stances.

Currently, we examine lexical features of participants' Facebook posts, with a particular focus on their choice of stylistic features. In other words, we study how participants say what they say, rather than the content of their messages. Linguistic style conveys valuable social information that reveals aspects of who we are to our interlocutors [Goffman 1959]. Indeed, it is well established that the manner in which we use stylistic features is correlated to our demographics (e.g., gender and age), socioe-

conomic status, and membership in particular groups [Labov 1990]. These patterns are so pervasive that authorship detection algorithms often achieve high accuracy on traditionally produced texts [Argamon et al. 2003] as well as very short social media messages [Nguyen et al. 2013]. For this reason, and because of the empathy-communication link, we expect that empathy is another aspect of the self that correlates to the linguistic style of participants' Facebook posts. After confirming this link, we then examine whether or not others mimic a given participant's linguistic style, by using the same linguistic features in comments on her post.

3. DATA COLLECTION AND METHODOLOGY

We developed a Facebook app through which we 1) obtained informed consent for participation, 2) administered Davis' Interpersonal Reactivity Index (IRI) to each participant and 3) captured the digital traces on his or her Wall (one month of recent activity) and profile.

Our research protocol has been approved by the University of Kent Ethics Committee. Due to University ethics restrictions, we are unable to share the raw data collected from participants' Facebook accounts, as this might unintentionally reveal their identities. However we have made the metadata available for other researchers.[2]

3.1. Participants

A total of 334 Facebook users engaged with our app. The current analysis focuses on the 110 participants (13 men, 97 women) who 1) communicated with friends exclusively in English and 2) had complete IRI profiles. Because we administered the IRI in English, and because multilingual users are likely to have atypical communication styles, we focus our study on empathy and mimicry in monolingual communication. Obviously, our sample is not gender-balanced. It is well established that in the general population, men systematically score lower than women on standardardized measures of empathy [Davis 1983]. However, as will be explained (Table III), we find both genders in the four empathy profiles we identified among our participants.

Through the app, we encouraged participants to invite their friends to take part in the study. Friends who accepted the invitation became new participants, in a recursive manner. Although we aimed to recruit a network of connected participants through this recruitment strategy, it proved challenging as the majority of the friends did not sign up to the study and/or did not complete the full IRI. Hence, we were unable to investigate other interesting research questions, such as the bi-directional nature of mimicry (e.g., the extent to which more empathic individuals mimic their friends, who then mimic them back). Nonetheless, our data allow us to examine whether an empathic personality tends to draw out more mimicry from others, a question motivated by our review of the literature, which has yet to be addressed.

Table I summarizes participants' communication activities and number of friends. Given that only 10% of users update their status on a daily basis,[3] the level of activity is as expected given the duration of our study. There were no statistically significant gender differences. In total, the corpus contains over 43.000 words written by our participants, as well as nearly 18.000 words written by their friends in comments on those posts.

3.2. Measuring Trait Empathy

Davis' Interpersonal Reactivity Index (IRI), a standard measure of trait empathy, consists of four subscales, two that measure cognitive dimensions of empathy, and two

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Table I. Mean / median Facebook friends and posting activity

# Friends	292.0 / 239
# Posts	3.14 / 2
# Comments received	7.72 / 5
# Words / post	28.0 / 15
# Words / comment	11.6 / 7

Table II. IRI dimensions of empathy

	Subscale	Description	Example item
Affective	Emotional concern (EC)	Other-oriented emotional response	I often have tender, concerned feelings for people less fortunate than me.
	Personal distress (PD)	Self-oriented emotional response	In emergency situations, I feel apprehensive and ill-at-ease.
Cognitive	Fantasy (FS)	Ability to get caught up in stories	I really get involved with the feelings of the characters in a novel.
	Perspective taking (PT)	Ability to take the point of view of others	I try to look at everybody's side of a disagreement before I make a decision.

affective dimensions as described in Table II. Each subscale is assessed with 7 items on a 5-point Likert scale (0 = does not describe me well to 4 = describes me well), such that a maximum score is 28. The IRI has demonstrated good intra-scale and test-retest reliability, and convergent validity is indicated by correlations with other established empathy scales [Davis 1983].

3.3. Linguistic Style Features

Following [Danescu-Niculescu-Mizil and Lee 2011] and [Danescu-Niculescu-Mizil et al. 2012], we employed the Linguistic Inquiry and Wordcount (LIWC) tool [Pennebaker et al. 2007] to process participants' textual posts and friends' comments. Social media textual exchanges are typically short and often do not have much context (i.e., a comment may be made in isolation rather than in the context of an ongoing conversation). In recent years, the use of LIWC has become popular with social media researchers as there is growing consensus that such wordcount-based features can be reliably applied to short texts, revealing interesting and meaningful properties of communicators' messages.

