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Social connection is a fundamental human need. As such, people's brains are sensitized to social cues, such as those carried by language, and to promoting social communication. The neural mechanisms of certain key building blocks in this process, such as receptivity to and reproduction of social language, however, are not known. We combined quantitative linguistic analysis and neuroimaging to connect neural activity in brain regions used to simulate the mental states of others with exposure to, and retransmission of, social language. Our results link findings on successful idea transmission from communication science, sociolinguistics, and cognitive neuroscience to prospectively predict the degree of social language that participants utilize when retransmitting ideas as a function of (1) initial language inputs and (2) neural activity during idea exposure.

Keywords: Social Language; Natural Language Processing; Social Sharing; fMRI; Mentalizing

Social interaction and communication are fundamental needs for humans (Baumeister & Leary, 1995), and as such, people are highly sensitized to multiple forms of social cues. One key tool facilitating social goals is language, which transmits both specific ideas as well as social cues through the words and patterns of words individuals select (Tomasello, 2000, 2008). Humans are particularly sensitive to

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words that are associated with instances of social interaction (or "social language"), and when exposed to ideas framed with such words people tend to use similar social language in response (e.g., in conversation) (Niederhoffer & Pennebaker, 2002, 2009). In other words, social language begets more social language. This raises a number of questions regarding the mechanisms involved and to what extent they extend to instances of message propagation. The current study examines the mechanisms involved in the processing and retransmission of social language in the novel context of word-of-mouth sharing.

Previous studies have leveraged neuroimaging methods such as functional magnetic resonance imaging (fMRI) as a method to examine multiple processes simultaneously during idea exposure; fMRI can reveal implicit and explicit factors leading to successful communication that may not be apparent from self-report measures or other experimental methods alone (Falk, Morelli, Welborn, Dambacher, & Lieberman, 2013; Hasson, Ghazanfar, Galantucci, Garrod, & Keysers, 2012). For example, Falk and colleagues (2013) characterized mechanisms associated with exposure to novel TV show ideas that are more likely to spread (a "buzz effect") and the characteristics of individuals who are likely to be more successful at spreading an idea (a "salesperson effect"). In their investigation, neural activity explained variance in successful idea retransmission beyond what was explained by participants' self-reported intentions to retransmit the ideas, highlighting one value of applying neural methods to the examination of communicative processes (Falk et al., 2013).

One core finding was that individual differences in neural activity within the temporoparietal junction (TPJ) were associated with being a better idea salesperson. Although one of many possible explanations, the TPJ is a region strongly associated with considering the mental states of others (Decety & Lamm, 2007; Mars et al., 2012; Saxe, 2010; Saxe & Kanwisher, 2003; Scholz, Triantafyllou, Whitfield-Gabrieli, Brown, & Saxe, 2009). Falk and colleagues suggested that individuals who engage in more consideration or simulation of others' viewpoints during initial idea exposure may be better positioned to later successfully communicate ideas to such others. In line with this explanation, in a secondary analysis of the same data-set described above, Falk, O'Donnell, and Lieberman (2012) found that activity within the TPJ during initial exposure to the TV show ideas predicted the later use of positive, evaluative language when participants subsequently described the shows to others. Neither analysis previously conducted by Falk and colleagues, however, directly addressed the type of social cues that might elicit activity within the mentalizing system or how such cues might elicit neural processing that predicts how the message would be retransmitted.

In an effort to more deeply explore the relationships between message features, neural processing, and subsequent communication of messages, we leverage the data collected from the same participants studied by Falk and colleagues during a new task in which the incoming ideas varied widely in terms of the social cues inherent in the incoming stimuli. The specific, quantifiable, social cue we focus on is the degree to which the language used was "social"—as measured using the Linguistic Inquiry and Word Count (LIWC) dictionary (Pennebaker, Chung, Ireland, Gonzales, & Booth, 2007; Tausczik & Pennebaker, 2010). Given the importance of social language for multiple outcomes ranging from depth of conversational engagement to success in cooperative problem solving (Dzindolet & Pierce, 2006; Gonzales, Hancock, & Pennebaker, 2010; Niederhoffer & Pennebaker, 2002, 2009), and our prior findings related to the use of neural systems implicated in mentalizing for the successful spread of ideas, we ask: What systems of the brain are activated by receiving social language? Does the resulting neural activity correlate with subsequent use of social language? Understanding how social language is processed by initial message recipients and then retransmitted is one key component of understanding how ideas are propagated and the types of motivations and processes that reproduce not only content but also broader social consequences of sharing.

Building on the work described above, the present investigation examines whether brain systems that are engaged in considering and simulating the mental states of others are particularly engaged by social features of language (e.g., words associated with social interaction), and whether activity within the brain's mentalizing system during exposure to ideas predicts the subsequent degree of social language employed in describing the ideas to others. We expect that language that calls to mind instances of social interaction to be associated with this process and will also activate neural regions most commonly associated with considering the mental states of others. This process, termed "mentalizing," most commonly activates the bilateral TPJ and dorsomedial prefrontal cortex (DMPFC) as well as the precuneus and posterior cingulate cortex (PC/PCC) (Denny, Kober, Wager, & Ochsner, 2012; Lieberman, 2010; Saxe, 2010; Saxe & Kanwisher, 2003; see Mars et al., 2012 for discussion of functional subdivisions within the TPJ).

Social language includes words that are widely used to describe instances of social interaction and engagement (e.g., you, your, them, friends, family, talk, share, people, call, etc.). Individuals then bring these words to mind when talking about social situations or when engaging others socially (Pennebaker et al., 2007), and as such they become associated with social interaction and social intent. Perhaps because of its social function, this type of language in particular has been shown to synchronize (i.e., speaker and hearer show matched frequencies of word category usage) during certain forms of successful communication (Gonzales et al., 2010; Ireland et al., 2011; Niederhoffer & Pennebaker, 2002). We extend these prior investigations to consider the context of idea retransmission to new interaction partners.

Background

Language and Social Interaction

Social interaction and communication are fundamental needs for humans (Baumeister & Leary, 1995; Cacioppo & Patrick, 2008; Eisenberger, 2012; Eisenberger & Lieberman, 2004). Indeed, scholars have noted that "many of our cognitive faculties emerge from interpersonal interactions, and that a complete understanding of the cognitive processes within a single individual's brain cannot be achieved without understanding the interactions among individuals" (Hasson & Honey, 2012, p. 1272). In addition, coupling between communicators has been observed on multiple levels, from nonverbal cues (Cappella, 1996; Cappella & Palmer, 1989; Clark, 2003; Giles & Smith, 1979; Richardson & Dale, 2005) to linguistic patterns (Branigan, Pickering, & Cleland, 2000; Dale & Spivey, 2006; Giles, Coupland, & Coupland, 1991; Gonzales et al., 2010; Niederhoffer & Pennebaker, 2002) to neural activity associated with producing and decoding narratives (Hasson et al., 2012; Stephens, Silbert, & Hasson, 2010).

We suggest that understanding neural mechanisms of social communication may provide a coherent link between observed behaviors and processes studied in other fields. This includes examining the coupling or synchronization on both the verbal and nonverbal levels that takes place in conversational dyads or offering insights about how the process of receptivity to linguistic social cues might tie in with broader understandings of social influence in social psychology, sociology, and other fields concerned with influence. In addition, the use of communication paradigms can expand our understanding of the range of processes supported by specific brain systems implicated in social thought (e.g., through what pathways might these brain systems aid in preparing us to effectively signal social intent to others and retransmit key pieces of cultural knowledge?).

Social Language Facilitates Social Communication

Previous studies have demonstrated how increased synchrony in dyadic communication of both verbal and nonverbal features is associated with more successful communication outcomes (Cappella, 1996, 1997; Cappella & Palmer, 1989; Semin, 2007). Recent work has used language quantification, specifically word category counting, to measure the degree of synchrony across a range of language features and found the coordination of levels of "social language" a prominent component (Goode & Robinson, 2013; Ireland et al., 2011; Niederhoffer & Pennebaker, 2002). In this context social language is understood and operationalized as words and patterns of words that are commonly used to describe instances of social interaction. Although patterns of linguistic usage are largely unconscious, it is possible that the use of "social language" across communicators is especially important because it may signal affiliative or cooperative intent (Tomasello, 2008; Tomasello, Carpenter, Call, Behne, & Moll, 2005). Indeed, it is well established that language form and function are intimately tied (Bybee, 2010; Croft & Cruse, 2004; Ellis & O'Donnell, 2012), with adult humans effortlessly transmitting and decoding meaning, even when they are not aware of the specific language forms they are utilizing to convey such meaning. In the present investigation, we extend past results to consider whether and how social language might not only synchronize between communication dyads, but might also influence idea retransmission.

