

Language Style Matching in Writing: Synchrony in Essays, Correspondence, and Poetry

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Each relationship has its own personality. Almost immediately after a social interaction begins, verbal and nonverbal behaviors become synchronized. Even in asocial contexts, individuals tend to produce utterances that match the grammatical structure of sentences they have recently heard or read. Three projects explore language style matching (LSM) in everyday writing tasks and professional writing. LSM is the relative use of 9 function word categories (e.g., articles, personal pronouns) between any 2 texts. In the first project, 2 samples totaling 1,744 college students answered 4 essay questions written in very different styles. Students automatically matched the language style of the target questions. Overall, the LSM metric was internally consistent and reliable across writing tasks. Women, participants of higher socioeconomic status, and students who earned higher test grades matched with targets more than others did. In the second project, 74 participants completed cliffhanger excerpts from popular fiction. Judges' ratings of excerpt–response similarity were related to content matching but not function word matching, as indexed by LSM. Further, participants were not able to intentionally increase style or content matching. In the final project, an archival study tracked the professional writing and personal correspondence of 3 pairs of famous writers across their relationships. Language matching in poetry and letters reflected fluctuations in the relationships of 3 couples: Sigmund Freud and Carl Jung, Elizabeth Barrett and Robert Browning, and Sylvia Plath and Ted Hughes. Implications for using LSM as an implicit marker of social engagement and influence are discussed.

Keywords: individual differences, mimicry, language, LSM, LIWC

A conversation between two people is often like a dance. One person may introduce a topic, and the other adds to it. Multiple studies indicate that people in interactions tend to mirror each other in their nonverbal behaviors (e.g., Bernieri, 1988; Bernieri, Davis, Rosenthal, & Knee, 1994), the words they use (Niederhoffer & Pennebaker, 2002), and even their autonomic nervous system activity (Levenson & Gottman, 1983). Similarly, people automatically switch their speaking styles in the middle of an intimate conversation if they answer their phone and their young child or demanding boss is on the other end.

Giles and Coupland (1991) sought to explain the ways people vary in their speaking styles using their communication accommodation theory (CAT). They argued that people alter their speaking style in order to coordinate with and accommodate different conversants, essentially adapting their language style in order to create a “positive image” in the minds of others (McCroskey & Richmond, 2000, p. 279). Although much of CAT is, of course, accommodation, a substantial part of communication accommodation can also be considered a form of verbal synchrony. For example, McCroskey and Richmond (2000) reported that subordinates found supervisors more attractive and credible when their respective communication styles were characterized by matching degrees of assertiveness and responsiveness.

Evidence of language synchrony is apparent at surprisingly molecular levels. Bock (1986) and her colleagues (see Pickering & Ferreira, 2008) have focused on the degree to which grammatical structures in conversations are repeated between speakers across multiple turns. In order to explain why one sentence structure tends to persevere through several utterances, she formulated the idea of structural priming. Structural priming occurs when an individual's impromptu natural language use automatically matches the grammatical structure of a previous prime. Structural priming is quite resilient: Priming effects have persevered through 12 intervening trials and postpriming delays of up to 20 min (Bock & Kroch, 1989; Boyland & Anderson, 1998). While invaluable as a foundation for future mimicry research, structural priming was originally studied most often by recording the sentences individuals produced in monologue in laboratory settings, thus limiting the

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extent to which findings from this literature can be used to predict dialogue in the real world.

Language and Cognitive Coordination

It is generally accepted that a primary outcome of linguistic coordination in conversation is the cultivation of common ground (i.e., matching cognitive frameworks in which conversants adopt shared assumptions, linguistic referents, and knowledge), and that this complex of commonly understood information can be established either intentionally or automatically. Traditionally, common ground was thought to be achieved through perspective taking, resulting from individuals' intentional attempts to construct a mental model of another person's knowledge and assumptions (Clark & Brennan, 1991). In contrast, the interactive alignment model proposes that common ground is the automatic consequence of multiply matched cognitive representations (Pickering & Garrod, 2004). The idea that individuals in conversation become cognitively aligned through automatic processes fits well with evidence that the brain prefers quick and dirty over more expensive and precise computations (e.g., Ferreira & Patson, 2007; Gigerenzer, 2004).

Revisions of the traditional common ground framework propose an even less effortful route to establishing shared knowledge in dialogue. Evidence suggests that individuals are able to adapt seamlessly to another's language use very early in conversations and make rapid adjustments in response to set-backs, such as misunderstandings and speech errors, as conversations progress. People tend to carry out these adjustments with very little effort, often managing to accommodate another person's perspective using cognitively cheap "one-bit" adjustments (e.g., recognizing that the person they are talking to is an undergraduate or a nonnative speaker) (Brennan & Hanna, 2009).

Other work suggests that linguistic synchrony is apparent in the coordination of automatic physiological activity and nonverbal behavior during conversation. Respiratory kinematics researchers find that conversants' breathing patterns are highly correlated, either negatively (out of phase) or positively (in phase) (Yang, 2007). Breathing is most closely synchronized near turn-taking and periods of simultaneous laughter or speech, times when it is most evident that people have coordinated or matching mental states (McFarland, 2001; Warner, 1996). Further, several studies have found that individuals in a conversation tend to have highly coordinated postural sway (subtle postural adjustments people make in order to maintain an upright standing position) and match each other's eye gaze, even in cases where subjects could not see their partner (Brown-Schmidt & Tanenhaus, 2008; Richardson, Dale, & Kirkham, 2007; Shockley, Santana, & Fowler, 2003).

Matching eye gaze and similar coordinative processes are normally interpreted as indicators rather than causes of joint understanding. For example, Brown-Schmidt and Tanenhaus (2008) found that gaze coordination was related to faster resolution of referential ambiguity in a language game that required subjects to describe a visually complex game board to an unseen partner. There is some evidence that gaze coordination can also play a causal role, however. Richardson and Dale (2005) found that listeners were better able to comprehend a speaker when their eye gaze was manipulated to match the speaker's gaze. Shockley, Richardson, and Dale (2009) interpret these results as evidence

that individuals in conversation understand each other by temporarily becoming part of one "coordinative structure," made up of a complex of reciprocal mental state simulations that manifest themselves in postural sway matching and linguistic convergence.

Mimicry in Dyads

Social psychological research on mimicry and coordination has established that when people interact with one another, they naturally synchronize their verbal and nonverbal behaviors. This often takes the form of nonverbal mimicry. For example, a person leans back in her chair and her friend follows suit, often not noticing that he has done so. Indeed, individuals are normally unaware that they are mimicking, that they are being mimicked, or that mimicry has any meaningful effects (for a review of this literature, see Chartrand & van Baaren, 2009).

Mimicry in interpersonal interaction is enormously pervasive and generally benefits both the mimicker and the target of mimicry. Nonverbal and verbal mimicry occurs between friends (McFarland, 2001), unacquainted ingroup members (Lakin, Chartrand, & Arkin, 2008; Yabar, Johnston, Miles, & Peace, 2006), and strangers of indeterminate group membership (Bernieri et al., 1994; Chartrand & Bargh, 1999). As noted above, people mimic an array of nonverbal behaviors, ranging from posture (LaFrance, 1985) to breathing patterns (McFarland, 2001), as well as verbal behaviors including but not limited to vocal intensity, loudness, and prosody (Meltzer, Morris, & Hayes, 1971; Natale, 1975; Shepard, Giles, & LePoire, 2001). Nonconscious mimicry processes form the foundation of social influence: Individuals' affective states, beliefs, and behavioral tendencies are highly communicable, and mimicry is a primary instrument by which these contagions are spread. Among other functions, mimicry is a conduit for moods and emotions (Hatfield, Cacioppo, & Rapson, 1993), attitudes (Ramanathan & McGill, 2007), rapport (Chartrand & Bargh, 1999), and prosociality toward both the mimicker and others (van Baaren, Holland, Kawakami, & van Knippenberg, 2004; van Baaren, Holland, Steenaert, & van Knippenberg, 2003).

Throughout the human lifespan, mimicry is used as a nonconscious affiliation strategy. Mimicry is not an acquired tool, but is with us from birth. Infants less than 24 hr old entrain to their mother's voice (Condon & Sander, 1974). Frame-by-frame analysis of videos of mothers and two-day-old neonates interacting showed that infants coordinate their movements with maternal speech patterns. Affiliation and mimicry remain functionally linked during adulthood. Nonverbal mimicry occurs to a greater degree among ingroup members than outgroup members (Yabar et al., 2006) and can be used as a strategy to recover lost status within a social ingroup (Lakin et al., 2008).

In part through mimicry, individuals often become very different people when they become part of a dyad. For example, researchers have found that married couples' facial features become more similar over time, most likely as a result of frequent empathic mimicry (Zajonc, Adelman, Murphy, & Niedenthal, 1987). Through nonverbal cue coordination and skilled use of transactive memory systems (see Peltokorpi, 2008), romantic couples outperform randomly assigned partners on joint memory tasks (Wegner, Erber, & Raymond, 1991). Further, while long-term couples' personalities probably do not actually converge over time (Caspi, Herbener, & Ozer, 1992), there is evidence that baseline person-

ality similarity promotes relationship satisfaction by fostering emotional contagion and convergence (Gonzaga, Campos, & Bradbury, 2007).