LIWC provides both psychological (i.e., content) and linguistic (i.e., style) measures of an input text. It consists of dictionaries of words that map onto meaningful categories; LIWC's output is the percentage of words in an input text that are related to a given category. Thus, LIWC does not require sophisticated pre-processing of texts. It is important to note that "typos" or misspellings occurring in our data would affect LIWC's ability to recognize participants' linguistic features; however, given that our work is focused on the stylistic (rather than content / psychological) features of LIWC, we believe that such errors are much less likely to occur. (See, for example, Oxford English Corpus' list of the most commonly misspelled words,[4] which demostrates that complex words with unusual spellings are those most likely to be in error).

We currently study four types of stylistic features of Facebook participants' language: pronouns, verb tense, negation/assent, and punctuation. In addition to these LIWC style features, we created dictionaries for emoticons[5] and Internet slang.[6] Next, we provide two anonymized examples from our corpus to illustrate linguistic mimicry and its detection.

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[4]http://www.oxforddictionaries.com/words/common-misspellings
[5]http://en.wikipedia.org/wiki/List_of_emoticons
[6]http://www.netlingo.com/top50/popular-text-terms.php

> **Post 1:** feels like a pedi mani kinda day !!! :)
> **Comment 1.1:** want one lol ;)
> **Comment 1.2:** oh yeah !!!!!

In the first post, we observe that the participant has a rather casual linguistic style. He or she uses no pronouns (i.e., "it," which would be the likely way to begin the sentence were it to be expressed more formally). In addition, multiple exclamation marks are used to convey excitement and an emoticon shows the participant's happy mood. Both of the participant's friends respond in their comments with a similar linguistic style. In particular, we observe the avoidance of pronouns in both comments. There is also evidence of mimicry with respect to the use of paralinguistic features (i.e., the emoticon in comment 1.1) as well as punctuation (comment 1.2).

> **Post 2:** I often times find it a challenge to relax fully. Always seem to be guarded.
> **Comment 2.1:** This has been my lesson this summer, [name]. I don't have to trust life. I just have to trust that I will land on my feet.
> **Comment 2.2:** I love your honesty as I have felt that way a time or two or three.

In the second example post, we observe a more formal linguistic style, which invokes the first person voice. Likewise, the participant's friends follow suit, both using first person pronouns. There are no paralinguistic features used, main verbs are present tense, and the use of punctuation marks is standard (full stops only, no use of repeated marks).

In short, both examples illustrate the phenomenon of linguistic mimicry. The key question to be addressed in the current study is whether or not friends systematically mimic a given participant's style. In addition, we ask whether the extent to which friends mimic another's style is correlated to that individual's level of trait empathy, as would be implied by the literature concerning empathic communication in face-to-face contexts.

3.4. Measuring Linguistic Mimicry

We use a probabilistic approach to measuring mimicry. Danescu-Niculescu-Mizil and Lee [Danescu-Niculescu-Mizil and Lee 2011] argue that simple measures of correlation are inappropriate in communication situations, since they do not account for asymmetry. We are studying participants' posts and friends' comments to those posts; thus, the situation is better modeled as one of a stimulus and a response. A participant, individual A, makes a post at time t, in which she uses a particular linguistic style feature, f. A friend, individual B, responds with a comment to that post at time $t + 1$, in which she may or may not incorporate feature f. Mimicry is observed when A's behavior triggers the same behavior by B. Specifically, we consider the difference between the conditional probability of B using feature f in the response to A, and the marginal probability that the feature f is used in any response to A:

$$Pr(B_{t+1}^f = 1 | A_t^f = 1) - Pr(B_{0...n \in t}^f = 1)$$

Note that in contrast to [Danescu-Niculescu-Mizil and Lee 2011], we do not differentiate between friends. In other words, we do not model the extent to which each individual friend of a given participant changes her linguistic style, but rather, the extent to which we observe mimicry on the whole (i.e., over all friends). We are interested in the increase in the probability of friends using each of the 15 stylistic features (Table 4) under study, given that the feature was used in a participant's trigger post.
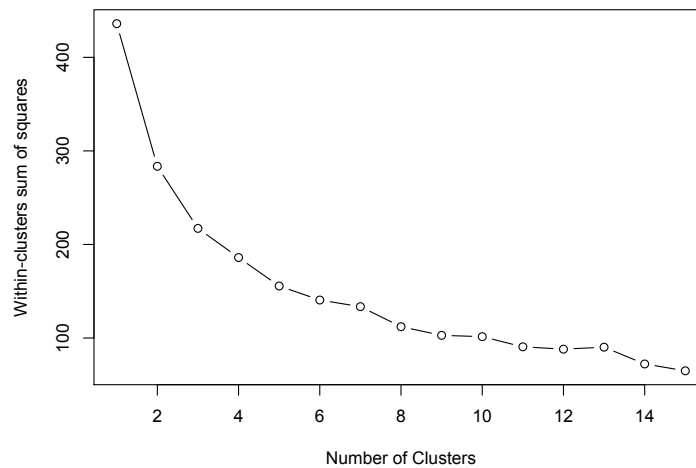
Fig. 2.   Determining the appropriate number of clusters.