Tools for integrating our understanding of social communication. Given that individuals may not be aware of the mechanisms that lead them to imbue their communications with broader social meaning (e.g., via patterns of language), the tools needed to examine these mechanisms need to be able to access and measure implicit processes. We propose a methodological combination of quantitative linguistics and neuroimaging as one approach to investigating the psychological processes associated with effective communication and the successful transmission of ideas, norms, and behaviors (O'Donnell & Falk, in press). Both linguistic and neuroimaging tools can be used to indirectly measure information about psychological processes that unfold during different stages of the communication process (Falk, Morelli, Welborn, Dambacher, & Lieberman, 2013; Lieberman, 2010; Pennebaker & King, 1999; Tausczik & Pennebaker, 2010).

More specifically, quantitative linguistic analysis can pick up on features of communication such as social orientation that contextualize specific information being delivered (Everett, 2012; Halliday, 1978; Hymes, 1974). Thus, during a communicative interaction language carries not only content information but also social cues. Through instances of associative learning [i.e., fast (System 1) thinking (Evans, 2003; Lieberman, 2003; McLaren et al., 2014; Oaksford & Chater, 2012) and implicit learning (Ellis, 2008; Shanks, 2010)], language users build up an inventory of word-to-social function mappings that they use to interpret the communicative intent of speakers (Hoey, 2005). Further, by this view, meaning in language is a result of the negotiation between language users, interacting in various social contexts, using language for various functions (Halliday, 1977; Halliday, Cermáková, Teubert, & Yallop, 2004), which by extension must be encoded, decoded, and planned and executed by the brain.

In parallel, neuroscience investigations have characterized brain systems associated with considering the mental states of others (Denny et al., 2012; Lieberman, 2010; Saxe, 2010; Saxe & Powell, 2006; Scholz et al., 2009)—termed mentalizing—and have established that the mentalizing system is engaged in successful speaker/listener coupling (Hasson et al., 2012; Stephens et al., 2010) as well as in the successful spread of ideas from person to person (Falk et al., 2013, 2012). Broadly, tools such as fMRI are able to interrogate multiple processes simultaneously, without the need to ask what types of mechanisms people think they are using (Lieberman, 2010). In past studies, this has offered novel insight into the mechanisms underlying a wide range of social psychological processes (Lieberman, 2010) and allowed researchers to predict variance in outcomes not explained by self-reports and other available measures (Berkman & Falk, 2013).

The Present Study

The present investigation builds on and extends prior findings by examining the neurocognitive mechanisms associated with exposure to one key vehicle for social communication—social language, and subsequently how neural activity within the brain's mentalizing system may prime or prepare communicators to later employ social language. In particular, in this study we combine fMRI analysis of neural activity in the mentalizing system during exposure to descriptions of novel products with linguistic categorical word scores (using LIWC; Pennebaker et al., 2007) of the language in the descriptions. We then examine whether mentalizing activity during initial idea exposure predicts subsequent uses of social language, beyond that contained in the initial idea descriptions. Our goal is to better understand how stimulus features (language) and individual features (neural response) are implicated in core components of social sharing and effective communication. Previous work has demonstrated how dyad synchrony, including similar rates of categorical word use (Niederhoffer & Pennebaker, 2002), improves communicative effectiveness. However, we anticipate that neural responses to social language in the initial stimuli and their association to social language usage in subsequent description will reveal processes that are engaged beyond encoding and recoding specific wording. Instead, we suggest that social language, in particular, may prime broader social cognition that goes beyond mere reproduction of language features and extends as well to social motivation and simulation of others' mental states.

Specifically, we hypothesized that: (1) activity in the mentalizing system, especially subregions of the TPJ previously implicated in successful idea propagation, would show greater activation when participants were exposed product descriptions high in social language; (2) activity in the mentalizing system during idea exposure would predict the usage of social language in post-scan product descriptions.

Method

Participants

Twenty undergraduate participants were recruited for a larger fMRI study in exchange for course credit or financial compensation. One participant's data were not used due to technical difficulties, leaving n =19 (11 female, mean age = 20.55, SD = 6.17). Participants were right-handed, spoke English fluently, and met the following criteria related to fMRI safety: (1) were not claustrophobic; (2) had no metal in their bodies (other than tooth fillings); (3) were not pregnant/breast-feeding; (4) were not currently taking psychoactive medication. Informed consent was obtained from all subjects in accordance with the policies of the University of California, Los Angeles (UCLA) Institutional Review Board.[1]

Stimuli

A set of 24 stimuli were created by asking undergraduate students not involved in the fMRI study to describe novel products they were familiar with, framed as personal reviews. The descriptions were selected for novelty (in 2008), edited for length (mean words 94.21, SD = 6.53 words) and consistency in terms of language complexity and reading level, but the original framing was not altered. Thus, the 24 product descriptions all consisted of positive recommendations for the product they described but varied in terms of their use of social language according to the tendency of the original communicator (see Figure 1 and the Appendix).

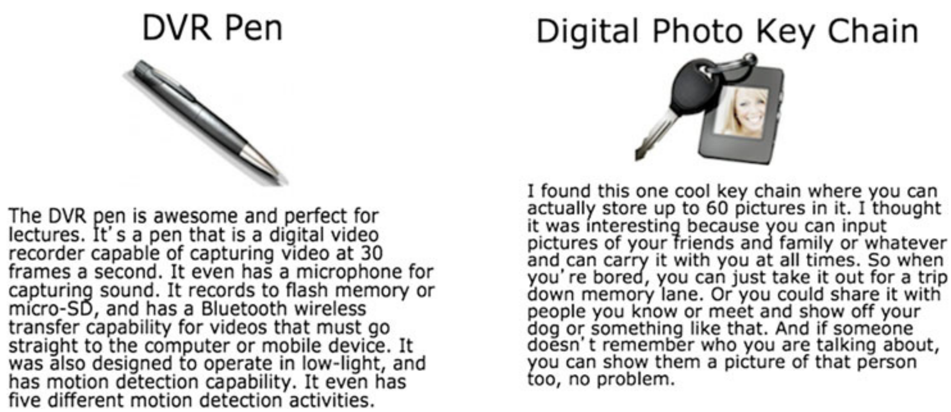

Figure 1 Example product stimuli used in fMRI task.

Procedure

During an fMRI session participants were shown descriptions of the 24 different products recommended by their peers and asked to indicate whether they would in turn recommend each product to a friend using a four-point scale (prompt: "Would you tell a friend about this product?," rating: 1 = Definitely not, 2 = Unlikely, 3 = Likely and 4 = Definitely; see Figure 2). They completed this task across four separate runs alongside a second task, the TV Show Task (Falk et al., 2013), that consisted of three separate runs. All the runs from each task were completed contiguously within task, but their orders within task were randomized and the order in which the tasks

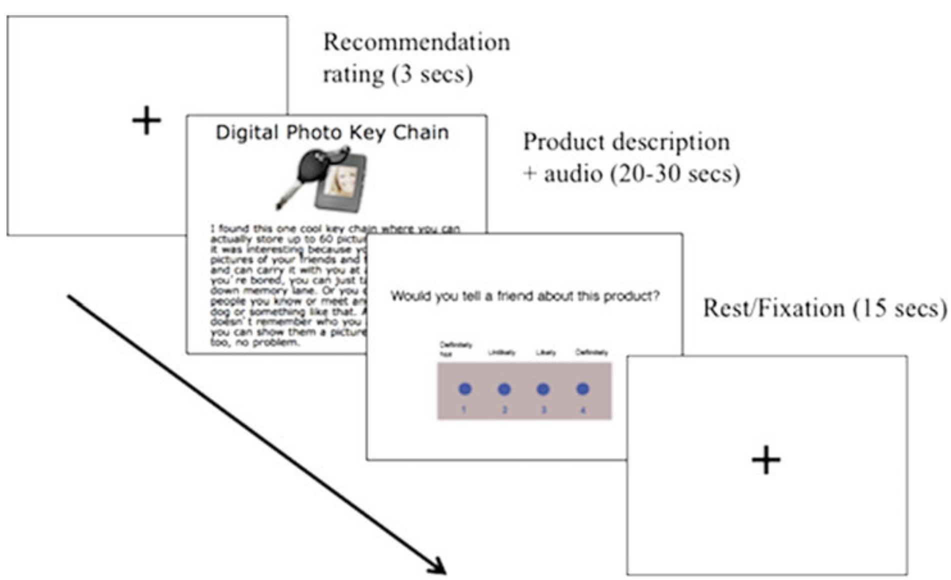

Figure 2 Product fMRI task.

were performed was counter-balanced, i.e., whether a participant completed the Product or TV Show Task first (see Falk et al., 2013 for more details of TV Show Task).