In order to explore the personality of dyads and groups, researchers have devised statistical methods of assessing the ways in which dyads are more than the sum of their parts. Various models such as the latent group model (Gonzalez & Griffin, 2002), the social relations model (Kenny, 1994), and the actor partner interdependence model (Kashy & Kenny, 1999) allow researchers to explore the ways that each individual's personality and perceptions influence and are influenced by their partner. For example, in a recent study of romantic relationships, researchers used latent models of empathy to reveal that both partners' relationship satisfaction over time is influenced by male partners' perceptions of their own and their partner's empathy, while actual levels of empathy and baseline satisfaction had no significant effect (Busby & Gardner, 2008). Findings using latent models and similar methods suggest that the personality of a dyad is rarely the sum of each individual's personality, but rather results from the interplay among each individual's actual personality traits and perceptions of their own and their partner's personality (Gonzalez & Griffin, 2002).

Language Style Matching

The basic tendency to synchronize with others carries over into natural language, even occurring in relative solitude where one's only companion is a page or screen filled with words. An example of nonconscious verbal mimicry occurs after becoming immersed in the work of a powerful author. Most authors are themselves voracious readers and, as a result, often unknowingly mimic other authors in their own work. As Annie Dillard (1989) notes, "[the writer] is careful of what he reads, for that is what he will write" (p. 68). Often this inspiration goes beyond mere influence into nonconscious linguistic mimicry, sometimes called *cryptomnesia* (F. K. Taylor, 1965) or *inadvertent plagiarism* (Brown & Murphy, 1989). It occurs when memories of others' words and thoughts are mistaken for one's own ideas, and has been documented in both laboratory studies and the naturalistic settings (F. K. Taylor, 1965). Automatic mimicry is quite persistent, occurring even when participants are advised to consciously avoid plagiarism, when they know researchers are on the alert for it, and when they have nothing to gain by plagiarizing (Brown & Murphy, 1989).

An important distinction in the study of verbal mimicry is between language content and style. The content of a text refers to the basic information that is conveyed—*what* the author is writing about. At a word level, language content includes nouns, regular verbs, and many adjectives and adverbs. Language style refers to the way the content is conveyed—*how* the author is writing. Style markers in text include a broad class of words referred to as function, closed class, or junk words. Style words, hereafter referred to as function words, include pronouns, prepositions, articles, conjunctions, auxiliary verbs, and a small group of similar words that have virtually no meaning on their own.

The distinction between style and content words is psychologically important on multiple levels. First, brain damage research indicates that the two types of words are processed differently in different brain regions. Broca's area, situated in the frontal lobe, is more closely linked with the use of style words, whereas Wer-

nicke's area is implicated in the use of content words (Miller, 1995). Indeed, style words are social by their very nature. Consider the sentence: *He placed it on the table*. The words *placed* and *table* are standard content words that have shared meaning for most English speakers. The words *he*, *it*, *on*, and *the*, however, are style words that are essentially place holders which only have specific meaning for the speaker and the audience. Who is *he* and what is *it*? The speaker and listener presumably know, but those not privy to the conversation cannot. The fact that it is *the* table as opposed to *a* table further assumes that it is a specific table in question that, again, the rest of us are unable to identify. Function words, then, demand social knowledge and skill to understand and use.

Because function words are inherently social, it is not surprising that they are related to an array of both situational processes and stable individual differences. The use of pronouns and other function words, for example, has been found to be related to stress (Cohn, Mehl, & Pennebaker, 2004), depression (Rude, Gortner, & Pennebaker, 2004; Weintraub, 1981), sex and sexual orientation (Groom & Pennebaker, 2005; Newman, Groom, Handelman, & Pennebaker, 2008), aging (Pennebaker & Stone, 2003), honesty (Newman, Pennebaker, Berry, & Richards, 2003), social status (Kacwicz, Pennebaker, Davis, Jeon, & Graesser, 2010), leadership (Chung & Pennebaker, 2007), psychological and physical health (see Tausczik & Pennebaker, 2010), and an array of common personality dimensions (e.g., Fast & Funder, 2008; Pennebaker & King, 1999). When people are stressed, depressed, dominant, or deceptive, they tend to talk differently from when they are relaxed, happy, subordinate, or honest. Male and female, young and old, gay and straight, different people tend to use function words differently.

The researchers who have addressed the idea that language can be contagious have generally done so in modular ways that tell us about aspects of the phenomenon. We know what it feels and looks like, when it tends to happen, and how it occurs cognitively, but we have yet to study synchrony in the context of real-world social interaction. Dillard (1989), Twain (1910), and others have noted that literature strongly influences one's own writing style, often in obvious, obtrusive ways. Giles (2009) and other communications theorists have found that communication convergence is related to cooperation and shared ingroup membership. Pickering and Garrod (2004) as well as other psycholinguists generally interpret linguistic coordination as a mechanistic process that facilitates language processing and shared understanding in dialogue. Psychologists, however, have yet to integrate these diverse observations by studying linguistic synchrony and its relation with behavioral outcomes and individual differences in its natural environment. In this article, we describe a method for quantifying verbal synchrony between two or more people by counting and categorizing the function words each individual uses.

The synchronized use of function words is called *language style matching*, or LSM. Previous LSM studies involved both laboratory-based natural interactions using written instant message (IM) conversations and face-to-face conversations between President Richard Nixon and his aides from the Watergate Tapes (Niederhoffer & Pennebaker, 2002). Across social contexts, dyads engaging in natural conversation matched each other's use of selected function and emotion word categories almost immediately and continued to do so over the course of the conversation. Within the Watergate conversations, Nixon and his aides were more

highly correlated than experiment participants in several categories, but significant degrees of matching were found in both settings. In contrast with the nonverbal mimicry literature, LSM was unrelated to participants' and judges' ratings of communication quality or interpersonal liking.

In interactions with more objective measures of communication success, LSM has been shown to function in ways that are similar to nonverbal mimicry. In an analysis of crisis negotiation transcripts, negotiations were more likely to end nonviolently when police negotiators and hostage takers matched each other's language use, an effect likely related to those negotiators' greater success in persuading hostage takers to focus on common ground and consistently see the situation from a shared perspective (P. J. Taylor & Thomas, 2008). Similarly, small groups that collaborated on an information search task in a face-to-face context performed objectively better and reported liking their fellow group members more the more they matched each other's language use (Gonzales, Hancock, & Pennebaker, 2010). However, the specific circumstances under which nonverbal and verbal mimicry serve similar functions remain to be discovered.

Although the collected evidence suggests that linguistic mimicry is ubiquitous and related to a range of pragmatically important behavioral and cognitive outcomes, any comment on the causal role of LSM would be speculative at this point. Thus, in this article we will conservatively assume that LSM reflects rather than causes its related outcomes. To the extent that function words are the automatic output of innate mental processes, language style is likely to be highly resistant to confound-free manipulation. In this respect, a person's speaking or writing style is akin to personality. Personality traits and patterns of function word use are similarly subject to both stability and change (Fleeson, 2004). Although verbal mimicry and other situational factors cause individuals' function word use to vary significantly from conversation to conversation, individual differences in function word tendencies are largely stable across contexts (Pennebaker, Chung, Ireland, Gonzales, & Booth, 2007). For example, women have been found to use conjunctions such as *and*, *but*, and *so* at much higher rates than do men (Ireland & Pennebaker, 2010). Although a linguistically typical woman's conjunction use might decrease to masculine levels within the context of a conversation with a linguistically representative man, she is still likely to use conjunctions more frequently than does a typical man on average across a wide range of conversations.

The aims of the current article are to establish the psychometric properties of LSM and to investigate the practical role that LSM plays in close relationships. In the two studies that make up the first project, we explore the basic psychometric properties of LSM by using the relatively subtle manipulation of writing instructions. In addition to measuring the internal consistency of LSM, the first two studies identify individual differences that are potentially related to LSM and illustrate ways that linguistic coordination can be used as a dyad-level measure of individual differences among relationships. The second project explores the degree to which LSM can be consciously boosted and whether the effects are dependent on the content of language. In the third project, we track synchrony in the professional work and correspondence of three real-life pairs (two married couples and one pair of platonic friends) over the course of their lives together, noting variations in LSM as a function of relationship status and duration. Evidence

from this study brings us closer to answering the question of how LSM reflects and perhaps brings about changes in close relationships.

Project 1: The Psychometrics of Synchrony

The first pair of studies explored the idea that people naturally match the language styles of questions that are posed to them. Students answered four short-answer essay questions written in four distinct styles in an online class writing assignment. Although we hypothesized that participants would naturally answer essay questions in the style that the questions were asked, we also explored the possibility that style matching is a traitlike individual difference. Further, we predicted that individual differences assumed to be related to social skills would be related to LSM.