As was previously explained, we do not have access to participants' social network on Facebook but rather, their posts and comments from friends on those posts. Given our constraints, the above framework, which models mimicry as a stimulus and a (possible) response, is appropriate.

4. ANALYSIS 1: EMPATHY PROFILES AND STYLE

To answer RQ1, we need to analyze the similarities and differences in scores on the four IRI dimensions. Davis [Davis 1983] emphasizes that the sum of IRI scores is not meaningful. Therefore, we applied k-means clustering on participants' normalized scores. We first plotted the within-clusters sum of squares by the number of clusters, as advocated by [Everitt and Hothorn 2009] and as shown in Figure 2. While the choice of the number of clusters is somewhat ambiguous, the goal is to find the point where adding another cluster will not result in a meaningful reduction in variance (i.e., the sum of the distances between each point and the centroid of its respective cluster). At the same time, the solution should make sense in the context of the problem/application.

Noting that the marginal improvement drops after three or four clusters in Figure 2, we settled on a four-cluster solution. We then used R's $plotcluster$[7] to separate participants into four groups, as shown in Figure 3. Because of the difficulty in visualizing four dimensions, we show clusters plotted onto the first two principal components (PC). PC2 is largely determined by personal distress (PD) score, whereas PC1 is a linear combination of the other three dimensions of empathy. As we shall see, personal distress (the only self-oriented dimension of empathy measured by the IRI) is key to differentiating dispositional empathy profiles.

Table III details the mean and median IRI scores over all participants, as well as by empathy profile. Cluster 1, which we call "other-oriented," consists of people who have a relatively high empathy level in all subscales but personal distress. This indicates that their empathic responses are oriented towards feeling and understanding others'
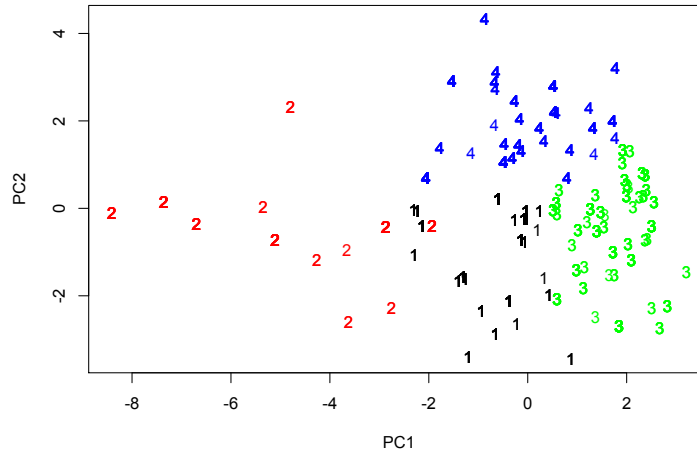
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[7]https://cran.r-project.org/web/packages/fpc/fpc.pdf

Fig. 3.   Clustering participants by IRI scores.

Table III. Mean/median IRI scores per empathy profile type.

	n (men)	EC	PD	FS	PT
All participants	110 (13)	24.6 / 26	14.7 / 15	22.0 / 24	21.6 / 23
1: Other-oriented	35 (4)	27.2 / 28	11.9 / 14	25.6 / 26	25.8 / 27
2: Low empathy	11 (3)	14.5 / 15	10.8 / 11	11.7 / 11	11.0 / 11
3: Cognitive empathic	29 (5)	24.0 / 24	11.5 / 12	17.9 / 18	21.1 / 22
4: Self-oriented empathic	35 (1)	25.8 / 27	21.5 / 21	25.1 / 26	21.2 / 23

emotions and thoughts. Cluster 2, which we call "low empathy," consists of people who scored lower on all sub-scales. Such individuals exhibit less sensitivity not only to others, but also to their own feelings of distress.

Cluster 3, "cognitive empathic," consists of individuals who scored lower than average in all but the PT subscale, on which they are close to the median over all participants. This indicates they generally understand how others feel but may not exhibit similar emotional responses themselves. Finally, Cluster 4 individuals are "self-oriented." Although they score average to high on all four dimensions, they have much higher levels of PD as compared to others. Therefore, while they may be able to relate to others' emotions, they have the tendency to direct their attention to their own negative emotions of distress and the reduction of those negative emotions.

In response to RQ1, concerning the empathy profiles of Facebook users, we find four distinct profiles among our study's participants. Most of these participants' IRI responses indicate that they have a disposition that facilitates their understanding of others' emotions, although they feel and respond to them to a different degree. We find relatively few individuals (only 11 of 110 participants) who exhibit low empathy in all four dimensions. One-way ANOVA was used to test whether there were differences between empathy profile groups with respect to number of Facebook friends, number of posts made, and total words written during the data collection period. Interestingly, while individuals of Type 2 had fewer friends and wrote less than others, the differences were not statistically significant.