After the scanning session participants were videotaped describing each of the 24 products, aided by a cue card that contained the name and pictures of each of the products. These video descriptions were then transcribed into standard orthography following rules of written text (e.g., sentences divisions), but keeping hesitations, and repetitions, and marking the length of significant pauses in parentheses.

Linguistic Measures

The social processes category from the English 2007 LIWC dictionary (Pennebaker et al., 2007) was used in the analysis. It consists of 455 words and captures both references to individuals who may be engaged in a social interaction (e.g., people, friends, someone, mother, father, they, you, etc.) and words used to describe these interactive processes (e.g., talk, share, write, etc.). Words from the Social Processes category accounted for 8.32% of words in the LIWC sample corpora used to determine base word usage rates (Pennebaker et al., 2007). Each of the original product descriptions used as stimuli and each participant's verbal description of each product were scored using LIWC. LIWC normalizes these scores according to text length. The 24 product descriptions used as experimental stimuli had a mean score of 8.10 (*SD* = 5.36) for the Social Processes category, which accounts for overall word count. These scores are referred to as "social language in." Table 1 shows two descriptions of products, which objectively both involve the potential for social interaction (video taping others; showing others photos), though in the stimulus set one is high (Digital Photo Key Chain) and the other low (DVR Pen) on social category words.

Table 1 Example stimuli used in the fMRI Products Task.

DVR Pen	Digital Photo Key Chain
The DVR Pen is awesome and perfect for lectures. It's a pen that is a digital video recorder capable of capturing video at 30 frames a second. It even has a microphone for capturing sound. It records to flash memory or micro-SD, and has a Bluetooth wireless transfer capability for videos that must go straight to the computer or mobile device. It was also designed to operate in low light, and has motion detection capability. It even has five different motion detection activities.	I found this one cool key chain where *you* can actually store up to 60 pictures in it. I thought it was interesting because *you* can input pictures of *your friends* and *family* or whatever and carry it with *you* at all times. So when *you're* bored, *you* can just take it out for a trip down memory lane. Or *you* could *share* it with *people you* know or *meet* or show off *your* dog or something like that. And if *someone* doesn't remember *who you* are *talking* about, *you* can show *them* a picture of that *person* too, no problem.
LIWC Social Processes: 0	LIWC Social Processes: 21.0

Note: These two product descriptions illustrate descriptions that score high and low on LIWC Social Processes category words (Italicized).

It should be clear from these extracts, which represent the extremes of the LIWC Social Processes category scores in our initial stimuli, how the words in this category bring to mind instances of social interaction and frame the information about the product within that context. It would be possible, for instance, to talk about the DVR Pen in a way that would incorporate many words associated with social interaction and about the Digital Photo Key Chain with no or very few such words (see Table 2). The variation found across the 24 products (see the Appendix) is a result of framing choices made by the 24 individuals who generated the initial product descriptions. We capitalize on this variation here to examine how such natural variation is encoded by subsequent message recipients. In addition, for discriminant validity, we examined scores on two other LIWC categories: (1) Cognitive processes (e.g., cause, know, ought) and (2) Affective processes (e.g., happy, cried, abandon) (Tausczik & Pennebaker, 2010).

Table 2 Example post-scan descriptions made by participants in the post-scan video task recalling what they remembered of each of the 24 products.

Digital Photo Key Chain	Digital Photo Key Chain
Another product was the Digital Photo Key Chain. And *you* could store up to 60 pictures of *friends* and *family*. Whatever you like to look at and carry around with *you* all the time. Um, if *you're* having a *conversation* with a *friend* and *they* didn't remember about *someone you* were *talking* about *you* could just pull out the keychain and show *them*. Or if *you're* bored *you* could reminisce through pictures of *your* life.	Uh the Digital Photo Key Chain, that was also something that's—is very cool just to—to be able to have tons of digital er 60 or something digital images to carry around and look at, um whenever just *your* free-time. It's kinda a cool little thing to have on *your* key chain it's really different.
LIWC Social Processes: 22.7	LIWC Social Processes: 3.45

DVR Pen	DVR Pen
The DVR Pen is a pen that not only fulfills the task of *writing* but it um, it contains video and voice recorder so if *you* use it in lecture so when *you* use it in a lecture *you* can not only *write your* notes but can also record *your* professor and so that way *you* can um, review what *your* professor *said* for an upcoming exam so I thought it was really an essential product, um, because it enhances the life of a college student and *helps them* um, economically.	Um the DVR Pen was kinda interesting it was—it's a little pen that jus—that has the ability to capture video and audio and um, it just seems it seems like something very high tech and very um, I don- I don't understand how *they* would be able to make a product like that now but it seems like something very interesting
LIWC Social Processes: 14.4	LIWC Social Processes: 1.56

Transcripts have been scored in the LIWC Social Processes category (words italicized). These examples illustrate that although in general social language in the initial descriptions (illustrated in Table 1) produced similar social language in the outputs, there was also significant individual variation in how participants translated the product ideas during retransmission.

After our fMRI participants were exposed to each of these ideas, they also recorded their own recommendations of the products. The post-scan product descriptions were transcribed from the video segments produced by the participants and scores were computed for the LIWC Social processes category. We refer to these scores as "social language out." Table 2 provides an example of the language used by two different participants when describing the Digital Photo Key Chain that vary between high (22.7) and low (3.45) on LIWC Social process scores. This demonstrates individual differences in the use of these linguistic features given that both participants are responding to same stimulus (the initial Digital Photo Key Chain description has an LIWC Social Processes score of 21.0).

fMRI Acquisition and Analysis

fMRI data acquisition. Imaging data were acquired using a Trio 3 Tesla head-only MRI scanner at the UCLA Ahmanson-Lovelace Brainmapping Center. Head motion was minimized using foam padding and surgical tape; goggles were also fixed in place using surgical tape connecting to the head coil and scanner bed. A set of high-resolution structural T2-weighted echo-planar images were acquired coplanar with the functional scans (spin-echo; TR = 5,000 ms; TE = 34 ms; matrix size = 128 × 128; 33 interleaved slices; field of view (FOV) = 220 mm; slice thickness = 4 mm; voxel size = 1.7 × 1.7 × 4.0 mm; flip angle = 90°). A high-resolution T1-weighted magnetization prepared rapid acquisition gradient echo (MP-RAGE) scan was also acquired in the coronal plane (TR = 2,300 ms; TE = 2.47 ms; matrix size = 64 × 64; FOV = 256 mm; slice thickness = 1.0 mm; 160 slices; voxel size = 1.3 ×. 1.3 × 1.0 mm; flip angle = 8°). Four functional runs were recorded for each participant (echo-planar T2-weighted gradient echo, TR = 2,000 ms, TE = 30 ms, flip angle = 75°, matrix size = 64 × 64, 33 axial slices, FOV (field of view) = 220 mm, 4 mm thick; voxel size = 3.4 × 3.4 × 4.0 mm). Each run consisted of six blocks (one product was described and rated in each block). The first two volumes from each run were discarded to allow the scanner to equilibrate. The data were analyzed using Statistical Parametric Mapping (SPM8, Wellcome Department of Cognitive Neurology, Institute of Neurology, London, UK).

fMRI preprocessing. Preprocessing steps were performed using SPM8 (Wellcome Department of Cognitive Neurology, Institute of Neurology, London, UK) apart from the despiking of the functional images that was carried out using the default options of AFNI 3dDespike (Cox, 1996). Using SPM8, despiked functional images were corrected for slice acquisition timing differences within volumes (slice order interleaved), realigned within and between runs to correct for residual head motion. These were then coregistered using a two-stage process in which the mean functional volume was coregistered with the matched-bandwidth structural scan, and the matched-bandwidth structural scan was coregistered with the MPRAGE, using six-parameter rigid body transformations. To ensure accurate skull stripping the coregistered MP-RAGE images were segmented and were then normalized into Montreal Neurological Institute (MNI) standard stereotactic space (using the

MNI152_T1_1mm template). The resulting parameters were applied to all segmented, coregistered, functional images. Finally the functional images were smoothed using a Gaussian kernel (8-mm full width at half maximum).

fMRI data analysis. We constructed individual models for each subject in which the description periods for each product were treated as separate regressors in the design matrix (i.e., an item-based model) with a single boxcar regressor for each 3-second rating period using Statistical Parametric Modeling (SPM8, Wellcome Department of Cognitive Neurology, Institute of Neurology, London, UK). Response periods were all modeled using one regressor of no interest. Fixation periods served as an implicit baseline. Corresponding random effects models were constructed at the group level, averaging across subject first-level models for each product.