Studies 1a and 1b were conceptually similar and were run in the fall semesters of subsequent years at the University of Texas at Austin. In Study 1a, students responded to four class-related questions written in different styles and presented in the same order for all participants. Study 1b counterbalanced both the order of the questions and the questions' writing style. That is, the control question was always concerning the same topic and written in the same writing style, and each of the three remaining questions was asked about in each of the three experimental styles.

Method.

Study 1a. Participants for Study 1a were 850 undergraduate students at the University of Texas at Austin (303 men, 544 women, 3 unreported; age $M = 18.2$ years, $SD = 1.35$). The self-reported ethnic makeup of the sample was 51.1 percent White, 16.0 percent Asian American, 14.5 percent Hispanic, 3.6 percent African American, 2.0 percent American Indian/Pacific Islander, and 12.8 percent other or unreported. A majority of participants were college freshmen (71.3%) and sophomores (20.9%). Students participated as part of a class writing assignment in an introductory psychology course. Only data from students who gave consent to have their writing assignment used as part of research were included.

Study 1b. Participants for Study 1b were 871 undergraduates (306 men, 562 women, 3 unreported; age $M = 18.8$, $SD = 1.22$) enrolled in two introductory psychology classes taught by the same instructors one year later. The ethnic makeup was 51.2 percent White, 16.0 percent Asian American, 19.3 percent Hispanic, 5.9 percent African American, 1.0 percent American Indian/Pacific Islander, and 6.7 percent other or unreported. Most participants (69.9%) were college freshmen. Participants took part in this experiment as part of a writing assignment for class credit. Again, only students who gave their consent to have their writing assignment used for research were included.

Procedure. To participate, students for both studies visited the class website. After clicking on the appropriate link, they entered their school ID and were directed to the first of four brief essay questions. They were told that they would receive feedback on language style matching, but the term was not defined until after the study was completed. For Study 1a, questions were presented in the same order for all participants. For Study 1b, questions and writing style were counterbalanced. Course credit was assigned on the basis of participants' completion of the assignment rather than on the accuracy of their answers. In class, the instructors an-

nounced that responses would be spot-checked to ensure academic honesty. Fewer than 2 percent of spot checks revealed problems.

For each of the four questions, a timer appeared on the web page and the participants were asked to write for a minimum of 5 min. If they wrote fewer than 80 words or submitted their answer in less than 5 min, they were prompted to write more. Once they wrote the requisite number of words and submitted their response, participants progressed to the next question.

The writing assignment consisted of four essay questions regarding social psychological theories covered in a recent reading assignment. For both studies, the questions asked students to provide a personal example of the fundamental attribution error, social facilitation, cognitive dissonance, and interpersonal attraction. All questions included approximately four sentences to introduce each term. Each question was designed to be stylistically distinct. For Study 1a, all students responded to the following questions in the same order:

Fundamental attribution error (straightforward, scientific style): One of the main themes this semester has been human irrationality. People often make assumptions about others based on inaccurate or insufficient information. . . . Identify an example of the fundamental attribution error that may have occurred in your own life and relate it to the textbook definition that is quoted above.

Social facilitation (convoluted, confusing style): As described in the book, social facilitation results when a group of people (e.g., friends, strangers, maybe even enemies[?]) observe a person's behavior. If the behavior is well learned (i.e., well practiced), the behavior is usually (but not always) performed more quickly; if it is complex or not well learned . . .

Cognitive dissonance (informal, personal, ditty or "valley" style): OK, we haven't talked about cognitive dissonance much in class. . . . I mean, it's so cool because it's super easy to see how cognitive dissonance can make you do crazy

things . . . hmmm, like, make you enjoy something that you normally wouldn't. . . . Your turn. No lame examples. Please!!!

Interpersonal attraction (arrogant and pedantic): Since time immemorial, laymen have doggedly adhered to pearls of folk wisdom such as, "Birds of a feather flock together" or "opposites attract." These platitudes are unquestionably simplistic. Nevertheless, one of the two is bound to be a close approximation of the social psychological truth. . . .

As seen in Tables 1 and 2, the four excerpts differed in their function word use. Function word distinctions between the different question styles in Study 1b were more dramatic than in Study 1a. Whereas in Study 1a each question ended differently, in Study 1b, the final two sentences of all prompts were identical. This ensured that, despite the divergent styles, all participants had the same basic information about the four topics and were asked to provide the same information (i.e., a discussion of the term and a real-life example) regardless of the question's style.

When participants had completed all questions, their four responses were automatically analyzed by an online text analysis program, the Linguistic Inquiry and Word Count (LIWC; Pennebaker, Booth, & Francis, 2007). The degree of stylistic similarity, or LSM, between each matched question-response pair was then calculated with these LIWC results. On the basis of these analyses, participants received feedback about their LSM scores and the possible meanings of these scores. Students were encouraged to print out information about both LSM and the four psychological topics addressed. Discussion of LSM continued in class after the writing assignments were completed.

In order to explore a broad range of individual differences in LSM, we instructed students to complete two individual difference measures in addition to other questionnaires they completed over the course of the class. All individual difference measures reported here were completed prior to participating in the writing exercise.

Table 1

LIWC Results for Subjects and Prompts and LSM for the Four Writing Styles in Study 1a

Category	Prompts				Subjects			
	Control ^a	Convoluted ^b	Valley ^c	Pedantic ^d	Control ^a	Convoluted ^b	Valley ^c	Pedantic ^d
WC	119.00	129.00	123.00	106.00	164.87	132.71	140.84	151.79
WPS	19.83	43.00	15.38	21.20	21.92	22.73	22.36	20.68
Personal pronoun	2.52	1.55	9.76	6.60	12.98	8.73	13.30	9.76
Impersonal pronoun	8.40	5.43	10.57	3.77	6.23	6.10	6.78	6.93
Articles	10.08	10.85	3.25	8.49	6.39	7.33	5.39	5.85
Auxiliary verbs	5.04	6.20	8.13	5.66	9.64	10.28	9.46	9.06
Adverbs	2.52	5.43	8.13	1.89	5.93	5.74	6.29	4.55
Prepositions	11.76	11.63	7.32	19.81	12.95	14.16	12.88	13.44
Conjunctions	5.04	7.75	8.13	4.72	7.56	8.45	8.12	7.03
Negations	0.00	1.55	0.81	0.00	1.84	1.03	2.03	1.13
Quantifiers	5.04	3.88	4.88	2.83	2.81	3.78	3.06	5.70
LSM <i>M</i>					.63	.73	.69	.76

Note. All values except those for WC and WPS are percentages of total words in a given text. LIWC = Linguistic Inquiry and Word Count; LSM = language style matching; WC = word count; WPS = words per sentence.

^a Control refers to a plain, straightforward writing style. ^b Convoluted refers to a prolix, needlessly complex style. ^c Valley refers to a young, informal style. ^d Pedantic refers to a stodgy, more obscurely worded style.

Table 2
LIWC Results for Subjects and Prompts and LSM for the Four Writing Styles in Study 1b

Category	Prompts				Subjects			
	Control ^a	Convolved ^b	Valley ^c	Pedantic ^d	Control ^a	Convolved ^b	Valley ^c	Pedantic ^d
WC	197.00	256.03	227.70	194.79	186.55	162.16	159.54	152.17
WPS	17.91	41.93	24.02	17.76	23.53	23.02	22.33	22.94
Personal pronoun	5.08	1.45	10.39	3.27	12.89	12.04	11.55	11.29
Impersonal pronoun	6.60	3.92	10.84	6.50	6.24	5.93	6.55	6.32
Articles	7.61	10.3	2.94	6.50	6.64	5.85	6.02	6.19
Auxiliary verbs	3.55	3.96	15.8	9.07	9.29	9.36	9.61	9.00
Adverbs	6.60	4.78	8.93	2.02	5.67	5.65	5.83	5.31
Prepositions	10.15	17.31	8.93	13.68	13.05	13.60	13.44	13.66
Conjunctions	7.11	9.38	6.57	6.49	7.54	7.99	7.92	7.56
Negations	0.51	1.15	1.46	0.51	1.74	1.42	1.44	1.38
Quantifiers	3.55	8.34	3.22	5.28	2.65	4.13	3.90	4.16
LSM <i>M</i>					.73 _b	.67 _c	.75 _a	.72 _b

Note. All values except those for WC and WPS are percentages of total words in a given text. For mean LSM scores, different subscripts indicate significant differences in matching across the four writing styles. LIWC = Linguistic Inquiry and Word Count; LSM = language style matching; WC = word count; WPS = words per sentence.

^a Control refers to a plain, straightforward writing style. ^b Convolved refers to a prolix, needlessly complex style. ^c Valley refers to a young, informal style. ^d Pedantic refers to a stodgy, more obscurely worded style.