To assess the relationship between empathy and language behavior (i.e., linguistic style) (RQ2), we analyzed participants' writing using both binary and continuous

Table IV. Proportion of posts using each stylistic feature, by participant empathy type.

		Type 1: Other-oriented	Type 2: Low empathy	Type 3: Cognitive	Type 4: Self-oriented	TOI χ^2	ANOVA F / HSD
Pronouns	I	0.6453	0.5075	0.5743	0.5338	8.3086*	n.s.
	we	0.1321	0.1343	0.0561	0.0797	11.7240**	n.s.
	you	0.2868	0.2687	0.1683	0.2072	12.646**	4.94** 1 & 3, 4
	she/he	0.1283	0.2687	0.08910	0.08764	19.988***	5.776*** 2 & 1, 3 4
	they	0.1245	0.02985	0.1419	0.06772	12.918**	n.s.
Verb tense	Past	0.3018	0.4029	0.3399	0.2868	n.s.	2.784* 2 & 1, 4
	Present	0.7698	0.5522	0.7227	0.7290	12.746**	3.468* 2 & 1,3,4
	Future	0.2188	0.1194	0.1452	0.1593	n.s.	n.s.
Negation	Negation	0.2830	0.3582	0.2442	0.2589	n.s.	n.s.
	Assent	0.1962	0.2985	0.1518	0.1952	8.1442*	9.230** 2 & 1,3,4
Punctuation	Exclamation	0.3924	0.3134	0.4521	0.5816	25.691***	18.71*** 4 & 1, 2, 3 2 & 3, 4
	Question	0.2000	0.1641	0.1287	0.1474	n.s.	n.s.
	All punct	0.9094	0.7761	0.9339	0.9362	19.657***	8.828*** 2 & 1, 3, 4 1 & 2, 4
Paraling	Chat & slang	0.5245	0.4477	0.5148	0.5338	n.s.	n.s.
	Emoticons	0.1207	0.04477	0.1518	0.1274	n.s.	n.s.

[a]***p<0.001, **p<0.01, *p<0.05

LIWC features. Continuous features are simply the output of LIWC, which corresponds to the percentage of words in participants' posts that belong to the given category. In other words, a continous measure on a feature tells us to what extent that stylistic feature is used by the participant. These variables are used in Analysis 1 (ANOVA tests in Table IV).

Given that posts are typically short, often resulting in very small or large percentages, we also discretized each feature. In other words, this tells us whether the feature is used at all or not. These variables were used in Analysis 1 (TOI in Table IV) and 2 and 3 (regressions in Tables V to X).

As shown in Table IV, we used the Chi-squared Test of Independence (TOI) [Gravetter and Wallnau 2016] to examine the distributions of the binary features across the four empathy groups (i.e., to assess whether the presence/absence of a feature is independent of participants' empathy profile). To compare the continuous features between groups (i.e., to assess whether the extent of use of a feature is independent of participants' empathy profile), we first normalized the scores, by taking the log transformation. We then applied one-way ANOVA. In the case of a significant result, this was followed up by Tukey HSD, to gauge which groups differed. Table IV details the proportion of participants' posts that use each feature as well as the test results.

4.1. Pronouns

Participants' use of pronouns reveals, quite literally, who they are talking to/about in their posts. We observe that in over half of all posts, the participants refer to themselves with the singular first person, "I." This is expected given that social media use is very self-focused [Naaman et al. 2010]. The most salient differences relate to the use of the second and third person pronouns. We find that other-oriented (Type 1) participants invoke "you" more often than others, and in particular, in comparison to Types 3 and 4. This is expected; these participants are generally disposed to focus on oth-

ers and "you" directly engages one's friends. However, we also find that low empathy participants (Type 2) write in the second person in 26% of their posts.

The group most likely to use singular third person pronouns (i.e., "she/he") is the low empathy group (Type 2). This is of note because it suggests a tendency to discuss specific third parties who are not involved in the current discussion. In other words, they appear not to focus on themselves or their conversational partners. In contrast, the other three groups of participants are significantly less likely to discuss absent others in posts.

4.2. Verb Tense

The low empathy participants used verb tenses differently than the other three groups. In particular, they used the past tense more often, and the present tense less often, than others. This may reflect a tendency to discuss things that happened in the past, rather than engage with others by discussing current issues and/or planning future events.

4.3. Negation / Assent

The groups did not differ significantly in their use of markers of negation (e.g., no, not, never). However, the low empathy group again differed with the others in terms of use of words expressing assent with friends (e.g., agree, OK, yes). Empathy is a tool or ability to understand and engage others. The fact that the low empathy group tends to assent more than others might indicate that, although these participants are uncomfortable with engaging with emotions in general, they still want to connect; assenting to others may be their way of doing so.