Region of interest (ROI) data were extracted for each product at the group level, representing the mean activation across all voxels in the ROI during exposure to the product minus mean activation during the implicit baseline (this is the item-based contrast) divided by mean activity during the baseline/rest period (to give a percent signal change). We constructed two separate sets of ROIs. The first focused on specific functionally defined regions of the mentalizing system within the bilateral TPJ, which have been previously associated with being a good "idea salesperson." This effect was established according to individual differences in people's ability to successfully convince others of the value of the idea salesperson's preferred ideas (Falk et al., 2013). Brain masks for functional ROIs were identified using xjview, and MarsBar (Brett, Anton, Valabregue, & Poline, 2002) was used to convert these image masks to ROIs (Figure 4). The second set of ROIs focused more broadly on a wider range of brain regions most commonly implicated in mentalizing (Lieberman, 2010; Saxe, 2010; Saxe & Kanwisher, 2003; Saxe & Powell, 2006), including the bilateral TPJ, the DMPFC, and PCC) (Figure 3). Anatomical ROIs were constructed in Wake Forest University Pickatlas toolbox within SPM (Maldjian, Laurienti, Burdette, & Kraft, 2003), combining gross definitions from the Automated Anatomical Labeling Atlas (AAL; Tzourio-Mazoyer et al., 2002) Brodmann areas. MarsBar (Brett et al., 2002) was used to convert these anatomical images to ROIs.

Combining fMRI and linguistic data. We combined neuroimaging data with computational linguistic quantification of (1) the linguistic input (i.e., the product descriptions) and (2) the post-scan language output, i.e., fMRI subjects' descriptions of the products, both using the standard word-counting approach described above, namely LIWC (Pennebaker et al., 2007; Tausczik & Pennebaker, 2010).

Statistical analysis combining our a priori hypothesized ROI data with quantitative linguistic output was carried out in R (R Core Team, 2013) using the *lme4* (Bates, Maechler, Bolker, & Walker, 2013) and *lmerTest* (Kuznetsova, Brockhoff, & Christensen, 2014) packages to perform linear mixed effects modeling.

We first ran a regression specifying fixed effects of LIWC Social Processes score for product stimuli predicting neural activity extracted as percent signal change from each of our hypothesized mentalizing network ROIs. Participants were treated as

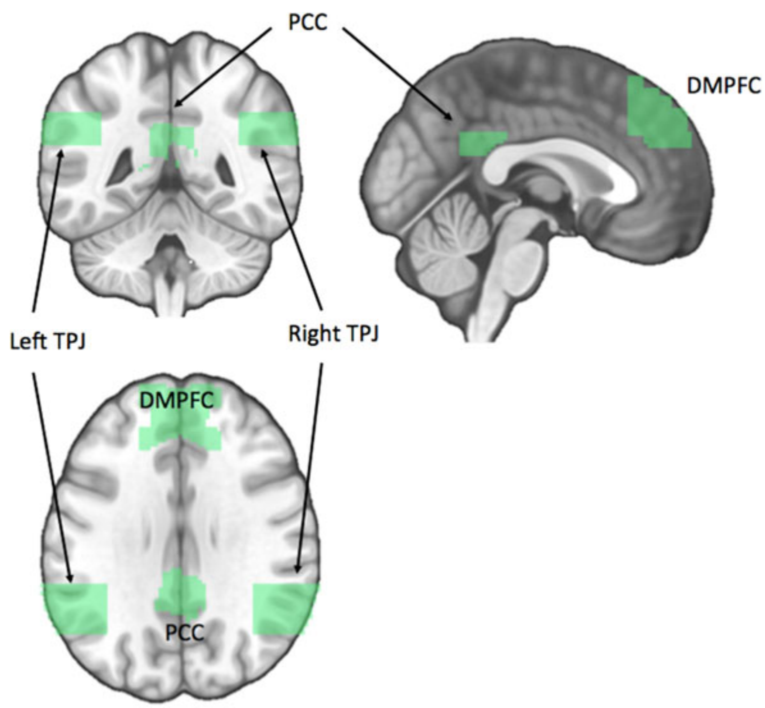

Figure 3 Anatomically defined regions of interest for the mentalizing network. TPJ = temporal parietal junction, DMPFC = dorsal medial prefrontal cortext, PCC = posterior cingulate cortex.

random effects with slopes and intercepts allowed to vary randomly, and accounting for nonindependence in the data from these two sources.

Next, we ran a regression specifying fixed effects of neural activity extracted as percent signal change from each of our mentalizing network ROIs, predicting LIWC Social Processes scores for each participant's post-scan descriptions of each product. Participants were treated as random effects with slopes and intercepts allowed to vary randomly.

Whole brain search. In addition to these ROI analyses, we also examined whole-brain parameter maps to uncover any regions outside of the mentalizing network that might be associated with social language in and social language out. The LIWC Social Processes scores from the product descriptions (social language in) and from participants' post-scan descriptions for each product (social language out) were used as parametric modulators of neural activity in two separate analyses of neural activity during exposure to the 24 product descriptions. To do so, for each participant we modeled neural activity associated with exposure to social language ("social language in") within a first-level fixed effects model using SPM8. More specifically, we modeled LWIC scores for each of the initial product stimulus descriptions within the LIWC Social Processes category as a parametric modulator of neural activity during exposure to the corresponding initial product ideas. This analysis identified voxels throughout the brain whose activation levels covaried with exposure to product descriptions that initially contained more social language within each subject. These subject-level models were combined in a random effects model to produce a whole-brain activation map of neural regions associated with exposure to more social language across participants.

Second, using a parallel procedure, for each participant we modeled neural activity associated with subsequent social language use (social language out) as a parametric modulator of neural activity during exposure to the initial product ideas within a fixed effects model in SPM8. These subject-level models were combined using a random effects model to produce whole-brain activation map of neural regions associated with subsequently using more social language to describe products across participants. Results were thresholded at $p = .005$, $K = 36$, corresponding to $p < .05$, corrected, based on a Monte Carlo Simulation implemented using AlphaSim in the software package AFNI (Ward, 2000).

Finally, we examined whether social language in the product descriptions was associated with greater subsequent use of social language to describe products, and whether neural activity within the mentalizing system remained predictive of this subsequent social language controlling for social language scores in the initial product descriptions.

Results

Behavioral Data and Association between Social Language in and Social Language out

The LIWC Social Processes scores for product descriptions in the stimuli (social language in) are shown in the Appendix next to each description (with words from the category italicized) ($M = 8.08$, $SD = 5.37$). Summary scores from participants post-scan descriptions are also shown for each product ($M = 8.44$, $SD = 4.67$). The stimuli LIWC scores (social language in) predicted the LIWC scores for Social Processes in the transcribed language produced by participants describing what they had seen in the scanner (social language out) ($t = 7.46$, $p < .001$, n_subjects = 19, n_descriptions = 24). That is, the degree of social language in was systematically, positively related to the degree of social language out (the language used by participants when they subsequently describe the stimuli to others), accounting for the nested structure of descriptions within products and participants.

Neural Activity Associated with Social Language

Neural correlates of social language in. We first examined neural activity during our scanned participants' exposure to the initial product descriptions as a function of social language in within a priori defined ROIs. Neural activity within the functionally defined bilateral TPJ ROI previously associated with the successful

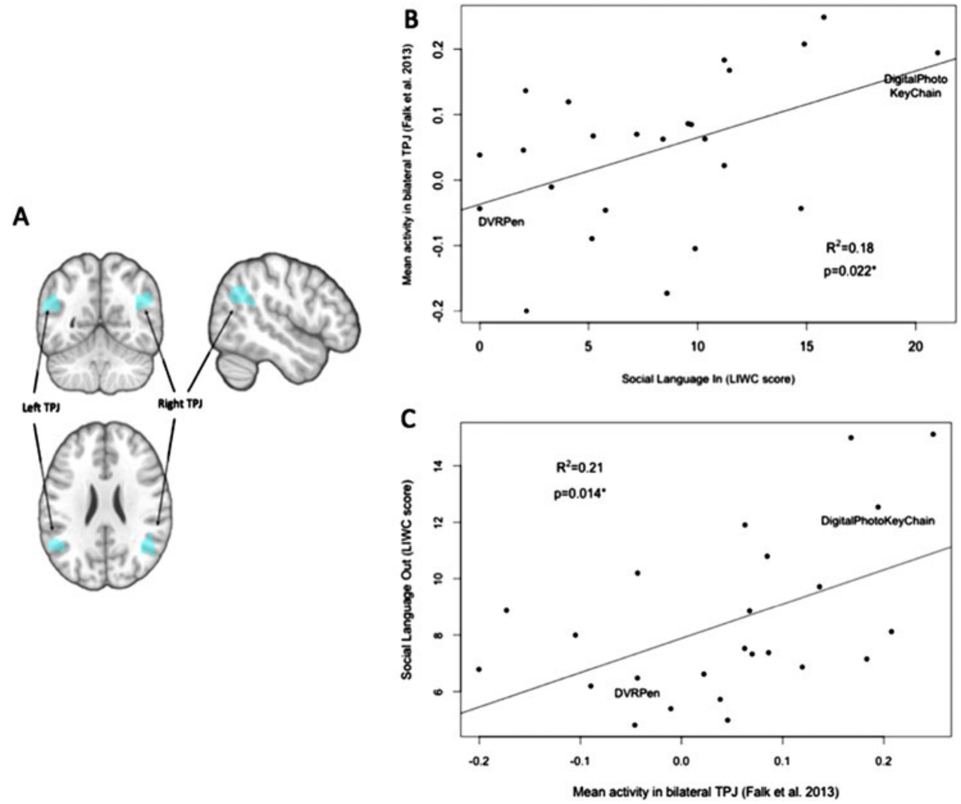

Figure 4 (A) Functionally defined regions of interest for the "salesperson effect " (Falk et al., 2013) in bilateral temporoparietal junction. Mean activity in these regions for each product (grouping across participants); (B) is predicted by LIWC Social Processes score for product description (social language in); and (C) predicts LIWC Social Processes score for post-scan product descriptions (social language out).