The questionnaires included the Ten-Item Personality Inventory (TIPI; Gosling, Rentfrow, & Swann, 2003), which is a brief inventory of Big Five personality dimensions, and the Social Skills Assessment (SSA). Although less nuanced than longer, multifaceted personality inventories, the TIPI has been found to have adequate reliability and convergent validity (see Gosling, Rentfrow, & Swann, 2003) and was well suited to the purpose of demonstrating personality assessment briefly as part of a larger class exercise.

The SSA is a 15-item scale created in our lab that assesses the degree to which individuals consider themselves to be competent, flexible, and at ease in social settings. Participants responded using a 5-point Likert-type scale ranging from A (*strongly disagree*) to E (*strongly agree*). Representative items include “I’m able to adapt easily to new settings with unfamiliar social rules” and “Small talk with strangers (like on a bus or plane) makes me uncomfortable” (reverse-scored). The current version is adapted from the SSA originally used by Niederhoffer and Pennebaker (2002). The psychometrics of the current scale are good (Cronbach’s $\alpha = .75$ and $.84$ in Studies 1a and 1b, respectively).

Analytic strategies. The primary goal of the first project was to establish the basic psychometric properties of LSM and to determine whether any major individual differences are associated with style matching. As mentioned earlier, LSM measures stylistic similarity between two texts by comparing their respective function word use. The 2007 version of LIWC (Pennebaker, Booth, & Francis, 2007) calculates the percentage of words in a text that fall into each of 15 function word categories, several of which overlap hierarchically (e.g., first-person singular pronouns are a subcategory of personal pronouns). The nine nonoverlapping function word categories—personal pronouns (e.g., *I, you*), impersonal pronouns (e.g., *this, it*), articles (e.g., *a, the*), auxiliary verbs (e.g., *am, have*), high-frequency adverbs (e.g., *very, well*), prepositions (e.g., *in, around*), conjunctions (e.g., *but, while*), negations (e.g., *not, no*), and quantifiers (e.g., *many, few*)—were used to assess LSM. The categories that make up the LSM metric were not

selected on any theoretical basis but were used in order to capture as completely as possible the stylistic elements of individuals’ language use, as defined by the basic function word categories in the English language.

Separate LSM scores were initially calculated for each of the nine function word categories. Each is a simple weighted difference score, computed by first dividing the absolute value of the difference between the same category in two text samples by the sum of those two values and then subtracting this dividend from one, such that higher scores correspond with higher degrees of LSM. For example, the LSM score for prepositions (preps) between two texts, 1 and 2, would be calculated as follows:

$$LSM_{preps} = 1 - [(|preps_1 - preps_2|) / (preps_1 + preps_2 + .0001)]$$

In this formula, $preps_1$ equals the percentage of prepositions in the first text, and $preps_2$ is the percentage in the second. In the denominator, .0001 is added in order to prevent empty sets that would occur if the value for the category in question made up zero percent of each text. LSM scores for each of the nine function word categories are finally averaged to yield a composite LSM score representing the stylistic similarity between two texts.

Note that if both texts being compared contain zero percent of any given LSM category, then LSM for that particular category will be 1.0. Because one function word category, negations, was not used in two of the Study 1a prompts, negations were excluded from the LSM computations for those questions. In Study 1b, on the other hand, negations were used at least once in all of the prompt questions, and the original nine-category LSM was consequently used for each question.

Although it resembles common measures of effect size, the final LSM score is a simple absolute difference score, weighted by each category’s overall frequency. Weighting each LSM calculation ensures that differences in lower frequency categories matter more than do comparable differences in higher frequency categories. For example, a 2 percent difference between two individuals’ use of negations, which make up about 3 percent of spoken conversation,

is more meaningful than is the same discrepancy for personal pronouns, which make up nearly 14 percent of words used in conversation (Pennebaker, Chung, et al., 2007).

In the current study, LSM scores were based on the function words used in each matching question–response pair. To illustrate, for each of LSM’s nine function word categories, LIWC results for the 119-word control question (concerning the fundamental attribution error) were compared against LIWC results for each of the 871 responses to that question using the LSM formula described earlier. The mean of the nine word-level LSM scores were then averaged, yielding a mean question-level LSM score. Finally, an overall mean LSM score was calculated for each participant on the basis of the average of the four question-level LSM scores.

Results. The results are divided into three questions. The first concerns the internal consistency of LSM scores themselves. The second question regards the degree to which style matching varies as a function of writing style and individual differences in participants’ tendency to match the writing style of questions. The final question addresses whether and to what degree LSM is related to selected individual difference measures.

Internal consistency of LSM measures. The first question concerns the comparability of the word-level LSM scores. That is, to what degree do the LSM scores for prepositions correlate with LSM scores for personal pronouns, articles, and so on? Recall that nine separate word-level LSM scores can be computed for each of the four questions. Using Cronbach’s alpha, the LSM metric was generally internally consistent, particularly in the second study. Mean reliability was modest (Cronbach’s $\alpha = .49$, $SD = .15$) for Study 1a and good (Cronbach’s $\alpha = .61$, $SD = .12$) for Study 1b. Greater reliability in Study 1b may have resulted from the longer questions and correspondingly longer responses. Overall, reliability in this pair of studies suggests that the more participants match a prompt in one function word category, the more they are likely to match the same prompt in LSM’s eight other function word categories as well.¹ These statistics provide confidence in the basic psychometric properties of LSM.

Reliability across questions. A second reliability question concerned whether participants would match consistently with questions written in different styles. Average reliability across questions for Studies 1a and 1b was low (Cronbach’s $\alpha = .32$), reflecting that different questions and writing styles tended to elicit different degrees of style matching. In Study 1b, questions were counterbalanced for style and topic in order to test the hypothesis that LSM varies as a function of writing style. Mauchly’s (1940) test determined that the assumption of sphericity had been violated, $\chi^2(5) = 32.11$, $p < .001$. The Greenhouse–Geisser (1959) correction for degrees of freedom was used ($\epsilon = .98$). A repeated measures analysis of variance (ANOVA) determined that writing style has a significant impact on LSM, $F(2.92, 2514.46) = 267.57$, $p < .001$ (see Table 2). Using a Bonferroni correction, pairwise t tests showed that participants matched more with the valley style questions ($M = .75$, $SD = .07$) than with the convoluted style ($M = .67$, $SD = .07$), $t(860) = 24.80$, $p < .001$; the pedantic style ($M = .72$, $SD = .06$), $t(861) = 9.82$, $p < .001$; or the control question ($M = .73$, $SD = .06$), $t(862) = 5.87$, $p < .001$. Further, LSM was significantly higher for pedantic than for convoluted prompts, $t(861) = 17.10$, $p < .001$.

LSM as an individual difference. A key benefit of using a repeated measures design was that it allowed us to assess whether

LSM is a traitlike individual difference. That is, are certain people chronically high or low style matchers regardless of contextual influences on LSM, such as differences in the prompts’ writing styles? To answer this question, we used a one-way analysis of covariance model with random effects. Controlling for the effect of question style on LSM, a significant proportion of the variance in LSM among questions was due to between-subjects variance (intra-class correlation coefficient = .45, Wald = 15.29, $p < .001$). Results demonstrate that the effect of individual differences in participants’ tendency to match prompts’ language use was comparable in significance to the effect of writing style on LSM scores reported earlier. In other words, LSM appears to be a product of the person as well as the situation.

Individual difference correlates of LSM. To address our exploratory questions about individual differences in matching, we correlated each person’s mean LSM scores with the personality and individual difference variables assessed in Studies 1a and 1b. As can be seen in Table 3, those who made higher class grades (based on four multiple-choice exams) and those of higher socioeconomic status (SES), as measured by parents’ education level, tended to match more overall (Cohen’s $d = 0.27$ and 0.17 , respectively). Note that parents’ education level is considered one of the stronger proxies for SES among college samples (see Hauser, 1994; Myrberg & Rosén, 2008). Women had slightly higher LSM than did men in Study 1a and significantly higher LSM in Study 1b (Cohen’s $d = 0.08$). By and large, no personality measures were consistently associated with LSM, including the SSA and most dimensions of the Big Five scale. One exception was neuroticism, which was negatively correlated with LSM in both Studies 1a and 1b (Cohen’s $d = -0.10$). Extraversion was positively correlated with LSM in Study 1b but was unrelated in Study 1a (Cohen’s $d = 0.06$). Finally, conscientiousness was negatively correlated with LSM in Study 1a but was not in Study 1b (Cohen’s $d = -0.09$).

Discussion. The two studies provide support for the prediction that people naturally match the writing styles of the questions that they answer. Results demonstrate that LSM is psychometrically sound. Reliability analyses revealed that LSM is internally consistent: People who matched a question’s personal pronoun use also tended to match the question’s usage of articles, prepositions, and other function words. Studies 1a and 1b also provided evidence for the hypothesis that LSM is, to a certain degree, a traitlike tendency. Further, the higher participants’ class grades and SES, the more they tended to match. Women matched significantly more than did men in Study 1b. Finally, whereas most traditional personality measures, such as extraversion and conscientiousness, were not

¹ Although internal reliability for LSM is adequate, particularly for a behavioral measure, it would be considered low for many more traditional self-report measures. To explore the possibility that people match with certain clusters of categories at different rates than other clusters, we conducted a series of principal components factor analyses for responses to each writing style in Studies 1a and 1b. Matching with the nine categories generally clustered into two or three factors. The only consistent finding was that LSM for personal pronouns and quantifiers loaded positively on the same factor across all writing styles, which is not readily interpretable. Factor loadings for other categories were seemingly random. Based on these analyses, analyzing LSM holistically appears to be the most psychometrically sound and parsimonious approach.