4.4. Punctuation

We examined participants' use of all punctuation marks, as well as their use of exclamation and question marks. Greater use of punctuation might indicate a more standard (i.e., formal) writing style. Likewise, greater use of exclamation marks might indicate a willingness to express excitement or emotion with friends. Finally, posing questions to friends could be a means to engage them.

Self-oriented participants showed the greatest use of exclamation marks. Given that this group has higher personal distress scores on the IRI than others, the use of exclamation marks might indicate a need and willingness to express their issues. No significant differences were found with respect to the use of question marks. Finally, it is of note that the low empathy group used all punctuation marks the least, which might indicate a reduced ability or desire to use established social conventions.

4.5. Slang / Emoticons

Consistent with the notion that lower empathy participants are less likely to be empathic communicators, they used chat slang and emoticons less than participants of other personality types. However, the differences were not statistically significant.

In summary, in response to RQ2, we find that empathy profiles are correlated to participants' use of linguistic style features, as observed in their Facebook snapshots.

5. ANALYSIS 2: MIMICRY AND EMPATHY PROFILES

We now move onto answering RQ3: Do more empathic individuals elicit more mimicry from their friends?

First, we examine whether or not we observe evidence of mimicry in our dataset, over all participants. Whereas Table IV described our participants' linguistic behaviors, Figure 4 depicts the behavior of their friends, in the comments made on participants' posts. Specifically, what is shown is the baseline probability of friends using
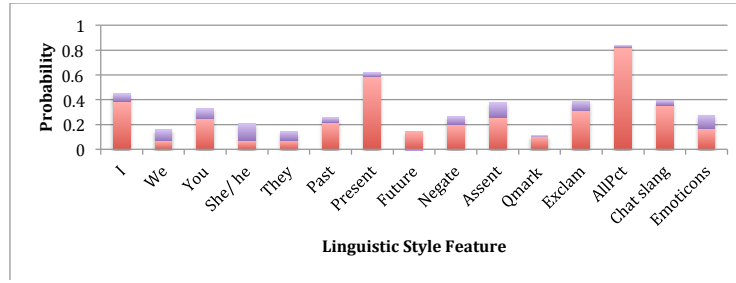
Fig. 4. Change in probability of feature use in friend's comment, when feature appears in post of a participant. Red bars indicate the marginal probability that feature appears in a comment; purple is the increase when feature is triggered by post.

each linguistic feature in a comment, regardless of whether the feature is used in the "trigger" post (red bars). The purple bars show the boost in the probability of a feature being used, when the trigger post uses the feature.

For 13 of 15 features, the "boost" in the likelihood of a friend using a feature in a response to a participant's post, is positive. For example, when a participant uses markers of assent ("yeah," "okay"), the likelihood that friends will also use them in their comments is 12% greater than the marginal probability. This "catchiness" between participants and their friends is not observed for two features: question marks and future verb tense. This is logical when one considers that a question sent out to friends would not typically be followed up by more questions; usually one would expect answers. Likewise, a post made in the future tense (e.g., "Will start my new job on Monday") would likely be answered with statements in present tense or short comments with no verb at all (e.g., "best of luck!" "I'm so happy for you!"). In sum, we observe evidence of mimicry, although some features are more likely to be mimicked by friends than others.

Having observed mimicry in general, we now examine whether participant empathy profile mitigates this process. To this end, we use a logit model to predict the log odds of a comment containing a given stylistic feature, f, based on the presence/absence of the feature in the trigger post, as well as the empathy profile of the participant who posted the trigger. We use Type 1 as our reference group, and create dummy variables for the three other empathy profile groups. The model is given by:

$$\ln \frac{Pr(B_i^f = 1)}{Pr(B_i^f = 0)} = \beta_0 + \beta_1 * A_i^f + \beta_2 * A_i^{Type2} + \beta_3 * A_i^{Type3} + \beta_4 * A_i^{Type4}$$

Where β_0 is the intercept, and the response, β_i^f is 1 if B's comment on A's post contains feature f, and 0 if it does not. Binary indicator variables account for the empathy profile of participant A; and are 1 or 0 if he or she belongs to groups 2, 3 or 4.

Table V shows the estimated model for each of the 15 stylistic features of language, along with the p-value for the test of statistical significance on each predictor. Coefficients in bold indicate that they are both statistically significant and have a positive effect size. The last three columns of Table V detail results of a 10-fold cross validation experiment, implemented in R [Starkweather 2011]. We used the characteristics of the post and its author to predict whether or not a response to the post would manifest the feature. We report the classification error for the model, and we compare this against a naive baseline, which assigns the majority class for all observations. For example, when we use the participant's behavior and empathy profile to predict whether or not the friend will use the pronoun "I" in her comment, performance improves by 18%.