transmission of ideas to others (the Salesperson Effect in Falk et al., 2013; Figure 4) was strongly associated with exposure to social language in (t = 3.96, p < .001).

In order to examine whether a broader range of ROIs within the mentalizing system would be associated with social language in, we examined activity within anatomically defined right and left TPJ, DMPFC, and PCC (Figure 3; Table 3). This ROI analysis suggested that the association between social language in and neural activity in the mentalizing system is most strongly focused in the bilateral TPJ and is particularly strongly associated with the left TPJ. This association was only significant for the Social Processes LIWC category and not for the two other LIWC categories, Cognitive Processes and Affective Processes, we examined.

Finally, we followed up this targeted ROI analysis, with a whole-brain analysis to ascertain if other regions outside of the mentalizing network, or more targeted subregions within our ROIs, might also be involved in individuals' response to language containing cues to situations of social interaction (Figure 5). This analysis

Table 3 Predicting neural activity in anatomical and functionally defined regions of interest using LIWC Social Processes scores in language input [Model: ROI ~ social_in + inscanner_rating + (1+ social_in | subject)].

ROI	*t*	*p*
DMPFC + lTPJ + rTPJ + PCC	1.352	.181
DMPFC	−0.006	.995
PCC	1.288	.198
rTPJ	1.691	.100
π lTPJ	3.910	.000***
Functional TPJ (Falk et al., 2013)	3.961	.000***
Functional rTPJ	2.615	0.014*
Functional lTPJ	4.84	0.000***

*$p < .05$. ***$p < .0001$.

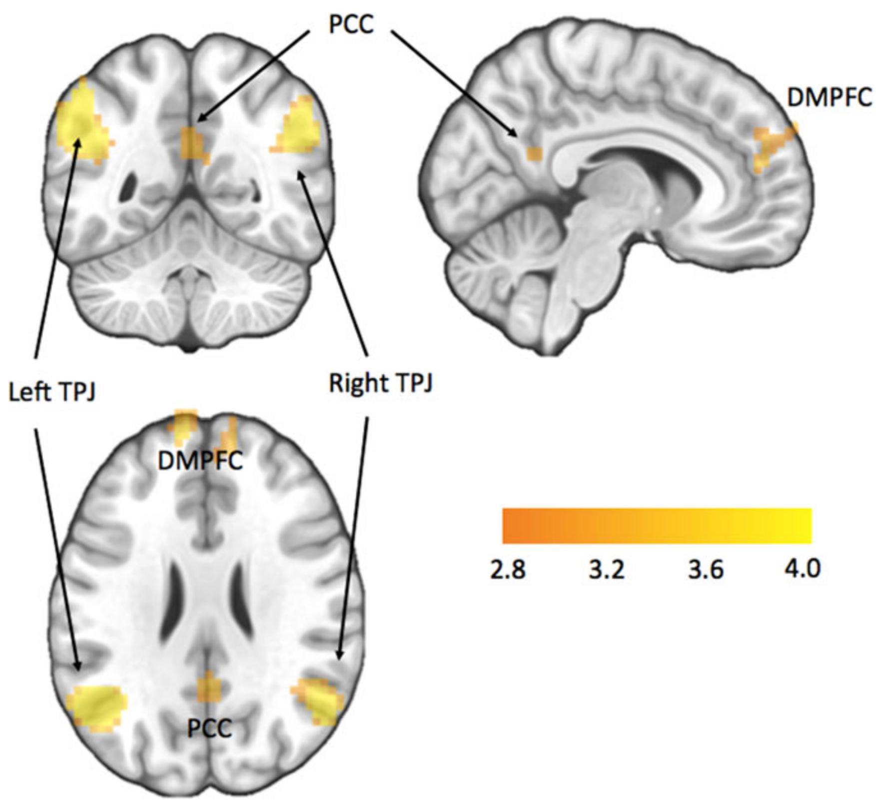

Figure 5 Neural activity associated with higher LIWC Social Processes scores in product stimuli (SOCIAL LANGUAGE IN) ($p < .005$, using cluster extent threshold $k = 36$, corresponding to $p < .05$, corrected for multiple comparisons). DMPFC = dorsal medial prefrontal cortex; PCC = posterior cingulate cortex; TPJ = temporoparietal junction.

Table 4 Associations between participant's neural activity during product idea exposure and LIWC Social Processes category scores for product descriptions (social language in).

	Local max				
Region	*x*	*y*	*z*	*K*	*t*-Stat
TPJ (right)	53	−60	28	213	7.08
TPJ (left)	−44	−67	34	508	6.61
TPJ (left)	−50	−57	28		5.39
TPJ/IPL (left)	−54	−50	46		5.36
DLPFC	−33	29	55	87	4.32
MPFC	−9	63	16	181	4.07
DMPFC	−13	60	25		3.89
DMPFC/superior frontal gyrus	−16	39	40		3.87
Temporal pole (left)	−47	1	−29	66	3.87
Posterior cingulate	1	−50	28	52	3.43
Precuneus (right)	11	−50	22		3.1

confirmed that activity within bilateral TPJ was robustly associated with exposure to higher levels of social language. In addition, activity within subregions of the mentalizing more broadly, including a subportion of DMPFC, PCC, and temporal pole, but little else in the brain, was associated with initial exposure to more social language (see Table 4).

Neural correlates of social language out. We next examined whether neural activity within the mentalizing system as participants were exposed to the initial product descriptions predicted the degree of social language used postscan. More specifically, we fitted a linear mixed effect model using parameter estimates for percent signal change extracted from the same ROIs described above (see Figures 3 and 4) to predict LIWC Social Processes scores in language output.

We found a significant relationship between levels of activity both within our functionally defined and anatomically defined mentalizing ROIs during exposure to product ideas and the subsequent level of social language usage when participants were asked to describe the product to others (Table 5). Consistent with the data reported above in which TPJ activity was particularly strongly associated with social language in, we found that when controlling for social language in, the effects of TPJ on social language out were no longer significant, whereas effects in the mentalizing system overall (t = 2.02, p = .053) and specifically in the DMPFC (t = 2.01, p = .046) remained significantly associated with social language out. This association was only significant for the Social Processes LIWC category and not for the two other LIWC categories we examined: Cognitive Processes (p = .296) and Affective Processes (p = .789).

To examine whether neural regions outside of our hypothesized mentalizing network were also associated with social language out, we ran a whole-brain search. Figure 6 shows the neural regions associated with higher LIWC Social Processes

Table 5 Predicting LIWC Social Processes scores in post-scan descriptions using neural activity in anatomical and functionally defined regions of interest.

	Model A		Model B	
ROI	*t*	*p*	*t*	*P*
DMPFC + lTPJ + rTPJ + PCC	2.410	.019*	2.072	.053
DMPFC	1.716	.088	2.013	.046*
PCC	1.691	.094	1.470	.143
rTPJ	2.165	.035*	1.360	.190
lTPJ	3.151	.008**	1.151	.150
Functional TPJ (Falk et al., 2013)	3.108	.007**	1.573	.133
Functional rTPJ	2.378	.021*	1.358	.192
Functional lTPJ	3.589	.029**	1.579	.134

Note: (1) Model A: Predicting social language out using neural activity in ROI controlling for in scanner rating [social_out ~ ROI + inscanner_rating + (1+ ROI | subject)]. (2) Model B: Predicting social language out using neural activity in ROI controlling for social language in and in scanner rating [social_out ~ ROI + social_in + inscanner_rating + (1+ ROI | subject)].
*$p < .05$. **$p < .001$.