Table 3
LSM Correlations and Effect Sizes for Individual Difference Measures in Projects 1 and 2

Individual difference	Project 1		Project 2	Overall <i>r</i>	Mean <i>d</i>
	Study 1a	Study 1b			
Sex ^a	.01	.07*	.32**	.05**	0.27
Average exam grade	.23**	.12**		.17**	0.35
Parents' education ^b	.10**	.07*	.07	.08**	0.16
Social skills ^c	.00	-.02	.32**	.01	0.21
Big Five scores ^d					
Extraversion	-.02	.08*	—	.03	0.06
Neuroticism	-.07 [†]	-.04	—	-.05**	-0.10
Agreeableness	.02	.02	—	.02	0.03
Openness	.00	-.02	—	-.01	-0.02
Conscientiousness	-.09**	.00	—	-.05*	-0.09

Note. Dashes indicate that the individual difference was not assessed. LSM = language style matching.

^a Sex was dummy-coded as 0 = men, 1 = women. ^b Mother's and father's mean education level was used to assess socioeconomic status. ^c In Project 1 the Social Skills Assessment was used, and in Project 2 the Brief Social Skills Assessment was used. ^d Big Five scores are based on the Ten-Item Personality Inventory (TIPI). The TIPI was taken prior to the study as part of a separate class assignment. Not all participants completed both the TIPI and the writing assignment in Project 1; for the TIPI correlations in Studies 1a and 1b, $n = 691$ and 612 , respectively.

[†] $p < .10$. * $p < .05$. ** $p < .01$.

consistently linked to LSM, neuroticism was modestly negatively correlated with LSM across both studies.

LSM occurs in response to a number of distinct writing styles. Moderate to high degrees of matching were observed in both Studies 1a and 1b. In Study 1b, clear style-based LSM differences emerged, with greater matching for the valley style (i.e., youthful and informal) prompt. The implicit ingroup membership of the questions' authors may explain this finding. Nonverbal mimicry tends to be greater for ingroup than outgroup members (Yabar et al., 2006). Students may have matched more with the valley-style prompt because its author was more likely perceived as a youthful, potential ingroup member than were the other authors, who may have been perceived as more professorial.

Further evidence for the role of group membership in style matching comes from the convoluted and pedantic prompts in Study 1b. These prompts were similar in terms of function word use, and LSM between the two sets of prompts was moderately high ($M = .71$). Further, questions concerned the same topics and used similar content words. Despite these linguistic similarities, matching with pedantically written questions ($M = .72$, $SD = .06$) was significantly higher than with the convoluted prompt ($M = .67$, $SD = .07$). Given the function word similarity between the prompts, differences in LSM cannot be explained by the linguistic content of the prompts alone. However, the implicit meaning of the different writing styles may be responsible for the different rates of matching. The two writing styles sounded like different people despite word-level similarities: The pedantic author was condescending but straightforward, whereas the convoluted author was maddeningly scatterbrained. Language processes such as LSM are principally communicative behaviors. Participants may have matched with the pedantic style more because they identified more with its author's implied personality, were less alienated by his/her likely group membership, or merely liked the author more (Chartrand & van Baaren, 2009; Yabar et al., 2006).

Recall that LSM taps the degree to which people naturally entrain their writing style with that of the target question. Those

with consistently higher LSM scores, then, should naturally be more sensitive to others' speaking or writing styles. We expected LSM to be related to individual differences that are conceptually related to this kind of sensitivity. Across both studies in Project 1, higher LSM scores were associated with better grades in the courses and social class. In two of the three laboratory studies, the second study of Project 1 and Project 2, women tended to have higher LSM scores than did men.

The pattern of effects is promising along several dimensions. Other researchers have found links between language and social class. Sénéchal and LeFevre (2002) found that the volume and variety of words spoken by parents at home is positively related to SES. One possibility is that more linguistically adept parents may have fostered their children's tendency to become engaged in academic tasks, leading to both higher essay-writing LSM and better exam scores. However, controlling for students' grades did not significantly diminish the SES-LSM relationship. Further, the course exams were all multiple choice and were unrelated to students' performance on writing assignments.

The course grades, sex, and social class effects address a broader social attunement dimension that LSM may reflect. The psychology classes that the students were taking were taught by upper-middle-class men in an environment that rewards students for doing well on exams. The course, and to a certain extent the exams, asked students to think like psychologists, as represented by their textbook and instructors. Those who naturally respond to variations in language style across writing assignment questions may be the same people who can adopt the general thinking styles of their instructors. Indeed, this process may be simpler for those whose own social class is most similar to their professors'.

The negative relationship between neuroticism and LSM is supported by evidence that neuroticism interferes with social attunement. Neuroticism is characterized by ruminative self-focus (Teasdale & Green, 2004) and attentional noise (Flehmig, Steinborn, Langner, & Westhoff, 2007), which may limit neurotic individuals' ability to fully engage with another person in conver-

sation. Insofar as style matching reflects a person's level of engagement in a dialogue (Niederhoffer & Pennebaker, 2002), LSM should be negatively correlated with neuroticism. Although the effects in this project were small, the consistent negative relationship between neuroticism and LSM suggests an underlying link that may reveal itself more clearly in highly social situations.

In the previous two studies, professors' questions and participants' responses constitute a thin slice of the semester-long interaction between professor and student. The correlation between LSM, social status, and exam grades suggests that verbal matching, like nonverbal mimicry, is associated with ingroup membership and affiliation motivation. Mimicry occurs to a greater degree when a person is attracted to (Karremans & Verwijmeren, 2008) or is otherwise motivated to ingratiate themselves with the target of mimicry (Lakin et al., 2008). If verbal mimicry is modulated by the same motivations that drive nonverbal mimicry, then the degree to which students matched or failed to match the essay questions' writing styles may reflect students' desire to affiliate with their professors and, more broadly, their university.

Findings from this study reveal that LSM occurs in the absence of direct communication, is internally reliable, and is likely a traitlike behavioral tendency. Results also suggest that LSM is related to group membership and may reflect a general tendency to be more socially attuned. If good students match with the language used in essay questions more than do worse students, it may be that, all other things being equal, businessmen match more with *Wall Street Journal* articles than do schoolteachers, conservatives match more with Newt Gingrich's language use than do liberals, and so on. However, it is unclear whether the relationship between test grades and style matching indicates that LSM has a strategic component or is the result of nonconscious affiliation motivations. The following project's primary purpose was to test the hypothesis that LSM can be deliberately controlled and to investigate the relationship between content and style matching.

Project 2: Matching With Fiction

The previous studies demonstrate how style matching works when students communicate remotely with a professor in the formal context of a class assignment. However, it was unclear whether LSM was automatic or resulted from participants' conscious efforts to match the prompts' writing styles. This study sought to determine whether people can match the writing style of a text when explicitly told to do so. Participants read short excerpts from best-selling novels and then were asked to complete the story in their own words. Half of the participants were told to pay attention to the author's writing style and to mimic it as closely as possible, and half were asked only to complete the story. If style matching is a controlled process, explicit instructions to match the writer's style will result in higher LSM.

A second limitation of the first project is that our data cannot disentangle style matching from content matching. When people entrain to the topic of a target text, function word matching may naturally follow. There is no question that content matching is a common feature of everyday conversation. Indeed, one of Grice's (1975) maxims is that for two people to maintain a coherent conversation, both must communicate only relevant information, thereby adhering to the same topic and using similar content words.

Within the world of artificial intelligence, virtually all attempts to understand and measure the similarity of text samples have focused on language content (e.g., nouns, verbs). One of the more widely used content matching approaches is based on latent semantic analysis (LSA; Foltz, Kintsch, & Landauer, 1998; Landauer & Dumais, 1997). LSA is akin to a factor analysis of content words (see Campbell & Pennebaker, 2003). In this study, we compared content themes from fiction excerpts and participants' responses using the University of Colorado's online LSA tool (lsa.colorado.edu). In computing text similarity, LSA relies on different comparison samples to establish the factor structures of a variety of content themes. For the purpose of the current study, we chose the English literature semantic space, which is based on selections of hundreds of popular and classic books and short stories, as the reference sample.

Another standard way of assessing similarity between texts is to obtain judges' ratings. As noted, people process function and content words differently in a number of ways. Most strikingly, function words are processed fluently and automatically, whereas content words are processed relatively more effortfully and are consequently more salient in both production and comprehension (Levelt, 1989; Van Petten & Kutas, 1991). As a result, judges' subjective ratings are more likely to reflect content than style matching. In order to test whether LSM is a nonredundant addition to researchers' arsenals, we compared judges' ratings of similarity with LSA and LSM.