Table V. Logit regression models for predicting presence/absence of feature in friends' comments.

	β_1: Posts	β_2: Type 2	β_3: Type 3	β_4: Type 4	Error	Baseline	δ
I	0.3231*	0.00998	0.06354	-0.0908	0.2400	0.4209	0.1809
We	1.1098**	-1.6480	0.3602	-0.2677	0.0635	0.0914	0.0278
You	0.3042*	0.6097**	0.4117**	0.1614	0.1954	0.2223	0.0269
She/he	1.9026***	-0.4509	-0.5360	-1.5738**	0.0591	0.1140	0.0548
They	0.08701**	0.003619	-0.001550	0.017330	0.07621	0.1072	0.0310
Past	0.4262*	-0.1909	-0.0523	-0.1022	0.1729	0.3183	0.1434
Present	n.s.	n.s.	n.s.	n.s.			
Future	n.s.	n.s.	n.s.	n.s.			
Negation	0.3929*	0.6927*	0.1530	0.0530	0.1691	0.2686	0.0995
Assent	0.5585**	0.3799	0.4850*	0.5541**	0.2001	0.1884	-0.0117
Exclam	0.4200**	0.8591**	-0.1013	0.2739	0.2176	0.4605	0.2429
Question	n.s.	n.s.	n.s.	n.s.			
All punct	n.s.	n.s.	n.s.	n.s.			
Chat slang	0.5165***	-0.3025	-0.0701	0.0676	0.2355	0.4819	0.2464
Emoticons	0.8573***	-0.4144	0.2725	0.1279	0.1149	0.1275	0.0126

^{a}***p<0.001, **p<0.01, *p<0.05

We observe that for 10 of 15 features, there is a significant, positive main effect for the trigger post. In other words, for most features, we observe a positive boost in the likelihood that it will be used in a friend's comment, given it was used in the trigger post. The participant's empathy profile appears to mitigate this relationship for only very few features. For instance, low empathy participants (Type 2), elicit mimicry responses from friends with probabilities that differ significantly from Type 1 participants (i.e., our baseline group) with respect to three features: you, negation, and exclamation marks. In contrast, Type 3 and 4 individuals' level of influence on the their friends' use of style in comments is significant for only one feature each.

We make the following observations: 1) the presence or absence of a feature in a post is the most influential factor in terms of whether or not it will also be used in friends' comments on that post; 2) this effect is generally positive; use of a feature in a post increases the probability that it will also be used in a friend's comment on the post; 3) there is no consistent pattern demonstrating how empathy profile mitigates this process. Therefore, in response to RQ3, we find little evidence that high-empathy participants are more likely to elicit a mimicry response from their friends, as compared to others.

6. ANALYSIS 3: MIMICRY AND WRITING STYLE

Now we ask whether it is the case that individual posts with particular linguistic characteristics are more likely than others to elicit mimicry (RQ4), regardless of the respective poster's disposition. To explore this, we again use a logit model, however, this time, we predict whether mimicry occurs in a comment, based on the stylistic features of the participant's post. In addition, we model mimicry by feature type (e.g., mimicry on one or more of the five pronouns). For instance, in Table VI, the response variable is mimicry with respect to the five pronouns; the response is 1 if the friend has mimicked the participant's post with respect to one or more pronouns, and 0 otherwise. Five models are tested, in order to see which type of features are most useful for predicting pronoun-based mimicry.

Similarly, Tables VII, VIII, IX and X detail the same models but for the prediction of mimicry based on other features (verb tense, markers of negation/assent, punctuation and slang, respectively).

Although the models exhibit varying degrees of predictive power, they do yield one very salient finding: there are three stylistic features that are consistently correlated

Table VI. Logit regression for predicting presence/absence of mimicry of *pronouns (baseline error: 0.310).*

Model	Sig. Predictors	Error	δ
1. Pronouns	I: 2.232*** you: 1.083*** she/he: 0.750** they: 1.108***	0.266	0.044
2. Verb tense	Past: 0.811*** Present: 1.1249*** Future: 0.439*	0.237	0.073
3. Negation	Negate: 0.881***	0.222	0.090
4. Punctuation	Qmark: 0.804***	0.220	0.089
5. Paraling	Chatslang: 0.820***	0.221	0.089

^{a}***p<0.001, **p<0.01, *p<0.05

Table VII. Logit regression for predicting presence/absence of mimicry of *verb tense (baseline error: 0.479).*

Model	Sig. Predictors	Error	δ
1. Pronouns	I: 1.336*** you: 0.907*** they: 1.324***	0.291	0.188
2. Verb tense	Past: 0.7928*** Present: 3.200***	0.358	0.121
3. Negation	Negate: 1.200***	0.265	0.214
4. Punctuation	Qmark: 0.749***	0.254	0.225
5. Paraling	Chatslang: 0.875***	0.262	0.217