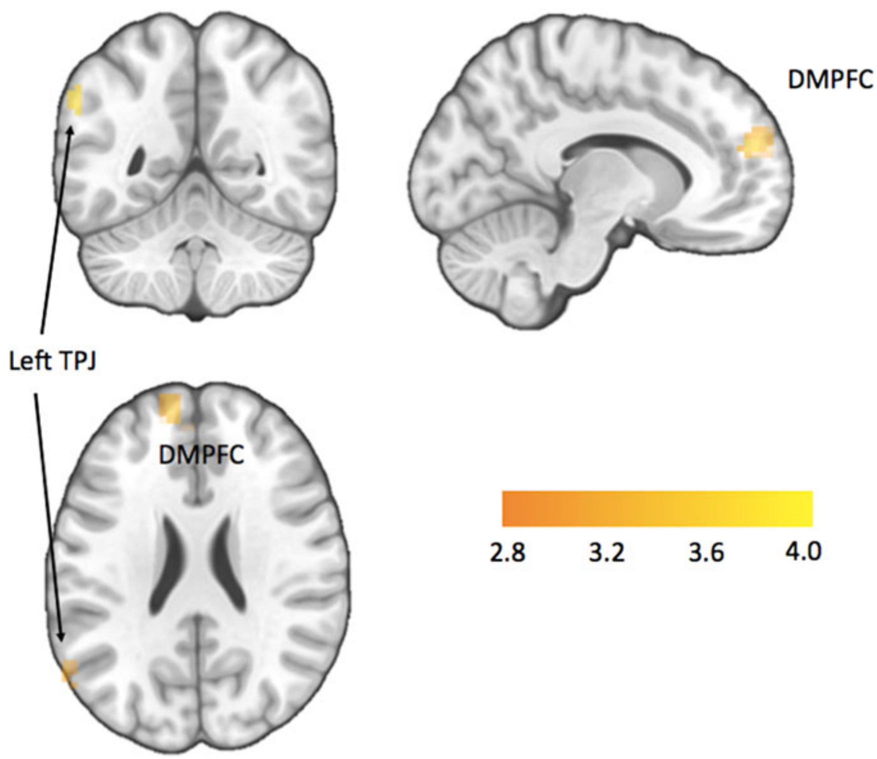

Figure 6 Neural activity associated with higher LIWC Social Processes scores in post-scan product descriptions (SOCIAL LANGUAGE OUT) ($p < .005$, using cluster extent threshold $k = 36$, corresponding to $p < .05$, corrected for multiple comparisons). DMPFC = dorsal medial prefrontal cortex; TPJ = temporoparietal junction.

Table 6 Associations between participants' neural activity during product idea exposure and LIWC Social Processes category scores for their subsequent descriptions of the products (social language out).

	Local max				
Region	*x*	*y*	*z*	*K*	*t*-Stat
DMPFC (left)	−13	56	19	61	4.42
	−2	50	19		3.18
TPJ (left)	−57	−64	40	69	3.96
BA40	−61	−60	31		3.76

scores. In this analysis, the only brain regions significantly associated with social language used in postscan descriptions are within the mentalizing system, including LTPJ and DMPFC (Table 6). Taken together, these results demonstrate that higher levels of activity in regions associated with processes of mentalizing during idea exposure are positively associated with greater usage of words from the LIWC Social Processes category.

Discussion

The present study demonstrates that social cues in language can activate neural systems implicated both in understanding the mental states of others and successfully retransmitting ideas. Furthermore, neural activity within such brain regions is also predictive of subsequent uses of social language when retransmitting the ideas, beyond what is predicted from features of the initial language stimulus. These effects were specific to the "social processes" category of language, suggesting that the neural effects observed go beyond mere semantic priming, such that social language in particular may call to mind instances of social interaction and prime further consideration of the mental states of others. Our findings add to a growing body of literature examining not only the mechanisms of successful communication in dyads (Hasson et al., 2012; Stephens et al., 2010) but also how simulation of others' mental states may facilitate effective idea retransmission (Falk et al., 2013, 2012).

More specifically, we have demonstrated: (1) Individuals vary in the way they choose to use social language when asked to provide positive personal recommendations of products. (2) To the extent that these cues can be measured using a quantitative linguistic tool, such as LIWC, there is an association between the use of social language and levels of neural activity in regions connected to processes of social cognition or mentalizing that is specific to the social processes category (i.e., not an exclusive effect of semantic priming or parroting). (3) Neural activity in these same regions during idea exposure prospectively predicts the use of social language in subsequent description of the idea, and (4) does so above and beyond the linguistic features of the initial seed idea.

Consistent with past work examining verbal synchrony or linguistic style matching (Ireland et al., 2011; Niederhoffer & Pennebaker, 2002), in this study we observed a significant relationship between use of social language by one communicator (social language in) and that by the initial listener who subsequently becomes a retransmitter (social language out). Our results go beyond the effects of mere matching, however, and illustrate one strength of adding a neuroimaging perspective. We found that cues represented through the use of social language patterns (but not other types of language patters) are associated with neural activity in hypothesized regions of TPJ as indexed by an ROI analysis, as well as a whole-brain search. TPJ is a brain region commonly associated with mentalizing (Denny et al., 2012; Lieberman, 2010; Saxe, 2010; Saxe & Kanwisher, 2003; Saxe & Powell, 2006) and has also been associated with individual differences in successfully spreading one's preferred ideas (Falk et al., 2013, 2012). To strengthen our confidence in our theorized link from social language in to mentalizing processes, we also compared the region of TPJ associated with "social language in" in our study to prior studies of mentalizing using Neurosynth (Yarkoni, Poldrack, Nichols, Van Essen, & Wager, 2011). This analysis suggested that the probability of mentalizing given the coordinate activations observed is high.

Furthermore, activity within the TPJ during exposure to the initial product ideas predicted the degree of social language used when participants later described the products, above and beyond the language contained in the initial seed descriptions. In other words, although neural activity within the TPJ was strongly associated with both exposure to social language in and production of social language out, when controlling for social language in, the effects of TPJ were diminished; however, overall effects within the hypothesized mentalizing network ROI (bilateral TPJ, PCC, and PC), and within DMPFC in particular, were strongly positively predictive of social language out, controlling for social language in. Effects within DMPFC and left TPJ were also reflected in a whole-brain search for regions associated with subsequent use of social language during idea retransmission.

We interpret these findings in the context of our hypothesis that social language, in particular, may prime broader social cognition that goes beyond mere reproduction of language features and extends as well to social motivation and simulation of others' mental states. In past work, DMPFC has been implicated in considering others' attributes and motivations (Lieberman, 2010; Mitchell, Macrae, & Banaji, 2006; Spunt, Falk, & Lieberman, 2010). Lieberman (2010) argues that DMPFC, perhaps more than other subregions of the mentalizing system, may be associated with motivational states, and it is possible that the continued prediction of social language out by DMPFC after controlling for initial social language in reflects that social language is not merely reproduced, but also serves specific motivational ends for the speaker (e.g., to bond or look good by communicating good ideas in a compelling way to others).

More generally, our analysis predicting social language out, controlling for social language in, suggests that the brain goes beyond merely processing and reproducing low-level features of social language, i.e., lexical and semantic processing. Individuals respond to social language cues in a novel idea description by engaging systems associated with social cognition, which are then subsequently associated with social language out. Social framing of the idea, using words that have a shared association with instances of social interaction, appears to enhance processes of mentalizing as individuals are exposed to the idea. In turn, increased mentalizing while being exposed to and encoding a novel idea makes it more likely that in subsequently describing the idea to others, individuals will use social words to frame their description.

These data are consistent with the idea that in taking in and processing social cues speakers may automatically process social intent, but that additional types of social cognition may be involved in successful preparation for communicating social intent to others. The present investigation builds on prior work suggesting that neural activity within the TPJ and mentalizing system more broadly are associated with the successful spread of ideas (Falk et al., 2013). Future research that brings together the results observed here with metrics of successful propagation to future idea recipients will be of interest in confirming whether the activity within hypothesized mentalizing regions observed here is directly linked to being later prepared to understand the motivations of others and retransmit ideas accordingly.

Understanding the mechanisms underlying how social language is retransmitted may also contribute to a better understanding of the role of social language patterns in promoting social bonds and cooperation and successful communication more broadly. This could occur either directly through the reproduction of social language patterns, or through broader engagement of social cognition that facilitates a range of future behaviors.