In the following study, our primary aims were to determine whether LSM will be higher when participants are instructed to match the story they are completing and to test the prediction that content matching (measured by LSA) rather than function word matching (measured by LSM) will be positively correlated with judges' ratings. Our final goal was to replicate the individual difference correlates found in Project 1.

Method. Participants were 74 University of Texas at Austin students (34 men, 39 women, 1 unreported). Students participated as part of the introductory psychology research credit option. Mean age was 19.4 years ($SD = 2.7$). The self-reported ethnic makeup of the sample was 60.3 percent White, 20.5 percent Hispanic, 11 percent Asian American, 4.1 percent African American, and 4.1 percent other ethnicities. Of these original 74 participants, 61 completed the first reading and writing task, 67 completed the second, and 65 completed the third. Some data were lost from 11 participants due to computer errors. No data were excluded.

Procedure. After signing up for an online experiment described as being about language and literature, students completed a general demographic questionnaire before progressing to the actual experiment. After reading a brief summary of the nature of the experiment and the tasks involved, students completed the Brief Social Skills Assessment (BSSA), a brief version of the SSA used in Studies 1a and 1b. The SSA was reduced to nine questions in order to shorten the questionnaire period prior to the reading and writing tasks, which required more time than did those in Studies 1a and 1b. Reliability for the nine-item BSSA remained good (Cronbach's $\alpha = .84$).

After completing these questionnaires, students were presented with the first experimental task. They were asked to read a short excerpt from a best-selling novel and then were randomly assigned one of two possible instructions:

Instruction 1 (No manipulation): Please finish the story. Be realistic about what likely happened in the scene after the one you just read.

Instruction 2 (Intentionality manipulation): Please finish the story the way the author intended. Be realistic about what likely happened in the scene after the one you just read. It's important that you maintain the author's voice and style: Write as though you are the author.

The three 20th-century American novels from which excerpts were taken varied significantly in writing style and content. All excerpts were roughly 800 words and were between one and two single-spaced pages long. The excerpt from Stephen King's (1986) *It* tells the emotional story of a woman choosing between her career and returning home to pursue a childhood monster. Dialogue dominates the excerpt. The excerpt from Elia Kazan's (1967/1985) *The Arrangement* is the wistful story of a deteriorating romantic relationship. In the third excerpt, from Arthur Hailey's (1968/2000) *Airport*, a man constructs a bomb. The story is largely a dry recitation of a homemade bomb recipe.

Each participant was randomly assigned an intentionality instruction for each of the three excerpts. Participants were given 7 min to complete the writing task. The order in which participants completed the reading and writing tasks was counterbalanced. After completing the three tasks, participants were debriefed and thanked.

Ratings. Three raters were recruited via Craigslist.com. All were familiar with professional writing and English literature: Two had received undergraduate degrees in English, and a third had editing and journalism work experience. Prior to their participation, raters were naïve to LSM research and to the purposes of their ratings. All judges were White women between the ages of 21 and 25.

Judges rated participants' responses for their similarity to the prompts in terms of writing style and quality on a 7-point Likert-type scale. The four items were "How stylistically similar was Part B to Part A?" (1 = *very dissimilar*, 7 = *very similar*), "How likely is it that Part A and Part B were written by the same author?" (1 = *very unlikely*, 7 = *very likely*), "How well-written was Part B?" (1 = *very poorly written*, 7 = *very well-written*), and "Compared with the writing quality of Part A, Part B was _____" (1 = *much worse*, 7 = *much better*). Part A was the original excerpt, and Part B referred to participants' responses.

Results. This study aimed to (a) investigate whether people's tendency to match the writing style of the target writer could be manipulated using writing instructions, (b) disentangle content and style matching by comparing both with judges' subjective similarity ratings, and (c) replicate individual difference correlates from Project 1.

Intentionality. The first goal of this study was to determine the degree to which LSM could be manipulated by instructing participants to match the excerpts' writing styles. To test this, mean LSM scores for control and instructed match conditions were compared using a paired-samples *t* test. On average, LSM did not differ between conditions (instructed match LSM $M = .77$, $SD = .07$; control LSM $M = .78$, $SD = .06$), $t(72) = 0.16$, *ns*. Note that there was a trend toward participants matching more with the prompts following the control instructions, providing tentative

evidence against the conscious control argument. Analyses between conditions using the content-matching LSA coefficients found no effects (match LSA $M = .50$, $SD = .05$; control LSA $M = .49$, $SD = .04$), $t(72) = -0.51$, *ns*.

Content vs. style matching. To disentangle content and style matching, LSA analyses compared each of the three stories with participants' responses to those stories. Mean LSA per participant was used as a general metric of each writer's tendency to match the content words of the excerpt he or she had just read. Mean LSA coefficients were moderate ($M = .50$, $SD = .07$). The lowest LSA coefficients were for the *Airport* excerpt (LSA $M = .45$, $SD = .07$), and the highest LSA scores were for responses to *The Arrangement* excerpt ($M = .53$, $SD = .08$) and *It* ($M = .51$, $SD = .08$). Across the three stories, LSA was only modestly reliable (Cronbach's $\alpha = .44$). Differences in LSA scores across writing prompts were comparable to differences in LSM (Cronbach's $\alpha = .37$), with participants matching the style words in *The Arrangement* ($M = .80$, $SD = .08$) and *It* ($M = .81$, $SD = .07$) more than those in the drier excerpt from *Airport* ($M = .70$, $SD = .08$).

To test the prediction that content word matching but not style word matching would be associated with judges' ratings, LSA and LSM were each entered alone and then together as predictors in linear regressions predicting judges' similarity ratings (see Table 4). The four ratings of excerpt-response similarity were highly consistent for each of the three excerpt-response pairs (Cronbach's $\alpha M = .93$; $SD = .02$) and were averaged to yield a composite similarity rating for each excerpt. The three composite similarity ratings were then averaged to yield one average similarity rating for each subject. In a linear regression, LSM failed to significantly predict ratings ($b = 0.15$), $t(71) = 1.24$, $p = .218$. LSA significantly predicted judges' ratings of excerpt-response similarity ($b = 0.34$), $t(71) = 3.03$, $p = .003$, and continued to predict judges' ratings when LSM was included in the model ($b = 0.38$), $t(70) = 2.77$, $p = .007$. Results suggest that ratings of similarity reflect judges' perception of content matching rather than stylistic similarity.

Individual differences. Correlations were computed between LSM scores and the various individual difference measures (see Table 3). Sex was significantly positively correlated with LSM, with women coded as 1 and men coded as 0, $r(71) = .32$, $p = .006$. Additionally, social skills, indexed by the BSSA, was positively

Table 4
Linear Regression Models Predicting Judges' Similarity Ratings in Project 2

Model and predictor	<i>b</i>	<i>SE</i>	<i>p</i>
1			
Constant	0.19	1.68	.913
LSM	2.69	2.17	.218
2			
Constant	-0.59	0.95	.536
LSA	5.76	1.90	.003
3			
Constant	0.09	1.61	.958
LSM	-1.32	2.53	.603
LSA	6.45	2.33	.007

Note. LSM = language style matching (style matching); LSA = latent semantic analysis (content matching).

correlated with mean LSM for the three excerpts, $r(66) = .32, p = .008$.

Discussion. The present study replicated and extended findings from Project 1. First, results suggest that LSM cannot be deliberately controlled. Second, LSA, a measure of content matching, but not LSM was positively related to judges' ratings of excerpt–response similarity. Finally, as in Study 1b, women tend to match more than men do. Self-reported social skills, measured via the BSSA, also emerged as a correlate of LSM.

The link between LSM and social skills appears to be consistent with past empathy research. Previous work has found that empathy is correlated with other forms of interpersonal mimicry (Sonnyby-Borgström, Jönsson, & Svanesson, 2003). Given that function words reliably reflect individual differences in thinking styles (Pennebaker & King, 1999), mimicking another person's linguistic style may indicate that an individual has, at least momentarily, adopted that person's way of thinking.

The finding that judges' ratings of synchrony or interaction quality are unrelated to LSM is consistent with previous evidence that outside observers are poor judges of function word synchrony (Niederhoffer & Pennebaker, 2002). Observers' inability to monitor LSM is likely attributable to differences in the ways individuals perceive function and content words. Function words are generally short, are frequently used, and have little semantic content outside the context of a sentence. As a result, function words are processed quite fluently and are less salient than content words in both comprehension and production (Van Petten & Kutas, 1991).