^{a}***p<0.001, **p<0.01, *p<0.05

Table VIII. Logit regression for predicting presence/absence of mimicry of *negation / assent (baseline error: 0.135).*

Model	Sig. Predictors	Error	δ
1. Pronouns	I: 0.667** we: 1.158***	0.122	0.013
2. Verb tense	Present: 0.572***	0.118	0.017
3. Negation	Negate: 2.632*** Assent: 3.112***	0.151	-0.016
4. Punctuation	n.s.		
5. Paraling	Chatslang: 1.472***	0.123	0.012

^{a}***p<0.001, **p<0.01, *p<0.05

Table IX. Logit regression for predicting presence/absence of mimicry of *punctuation (baseline error: 0.249).*

Model	Sig. Predictors	Error	δ
1. Pronouns	I: 0.629***	0.186	0.063
2. Verb tense	Present: 1.048***	0.189	0.060
3. Negation	Negate: 1.072***	0.188	0.061
4. Punctuation	Exclam: 0.745*** Qmark: 0.538*	0.186	0.063
5. Paraling	Chatslang: 0.476**	0.184	0.065

^{a}***p<0.001, **p<0.01, *p<0.05

Table X. Logit regression for predicting presence/absence of mimicry of *paralinguistic features (baseline error: 0.244).*

Model	Sig. Predictors	Error	δ
1. Pronouns	I: 0.621*** They: 0.527*	0.193	0.051
2. Verb tense	Present: 0.648**	0.188	0.056
3. Negation	Negate: 0.784*** Assent: 1.112***	0.195	0.049
4. Punctuation	Exclam: 0.356*** Qmark: 0.522*	0.186	0.058
5. Paraling	Emoticons: 1.551*** Chatslang: 3.397**	0.229	0.015

[a] ***p<0.001, **p<0.01, *p<0.05

to an increased probability that a friend will respond with some form of mimicry in her comment to the post. In particular, when a participant writes in her own, first-person voice ("I"), discusses the here and now ("present verb tense"), and uses slang typical of chat and Internet language, she is more likely to be mimicked by her friends in their comments. Therefore, in response to RQ4, we conclude that using a casual, personal writing style is more likely to elicit a response via mimicry from friends.

7. DISCUSSION

Scientists have produced convincing evidence that humans are "wired" to be social. For instance, it has recently been shown that the area of the brain that is active when we are at rest (i.e., processing social information rather than engaging in active problem solving) is the same area already known to neuropsychologists as our "social cognitive network" [Lieberman 2013]. However, while being social may be our instinct, there is no doubt that some of us have mastered the necessary tools for positive, empathic interactions more so than others. Some of us, by virtue of our dispositions, may find it second nature to "speak another's language," and in turn, to elicit a similar response from others. In contrast, some of us need to make a conscious effort to learn to communicate empathically.

In Analysis 1, we used all participants' posts collected, in order to explore correlations between their empathy profiles and Facebook writing patterns. We confirmed that dispositional empathy is correlated to the use of particular stylistic features, in ways that we would expect (e.g., more other-oriented individuals directly engage friends via the pronoun "you," whereas lower-empathy individuals refer more often to third parties.) However, while empathy profile correlates to one's overall, ongoing patterns of language use, we found in Analysis 2 that a participant's empathy profile was not a strong predictor that a friend would mimic her in any given post/comment interaction. In other words, the "triggering" effect on mimicry did not appear to be mitigated by the participant's general disposition.

Finally, Analysis 3 demonstrated consistently that particular linguistic style features were the best predictors that friends would mimic participants' use of five different classes of features (i.e., the pronouns, verb tenses, markers of negation/assent, punctuation and paralinguistic features that participants used in posts). The three features that were the best predictors of mimicry ("I," present tense verbs, markers of chat / Internet slang), suggest that a casual, personal tone in one's posts is most likely to result in fostering the "empathy symbiosis" with one's interlocutors, by encouraging mutual mimicry. This result is logical, given the the informal nature of communication on Facebook.

7.1. Implications

The results of our study have implications for both mediated communications between human users, and for interactions between humans and machines. We adopted the perspective that linguistic mimicry could be a tool for fostering empathy between interlocutors in a social media environment. As explained earlier, mimicry has been linked to positive benefits such as increased trust and social cohesion.

With respect to mediated communications between users, our observations support the notion that users can learn empathic communication skills. Individuals may have a personality or disposition that enables them to know and/or feel what another is feeling relatively easily. However, it is their linguistic style that plays the key role in achieving mutual mimicry, which might lead to the "empathy symbiosis." Knowing how to choose the ideal communication strategy would be useful in terms of achieving a desired outcome via social media; for example, to convince others to donate money to a worthy cause, to persuade individuals to adopt a healthy lifestyle, or to help out with research participation online. Therefore, we used an everyday social media context, Facebook, to explore the connections between disposition (i.e., empathy profile), writing style, and the elicitation of a mimicry response on one's linguistic style. Taking the implications of our current results with respect to CMC one step further, one could envisage a new generation of social technologies that would analyze in real time the text a user is producing, and provide suggestions to revise the text to facilitate "empathy symbiosis," helping to establish trust and cooperation.