At the level of language processing and reproduction, recent studies have found neural activity in the TPJ related to higher linguistic levels and functions (e.g., pragmatic aspects of communication and speech acts; Egorova, Pulvermuller, & Shtyrov, 2014; Egorova, Shtyrov, & Pulvermuller, 2013; Sassa et al., 2007). Exposure to linguistic cues that prime social connection (e.g., the social processes category of LIWC) may make understanding linguistic input and generation of linguistic output to connect with others all the more salient. Future work is needed to isolate and clarify the roles of specific linguistic features and task and contextual factors (i.e., idea sharing) in relation to the activity in the neural regions reported here. Such work could also link specific language inputs and outputs to real-world relevant behaviors known to covary with higher levels of theory of mind and with higher levels of activity within the brain's mentalizing system (Dietvorst et al., 2009). In addition, there is some overlap with the mentalizing regions focused on in the current investigation, particularly in the left hemisphere, and with regions associated with a range of lower-level linguistic phenomena (i.e., phonological, lexical, syntactic, and semantic; Friederici, 2011; Vigneau et al., 2006). Although we have focused on higher-level social motivations, it is likely that the physical proximity between regions involved in mentalizing and language processing could facilitate the types of effects observed here, and future work should engage such possibilities (Arbib, 2012).

At the level of broader motivations, we have conceptualized the LIWC category *social processes* not simply as a list of independent words which at the semantic level contain social elements but as markers that represent a part of an associative network of commonly co-occurring words in instances of language used describing social interaction. That is, our experience of communicative events describing instances of social interaction is partially organized and encoded around the frequent words and language patterns particularly associated with these discourses. This is the basis for our hypotheses concerning the mentalizing system and the idea that social language may not only beget more social language, but also broader social cognition. Although this suggestion is speculative beyond the scope of our current data, it is consistent with the cited linguistic models, data collected through collocational analysis of large-scale corpora, and links to work on associative learning and involved neural systems (e.g., Bar, 2007; Bar, Aminoff, Mason, & Fenske, 2007).

Links between social language and social cognition may be especially important in the context of preparing to retransmit ideas to others. The regions of TPJ that we observed to be associated with social language in, and predictive of social language out, have been previously implicated in successful message propagation (Falk et al., 2013). We suggest that mentalizing may be key in initially evaluating ideas and in preparing for future successful social interactions (Dietvorst et al., 2009). Future research that combines past findings regarding synchronization of socially oriented words and linguistic features in the communication literature (Cappella, 1996; Giles & Smith, 1979; Giles et al., 1991; Goode & Robinson, 2013; Niederhoffer & Pennebaker, 2002; Semin, 2007) with neuroscientific investigations of speaker–listener synchronization (Hasson et al., 2012; Stephens et al., 2010) will provide more robust evidence for a conceptual model that links language, neural activity, behavior, and relational outcomes. Future investigations that further compare such synchrony in the context of dynamic dyads with retransmission to specific and general others will also inform our understanding on the extent to which the mechanisms observed underpin successful communication in general, or are used selectively according to social goals.

Each of the discussion points above should be interpreted within the bounds of specific limits, however. Most notably with respect to the language variables, the variation in the amount of social language in the product descriptions was naturally occurring in different undergraduates—although this language captures a high degree of external validity, we did not experimentally manipulate the language features. A future study could manipulate this variation and create different versions of the product descriptions, which are high and low in the frequency of these words. This would control for the possibility that some types of products could be, by design and function, more social than others. Given the large number of products, and the variation in subsequent language used to describe products that were initially high and low in social language in, however, we believe the results will remain robust. In addition, although it has substantial advantages for parsimony, the use of a dictionary-based approach to linguistic quantification of social and psychological categories has some limitations in terms of domain coverage and the simplicity of the model of language usage (O'Donnell & Falk, in press). Future studies might also make use of other types of linguistic quantification (such as supervised machine learning classification) in combination with neuroimaging. With respect to the neuroimaging component of our work, as is characteristic of fMRI studies, we report findings based on a relatively small number (n = 19) of subjects. Likewise, as with most neuroimaging work, the psychological functions ascribed to the neural ROIs represent only one of several possible interpretations—the usual caution with respect to reverse inference that has been leveled at brain mapping studies applies equally to this work (Poldrack, 2006).

Despite these considerations, our findings make a novel methodological contribution, illustrating the combination of neural and linguistic tools to understand psychological responses to persuasive communication, message processing, and the spread of ideas. They highlight the importance of considering the role of social cues encoded in language patterns and the role of neurocognitive mechanisms associated with social processes for the discussion of successful communication.

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Note

[1] The data reported in this study come from the Products Task and were collected from the same participants and during the same scanning sessions as the TV Shows Task described elsewhere (Falk et al., 2013, 2012).

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Appendix. LIWC Social Processes category scores for product stimuli (in category words italicized)

Product	Description	LIWC Social score	Mean Social score in post-scan descriptions
Staircase Storage	I have a really small apartment, even though it's two floors. Storage under staircases has been around for years, but recently I read online about this new system that takes it one step further. It's a simple yet obvious idea. It's under-the-staircase drawer solution that uses each step as a storage drawer. The space underneath each stair is used as a drawer which is a great way to utilize a generally overlooked space. Step up and open the drawer which can be used for many and varied purposes with the only problem being remembering which drawer held what.	0	5.60 (*SD* = 3.20)
DVR Pen	The DVR Pen is awesome and perfect for lectures. It's a pen that is a digital video recorder capable of capturing video at 30 frames a second. It even has a microphone for capturing sound. It records to flash memory or micro-SD, and has a Bluetooth wireless transfer capability for videos that must go straight to the computer or mobile device. It was also designed to operate in low light, and has motion detection capability. It even has five different motion detection activities.	0	5.48 (*SD* = 4.09)
Periodic Element Rings	I'm sort of a geek, but I like to think of myself as a fashionable geek. I recently got one of the Periodic Rings, which are literal rings of chemical elements from the periodic table. I got the "Ag" one, which is silver. It looks exactly like the	2	4.24 (*SD* = 3.46)

(*Continued*)

Product	Description	LIWC Social score	Mean Social score in post-scan descriptions
	element box from the periodic table. These rings are also made of exactly what *they say* – so the platinum version is really expensive, but the silver and gold ones are a little more reasonable. I'm hoping someday that I can collect all three to become some sort of science teacher superhero.		
Doggy Treadmill	Sometimes I have so much to do that I don't have time to walk my dog. But I found out about this new doggy treadmill that's like a regular treadmill for *adults* except it has special features designed just for dogs. The treadmill is enclosed by a coated metal gate so that *your* pet will be safe while working out on the treadmill. It also comes with a safety leash that stops the treadmill when pulled. Now my dog can work out at home to keep in shape and I can finish my own work.	2.11	8.59 (*SD* = 4.96)
Flatwire	I don't like my room being cluttered with wires, but so far, I haven't found anything like a wireless power source. I recently found the next best thing though, flat wires. Since its first patent in 1995, FlatWire Ready has been winning awards and converts a unique approach to electrical wiring. The technology seems, pretty easy, even for *someone* like me to set up. I think *their* motto goes something like: Map it, Stick It, Click It, and Make it Disappear. At least I don't have to worry about tripping over any wires anymore.	2.15	6.58 (*SD* = 4.92)
STRIDA Bike	I want the STRIDA bike for going around campus and keeping in my apartment. This bike is ideal for short daily commutes because all the useful and practical features it has. The seating position and the mounted handlebars *provide* the rider with a good vantage point in traffic. The disk brakes *provide* a quick and smooth stop, not to *mention* that the bike can be folded in a matter of seconds. The STRIDA is completely collapsible and can be stored or transported in the small storage bag that comes with it.	3.3	4.32 (*SD* = 3.87)
Beard Cap		4.08	6.17 (*SD* = 2.92)

(*Continued*)

Product	Description	LIWC Social score	Mean Social score in post-scan descriptions
	I'm from the East Coast, so I'm always looking for stuff to keep warm when I go *visit* my *parents*, or just when I go skiing on vacation or whatever. If *you're* somewhere cold, or if *you* just have a thing for funny-looking headgear, check out the Beard Cap. It's made from Icelandic wool, and it's handmade, which I like. It's a woven cap that covers the entire head except for the eyes and nose, and features an awesome beard-like shape, complete with a woven faux mustache. I think it's unique looking and it makes me laugh.		
Nightlight Airbed	The Nightlight Airbed by Coleman is great if *you're* having a *guest* over or for *people who love* to camp like me. The mattress is really comfortable. The 8-inch-thick air coil design provides full body support and allows for a good night's rest. The Nightlight Airbed is also covered with soft suede to ensure maximum comfort. This mattress even has a built in flashlight that lasts up to 8 hours and is powered by only three AAA batteries. This product was made specifically for the outdoors so it is very durable, leak proof, and puncture-resistant.	5.15	6.16 (*SD* = 3.90)
Wall Decals	*You* can't really paint the apartment or dorm walls but Wall Decals are an instant way to glam up *your* room without damaging the paint or walls and getting charged for it. There are many cool styles and varieties like shirt designs or even chandeliers. *They* are removeable and reuseable, so *you* can change things around when *you* get bored or feel like redecorating. It's simple and takes only minutes. Wall decals make the walls really unique while avoiding the messiness of wall painting. It's great for dorms, apartments, studios, houses, or the office.	5.21	7.71 (*SD* = 4.70)
Powerstick	So I was thinking, "Wouldn't it be great to have a portable power source for my gadgets that didn't take up much space and was easy to charge?" So I looked around some and found "The	5.77	4.10 (*SD* = 4.16)