Studies in Project 1 have demonstrated that LSM occurs in controlled laboratory settings with college students. Outside the lab, however, individuals' goals and emotions likely affect LSM in more complex ways. Mimicry is known to vary widely as a function of situational pressures, personal goals, and emotional states. Emotional contagion has been found to occur to a lesser degree for negative emotions (Kimura & Daibo, 2006), particularly when expressed by outgroup members (Bourgeois & Hess, 2008). Other mimicry research has found that liking increases mimicry and that mimicry leads to increased rapport (Bernieri, 1988; Chartrand & Bargh, 1999). Together, the evidence suggests that dyads with divergent goals and emotions will exhibit lower levels of LSM. To test this prediction outside the lab, the next study closely examines the life's work and letters of three historical pairs: two married couples and one pair of platonic colleagues. LSM analyses were supplemented by historical clues taken from a rich body of professional work, correspondence, and biographical studies.

Project 3: Language Synchrony in Real Life

One limitation of the prior studies was low ecological validity. In the previous projects, participants' language use was not traditionally communicative. However, LSM, as with all linguistic processes, is inherently social and originates from communication in the context of interpersonal relationships. As a result, examples of verbal mimicry found in everyday life and in lab settings are bound to differ in important ways. Niederhoffer and Pennebaker (2002) examined LSM both in and out of the lab and found that real-world LSM was higher for the majority of word categories. This may be explained by the theory that LSM increases with individuals' engagement in a conversation. If this is true, it follows

that higher levels of LSM will be found in social, engaging real-world tasks than in the laboratory tasks employed previously.

Professional writing and personal letters are examples of real-world tasks that are likely to engage their authors' attention. Further, in the case of famous authors, the biographical context in which these texts were written is often well known. As a series of case studies, the third project examined the language and lives of three pairs of writers who left behind large corpora of published work and correspondence: psychoanalysts Sigmund Freud and Carl Jung, married poets Elizabeth Barrett and Robert Browning, and married writers Sylvia Plath and Ted Hughes. The text of the authors' letters and other reliable biographical information were referred to as evidence of changes in their relationship and were used to chart the degree to which LSM in pairs' language use corresponds with these fluctuations. Further, in using both direct (correspondence) and indirect (poetry) communication, our goal is to test the robustness of the LSM metric and explore cases in which LSM might serve as an unobtrusive means of measuring relationship quality from a distance.

Analyzing published work introduces the question of whether texts are the original product of each individual author. However, there is evidence for each pair that, aside from proofreading within each pair of married poets and translation of letters originally written in German, the authors' published poems and correspondence are their unaltered intellectual property. In addition, although the letters and particularly the poems were no doubt edited by their authors, personality traits and psychological states have been accurately inferred from heavily edited language use in previous research (Argamon, Koppel, Pennebaker, & Schler, 2009; Back et al., 2010; Stirman & Pennebaker, 2001; Toma & Hancock, in press).

The Freud–Jung Letters

In 1906, psychiatrists Freud and Jung sent each other copies of their respective articles. After only a few letters, the two became close friends. Although mutual warmth is apparent in their letters, their friendship was initially motivated on both sides by professional ambition. Freud was concerned that psychoanalysis was seen as a specifically Jewish school of thought, and Jung—young, prolific, and Christian—appeared to be the perfect antidote (McGuire, 1974). His agenda was far from hidden. Freud called Jung “My dear friend and heir” in a letter written shortly after one of their first face-to-face meetings in 1908 (McGuire, 1974, pp. 172–173). Jung was equally explicit about the fact that he viewed Freud primarily as a paternalistic mentor. In early 1908 he requested of Freud, “let me enjoy your friendship not as one between equals but as that of father and son. This distance appears to me fitting and natural” (McGuire, 1974, p. 122).

In the end, it was this distance that brought about their final break. From the beginning, Jung was openly skeptical about aspects of Freud's work, in particular taking issue with the primacy of sexuality in his theories. Although early on their disagreements were ignored in favor of jointly lobbying for the scientific community's acceptance of psychoanalytic theory, their differences came to the forefront after they had largely achieved this goal. By 1912, Jung was no longer willing to tolerate Freud's inability to accept criticism or relinquish authority. In his response to a letter in which Freud points out a Freudian slip made by Jung in a previous letter (Jung had written “Even Adler's cronies do not

consider me one of *yours*” when he meant to say *theirs*²), he erupts:

You go around sniffing out all the symptomatic actions in your vicinity, thus reducing everyone to the level of sons and daughters who blushing admit the existence of their faults. Meanwhile you remain on top as the father, sitting pretty. For sheer obsequiousness nobody dares to pluck the prophet by the beard. (McGuire, 1974, p. 535)

In 1913 Freud responded by recommending that they “abandon . . . personal relations entirely,” adding, “I shall lose nothing by it, for my only emotional tie with you has long been a thin thread—the lingering effect of past disappointments” (McGuire, 1974, p. 539). After sending a few conciliatory letters, which Freud apparently ignored, Jung gave up as well, permanently ending their 7-year-long friendship and collaboration.

Method. The principal goal of this study was to assess whether LSM fluctuates with changes in the quality of Freud and Jung’s professional and personal relationship. To address this question, we first analyzed whether the two matched each other’s language use most when they were in harmony in terms of their emotions and mental states and least when their relationship was unraveling. These analyses also addressed the possibility that LSM can be used to foreshadow as well as reflect the end of a relationship. Second, turn-by-turn LSM analyses were used to determine whether Freud or Jung led or followed the other’s language use and whether this tendency changed over time.

Building on research that finds that emotional asynchrony (Kimura & Daibo, 2006) and different interactional goals interfere with mimicry and efficient communication (Giles & Coupland, 1991), we expected to find significant differences in LSM between the different time periods. Second, consistent with the finding that lower status individuals mimic higher status leaders more than the reverse (Cheng & Chartrand, 2003), sequential LSM analyses were expected to reveal status-based differences in LSM. Specifically, it was predicted that (a) LSM would be highest during the midpoint of their relationship, in 1909, and lowest in the final time period, from 1912 to 1913, and (b) Jung, the younger, less famous man, would match with Freud at a higher rate than Freud would match with Jung on average across all time periods.

The letters. The correspondence between Sigmund Freud and Carl Jung lasted 7 years, from April 1906 to April 1913, and consisted of 337 letters containing 174,438 words. Mass mailings (e.g., circulars from the International Psychoanalytic Association), postcards, and correspondence cards were excluded from linguistic analysis. All letters were translated into English from the original German (R. F. C. Hull and Ralph Manheim in McGuire, 1974). On average, Freud tended to write slightly less often (Freud $n = 157$ vs. Jung $n = 180$) but at greater length than did Jung (Freud word count $M = 563.1$, $SD = 311.9$; Jung word count $M = 480.1$, $SD = 277.0$; also see Table 5).

Importantly, Freud’s and Jung’s families fully cooperated in releasing the letters for publication. There is no evidence that any letters were censored. In a letter to William McGuire, the editor of the published volume of the Freud–Jung letters, Freud’s son Ernst Freud wrote, “In order to guarantee impartiality, these letters will be printed like historical documents, that is to say without any comments whatsoever and absolutely complete, unless discretion

Table 5
Descriptive Statistics for LSM in Each Time Period in the Three Case Studies of Project 3

Study and period	Year	<i>N</i>	Mean LSM	<i>SD</i>
Freud and Jung ^a				
1	1906–1907	56 (744)	.86 _a	.05
2	1908	61 (924)	.84 _b	.08
3	1909	47 (528)	.87 _a	.05
4	1910	56 (784)	.86 _a	.07
5	1911	60 (896)	.84 _b	.07
6	1912–1913	57 (741)	.78 _c	.13
The Brownings				
1	1838–1844	62 (840)	.75 _a	.09
2	1845–1846	59 (870)	.69 _b	.09
3	1847–1855	80 (1,200)	.81 _c	.08
4	1856–1861	45 (486)	.70 _b	.11
Plath and Hughes				
1	1944–1955	44 (420)	.62 _a	.11
2	1956–1960	120 (2,759)	.68 _b	.10
3	1961–1963	80 (1,239)	.65 _c	.12

Note. The year column indicates the year in which a letter or poem was written. *N* is the number of letters written in that time period, with the number of LSM comparisons made in parentheses. Significance was determined using Bonferroni post hoc tests for multiple comparisons. LSM scores with different subscripts are significantly different from each other within that case study. LSM = language style matching.

^a For the Freud–Jung letters, letters from 1906 ($N = 10$) and 1913 ($N = 10$) are included with adjacent years, forming Time Periods 1 and 6, respectively.

All $ps < .0001$.

concerning former patients or colleagues makes omissions unavoidable” (quoted in McGuire, 1974, p. xxxviii).

Jung and Freud corresponded for only part of the years 1906 and 1913. Together they wrote only 10 letters in each year at the beginning and end of their correspondence, severely limiting statistical power for those years. To resolve this issue, letters from 1906 and 1913 were included in the adjacent years, resulting in six total time periods. All statistics comparing changes in LSM over the course of the correspondence use these aggregate time periods, where Time Periods 1 and 6 include letters from slightly more than one year.