Linguistic mimicry is a device that could also be used by artificial agents to emulate empathic interactions with humans. The idea of agents adapting or aligning to an interlocutor's linguistic style for improving user engagement is not new [De Jong et al. 2008; Campano et al. 2015]. In fact, the state-of-the-art in human-computer interaction (HCI) shows that people tend to align aspects of their language with their conversational partners, both humans and computers/agents [Cowan et al. 2015], and even very strong default preferences of the user may be influenced by an interlocutor's linguistic choices.

Our results suggest that it may not be necessary for the system to build a complete empathic profile on the user in question. In other words, a model based on the human user's most recent linguistic patterns would be a fruitful area for exploration. In particular, when the user's message is personal in tone, it would be most appropriate for the machine to respond with linguistic mimicry. In addition, we observed that mimicry is most salient for linguistic features that are less commonly used overall (e.g., in Facebook, emoticons or markers of assent, as shown in Figure 4). Therefore, the artificial agents' model must monitor the interlocutor of interest, as well as the linguistic patterns of all human users.

In sum, the current study has shed light on one device, linguistic mimicry, for the expression of empathy, and the extent to which people with varying abilities in relating to the thoughts and feelings of others, are able to elicit empathic responses from their friends via mimicry. We found that Facebook friends' reception of messages (i.e., whether or not they respond with mimicry) is best predicted by the linguistic features of the current message, rather than the disposition of the interlocutor. Given that disposition (i.e., trait empathy) is clearly related to linguistic style, this means that it is the "here and now" that might trigger empathic reactions, rather than a user's history (i.e., established linguistic style). This can certainly be exploited by both human and computer agents in achieving pro-social interactions. In sum, our research suggests that mimicry of linguistic and empathic interlocutor's characteristics, that are interconnected, could greatly benefit artificial agents in HCI to improve recognition

and comprehension, as well as imitate more naturalistic output by agents, and thus ultimately improve user engagement and communication success.

7.2. Limitations

It must be stated that, like many studies carried out outline via an app, our sample is comprised of people who volunteered their time to participate in our study. Although they were not compensated, we offered to profile their "empathy type," as well as those of their friends with whom they shared a link to our study. It is expected that the manner in which we recruited participants led to a sample of individuals who are not representative of the population of Facebook users at large. Our sample is international, and women are overrepresented. It has been well established that women test as being more empathic as compared to men [Davis 1983]. Yet, as shown in Table III, we did not find that men clustered together into one empathy profile. In other words, although our recruitment technique likely attracted Facebook users who have an interest in empathy and emotion in general, we did not find a strong link between gender and empathy among our participants. Nonetheless, we should be careful when interpreting the results, and we cannot make any observations with respect to the role of gender in eliciting mimicry responses.

Within the scope of our research, we studied linguistic mimicry in relation to the linguistic styles used by Facebook users. We believe that this is a fruitful research direction, and hence would like to highlight the possibilities of investigating other linguistic features which are equally interesting in relations to mimicry. For instance, future work can focus on lexical richness, lexical density, and grammatical sophistication / complexity .

8. CONCLUSIONS

Placing the current study in a broader research context, there is still much to learn concerning the relation between empathy and the various forms social contagion, including mimicry of an interlocutor's linguistic patterns. Neuroscientists generally agree that our empathic responses are controlled by two separate systems in the brain: a basic system that facilitates emotional empathy and a cognitive system that enables us to engage in perspective-taking [Shamay-Tsoory et al. 2009]. However, if and how these systems interact is still under debate. Given the fact that empathic responses are malleable, and are highly influenced by social factors such as interpersonal relationships and context, further research addressing the differences in empathic responses such as linguistic mimicry, promises to enrich our scientific understanding of the phenomenon, as well as provide guidelines as to how they might be exploited for society's benefit [Singer and Lamm 2009].

We presented the first study on empathy and linguistic mimicry in social media. We demonstrated that although users with different empathy profiles do communicate using particular stylistic features, the main predictor of mimicry, a key driver of positive social interaction, is the linguistic style adopted by the user during a particular interaction. We laid the groundwork for further study of social media activities, communication patterns and the human characteristic of empathy.

Further research concerning the role of empathy in CMC will not only contribute to a better understanding of communication processes, but can also inform the design of future technologies, enhancing both human-human and human-computer interaction. Thus far, the implications for systems that adapt to user characteristics (e.g., human-computer dialog systems) [Mairesse and Walker 2010] are that linguistic mimicry is indeed pervasive, and likely enhances communication and experience for all users, regardless of their levels of trait empathy.

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