(*Continued*)

Product	Description	LIWC Social score	Mean Social score in post-scan descriptions
	Powerstick," it's a thumb-sized accessory that charges via the built-in USB connector and it can *provide* extra juice for lots of different devices, including my *cell phone* and iPod, and others that charge via mini-USB. I also like it because it has a simple fuel gauge graphic that *lets you* know how the charging is going and how much power *you* have left. It's genius.		
Belkin Mini Surge Protector	I kind of can't believe that no one has really made something like this before, but the Belkin Mini Surge Protector with USB Charger is really a pretty neat product that fulfills a need that I hadn't been able to fill before. It's basically a little power strip that expands one power outlet into three, but the surge bar also *offers* two USB ports for charging up *your* gadgets. So *you* can recharge *everything* at once, including *your* laptop, *phone*, ipod, whatever. It's pretty sleek looking and if *you're* a frequent traveler, this can be pretty useful.	7.22	5.93 (*SD* = 4.46)
Green Cell Battery	The Green *Cell* Battery is the perfect solution to the waste caused by discarded batteries. It's a single battery that is designed to fit all types of *personal* electronic devices. No more searching for chargers or buying different size batteries for each device. The Green *Cell* Battery is made without harmful chemicals, and it's eco-*friendly*. The batteries can be replaced or recharged at *your* local vending machine. So it's so convenient. This battery is the solution that *we* all have been waiting for, so go out and *help* make *our* world a better place.	8.42	7.26 (*SD* = 3.91)
Nokia Morph Phone	I found out about the concept *phone* Nokia was working on *called* Morph online. It's really advanced and uses exciting new nanotechnology. It comes in several cool, bright transparent colors, and it can morph shape. *You* can stretch it out to get a full keyboard and touch pad or fold it up and wear it around *your* wrist. It also features self-cleaning surfaces and saves energy as	8.6	7.10 (*SD* = 5.04)

(*Continued*)

Product	Description	LIWC Social score	Mean Social score in post-scan descriptions
	well by harvesting energy from the local environment. I can't wait for these *phones* to come out! *They said* this technology would be available soon.		
Flowbee	Flowbee is awesome; *you* can stay at home and cut *your* hair exactly the way *you* want. It's simple, easy, and precise. Flowbee uses a vacuum to suction hair up and uses a spacer to cut the desired length. The spacer makes it impossible to cut the hair shorter than the length it is set for. So *you* can't mess up or get a bad hair cut. *They* even have a specially designed spacer for a tapered cut. So now *everyone* in the *family* can cut *their* hair at home, even the *family* pet.	9.57	6.44 (*SD* = 3.90)
FPS Vest	I am really into video *games*. But I'm over holding those awkward controllers. So I was really excited to find out about the FPS Vests. *They're* strap-on vests that stimulate all the action from *your game*. Being hit by bullets, kicks and punches, explosions, and crashing into stuff. *They're* making more and more *games* that are compatible with the vests too. It really takes *your* gaming to a whole another level.	9.72	9.90 (*SD* = 4.85)
LCD Keyboard	There's a new keyboard in development that doesn't have any keys to it; it just consists of several large LCD screens. It's basically a rectangular LCD screen that's touch sensitive and can display any image *you* want to *interact* with on it. *You* can design *your* own keyboard *layout* or have different keys on each button specific to *your* need or wants. *You* can customize it any way *you* want to fit *your* personality or just to change it up when *you* are bored. It's capabilities are extremely different and new.	9.89	6.53 (*SD* = 4.24)
Nike Pedometer	I like how treadmills keep tracks of how long *you've* run and the calories *you've* burned, but I'd rather run outside. I've tried some pedometers but *they* were too bulky and big. However, Nike has come out with a small, discrete chip that *you* can stick on *your* shoes to transmit the distance *you've* run, calories *you've* burned, and the time to *your* iPod. It's	10.34	11.20 (*SD* = 4.43)

(*Continued*)

Product	Description	LIWC Social score	Mean Social score in post-scan descriptions
	great because it doesn't impede *your* running at all. Now I can run outside and get my numbers without the extra weight.		
Clocky	There's an alarm clock that actually gets me out of bed *called* Clocky. It's not like regular alarm clocks that go on *your* night stand, *you* can keep hitting the snooze button, keep on sleeping, and miss classes, flights, and appointments. After the first snooze, Clocky goes off and randomly rolls around, forcing *you* to get up to stop the noise. It's a good way to get *you* out of bed, it gets *your* blood pumping, chasing it around, it also *helps you* wake up and start *your* day. It's perfect for *people who* have trouble waking up.	11.22	6.33 (*SD* = 2.92)
Tap Project	I recently *heard* about a cool new program *called* the "Tap Project." Basically, while *we're* over here buying $2 bottles of water, more than a billion *people* all over the world have little or no access to clean water. The Tap Project *lets us* change that a bit, just by going out to dinner with *friends*. At *participating* restaurants, *you* can donate $1 for each glass of water served. The donations will be used to *provide* safe drinking water to poor areas. In fact, one dollar provides a *child* in need with 40 days of clean water, which is pretty cool.	11.22	6.20 (*SD* = 3.77)
Chatterbowl	I feel bad when I go to work and leave my pet home alone. But I found these new "*talking*" pet bowls *called Chatterbowls* that are the perfect gadgets for my pets *who* get lonely and anxious when left alone. These bowls are very simple to operate. The voice box is located underneath the bowl and can hold up to 10 *messages* from the pet's *owner*. When the pet approaches the bowl the voice box plays back the *owner's message*. Now *you* can leave *your* pet home alone having the peace of mind that *they* have company.	11.46	13.47 (*SD* = 6.43)
ATP Photofinder	The ATP Photo Finder is really cool. Basically, it's like having a geo-tagging feature for *your* digital camera. The ATP	14.74	9.35 (*SD* = 5.41)

(*Continued*)

Product	Description	LIWC Social score	Mean Social score in post-scan descriptions
	Photo Finder adds the necessary tags to *your* photos when *you* take *them*. Pretty much, *you* turn the Photo Finder on while *you're* shooting, then insert *your* memory card into the device when *you're* finished. It matches the time stamps on the pics with *your* location at the time, tagging each photo with *your* position so *you* can use tools like Google Earth to pinpoint exactly where *you* were when *you* saw that *guy*.		
ONElink Smoke Detector	My *friend* has the ONELink Carbon Monoxide and Smoke Detector system at her house and it's pretty cool. It takes *your* smoke detector wireless and *tells you* exactly what the problem is that *you* are dealing with. *They* have voiceovers which *tell you* both the location and type of danger occurring in *your* home. Also, this detector can be customized to *your* home so that it *tells you* the quickest route to get to safety. Every home or office needs the safety and security that the ONELink Carbon Monoxide and Smoke Detector can *provide*.	14.89	8.13 (*SD* = 3.94)
Kiddo Alarm	I always feel bad for the *kids* put on a leash. It looks silly. I think *they* should use the Kiddo alarm instead. It's from Smart Target and allows *parents* to keep track of wandering *children*, without the leash. The *adult* carries the *receiver* and the transmitter is worn by the *child*. *You* program a proximity range and the *adult* is automatically alerted by visual signal on the *receiver* whenever the *child* has stepped out of the invisible boundaries set up by the *parent*. *You* can keep *your child* safe with the Kiddo alarm system.	15.79	13.59 (*SD* = 6.19)
Digital Photo Key Chain	I found this one cool key chain where *you* can actually store up to 60 pictures in it. I thought it was interesting because *you* can input pictures of *your friend*s and *family* or whatever and carry it with *you* at all times. So when *you're* bored, *you* can just take it out for a trip down memory lane. Or *you* could *share* it with *people you* know or *meet* or show off *your* dog or something like that. And if	21	11.41 (*SD* = 6.42)

(*Continued*)

Product	Description	LIWC Social score	Mean Social score in post-scan descriptions
	someone doesn't remember *who you* are *talking* about, *you* can show *them* a picture of that *person* too, no problem.		
		M = 8.08 (*SD* = 5.37)	*M* = 8.44 (*SD* = 4.67) (for 405 descriptions)