Analytic strategies. In an analysis of a near-complete correspondence such as the Freud–Jung letters, there are two primary ways to compute interpersonal LSM. Given the nature of the correspondence between the two men, a turn-by-turn, or sequential, LSM score can be calculated. The degree of matching between two letters can always be attributed entirely to the response: Within that discrete pair of letters, any matching that occurs can only be the result of the responder mimicking the letter he is responding to. Alternatively, a more powerful strategy is to compare each individual letter with every one of the recipient’s letters within that time period. For example, if Freud and Jung both wrote 10 letters in a time period, we would calculate 100 LSM scores, the average of which would be the mean LSM for that time period. In addition to providing a larger sample of LSM scores, this strategy

² In German, capitalized *Ihre* means “yours,” whereas lowercase *ihre* translates to “theirs.” In writing *Ihre*, Jung seemed to imply that not even a group of Freudian dissenters would consider Jung a Freudian.

uses every letter available in a time period. In contrast, sequential LSM compares a response with only the letter immediately preceding it in sequence, thus excluding multiple letters sent by one writer in a row.

Both computational methods were used. To assess changes in the degree of matching across the six time periods, the second, more statistically powerful method was adopted. To determine whether Freud or Jung matched with the other the most during the six time periods, sequential LSM calculations were used.

Results and discussion. To test the hypothesis that LSM increased during the first half of Freud and Jung's relationship and decreased in the years preceding their final break, LSM for each time period was calculated using the mean of the multiple comparisons of letters within each time period.³ A repeated measures ANOVA was conducted to assess the effect of time period on LSM across the six time periods of the correspondence. Results show that LSM varied significantly as a function of time period, $F(5, 527) = 75.57, p < .0001$ (see Figure 1, left section). Bonferroni post hoc tests were used to determine which of the annual means differed significantly. Freud and Jung matched each other's language use most in the first half of their relationship, with the exception of 1908 ($M = .84, SD = .08$), when LSM was as low as it was in 1911 ($M = .84, SD = .07$), the penultimate time period of Freud and Jung's relationship. In Time Periods 1 (1906–1907), 3 (1909), and 4 (1910), LSM was significantly higher than in Time Periods 2 (1908), 5 (1911), and 6 (1912–1913), $p < .0001$. Beginning with a slight decrease in 1910 ($M = .86, SD = .07$), LSM declined linearly until the final time period of Freud and Jung's personal and professional relationship, Time Period 6 (1912–1913), when LSM was significantly lower than at any other time ($M = .78, SD = .13$), $p < .0001$.

In order to address whether Freud or Jung matched the other's language more, mean LSM was calculated for each author in each of the six time periods from 1906–1913 using the sequential LSM method. That is, LSM was computed by comparing every letter with the letter immediately preceding it. The score resulting from each of these sequential computations was attributed to the author of the response, yielding a series of individual LSM scores that allow comparisons between Freud's and Jung's tendency to match with the other's language within each of the six time periods used previously. From the 337 letters analyzed, 267 sequential LSM comparisons (Freud $n = 133$, Jung $n = 134$) could be made. It was not possible to calculate interpersonal LSM for each pair of letters: Freud and Jung often sent subsequent letters before receiving a reply, and at least 13 letters (Freud $n = 10$, Jung $n = 3$) were lost (McGuire, 1974). When there were two or more letters from one sender in a row, LSM was calculated using only the letter immediately preceding a response.

On average, Freud and Jung matched with each other at almost exactly the same rate (both Freud and Jung $M = .86, SD = .07$) across their correspondence. Within each time period, small differences emerge. Freud tended to have higher LSM than did Jung during Time Periods 2, 3, and 4 and matched slightly less than Jung did at the end, in Time Periods 5 and 6. However, effects were uniformly subtle, with Cohen's d ranging from 0.17 to 0.32. Further, pairwise t tests showed that Freud and Jung matched with each other at nonsignificantly different rates within each of the six time periods (all $ps > .25$).

The unexpected drop in LSM in 1908 does not appear to reflect a rift in their friendship. The two exchanged 60 letters in 1908, more than in any other year, and their letters reveal no major arguments. In fact, both men used fewer words related to anger in 1908 ($M = .38, SD = .40$) than on average in the two previous years ($M = .52, SD = .47$). Freud and Jung did experience a few misunderstandings early in the year, but they were apparently resolved amicably. The decrease in LSM in 1908 may be attributed to situational variables that were unrelated to the quality of Freud and Jung's friendship. The year was unusually stressful and transitional for Jung. He suffered from two severe episodes of influenza during the first half of 1908, was exhausted by both military service and clinical duties, and was planning his departure from his psychiatric post early the following year.

Despite their status differences during the first few years of their relationship, Freud and Jung did not differ in the degree to which they matched each other's writing styles. Although unexpected, this is not inconsistent with the theory that LSM, like nonverbal mimicry, can be used as a nonconscious affiliation strategy (Cheng & Chartrand, 2003; Lakin et al., 2008). Freud and Jung's efforts to become closer to each other were closely matched throughout their relationship. In the first few years, each man needed the other: Freud solicited Jung to be his heir, and Jung worked equally hard to gain entry to Freud's inner circle. However, later, once psychoanalytic theory gained international recognition (often identified as occurring in the summer of 1909, when Freud and Jung lectured at Clark University to great acclaim), both men needed each other much less (Rosenzweig, 1994). LSM in letters written by both began to decline shortly after, in 1910.

LSM in the Freud–Jung letters appears to be indicative of interpersonal harmony, both in terms of each writer's feelings toward the other and their respective states of mind while writing. When Jung and Freud were ill and overworked, LSM was nearly as low as it was during more contentious periods of their relationship. Further, using LSM we may be able to pinpoint the point at which the pair's relationship took an inexorable turn for the worse. In 1910, LSM begins to decline, prefiguring Freud and Jung's final break by 3 years.

The Poetry of Elizabeth Barrett and Robert Browning

Elizabeth Barrett Browning and Robert Browning are renowned Victorian-era poets. Their relationship has been mythologized by the publication of Elizabeth's *Sonnets From the Portuguese* and a collection of their courtship correspondence, as well as several novels, plays, and biographies written about their romance. The pair may not have been as star-crossed, however, as dramatizations imply. Although the poets' health and family lives differed greatly, they were well matched demographically and ideologically. Both were born in England to upper-middle-class families, and both were well-educated, precocious children who wrote prolifically from an early age.

The main difference between Robert and Elizabeth's lives was tragedy. At 14, Elizabeth developed a chronic lung condition that

³ The pattern of differences in mean LSM between the six time periods was the same using both the sequential method of computing LSM and the more statistically powerful method used in this section.

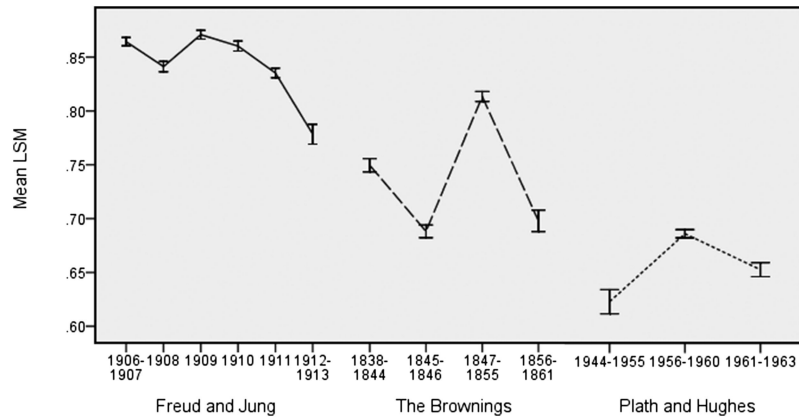


Figure 1. Mean LSM by time period across the three case studies in Project 3. All LSM comparisons were made using the text-by-text method, wherein every text by one author within each time period was compared with every text written by the other author within the same time period. Error bars are 95% confidence intervals. LSM = language style matching.

would leave her an invalid opiate addict for most of her life. When Elizabeth was 22, her mother died. At 32, her favorite brother drowned, for which she blamed herself. Most notoriously, her despotic father forbade any of his children to marry. Robert, on the other hand, generally led a happy life free of major trauma and illness.

Both Robert and Elizabeth were successful London-based poets, but their writings were stylistically very different. Elizabeth often wrote personal poetry about her own emotions and experiences, whereas Robert tended to write about human psychology (Ches-terton, 1903). Elizabeth's most enduring poems are about love. Her *Sonnets From the Portuguese* (E. B. B. Browning, 1845/1906), written during her courtship with Robert, tell of his unexpected love and the extremes of anxiety and happiness it caused her.

In 1844, Elizabeth's *Poems* (E. B. B. Browning, 1844) was published to critical and popular acclaim. A poem in her collection contained a reference to Robert's lesser known *Bells and Pomegranates* (R. Browning, 1841/1896). Robert noticed the reference and wrote Elizabeth a letter thanking her for the compliment. In his first letter he expressed his love for Elizabeth's poetry and, though they had never met or corresponded, for Elizabeth as well.

At the time of the first letter, Elizabeth was a bedridden 38-year-old. Robert was robust, social, and six years younger. The authors maintained an intense correspondence after Robert's initial fan letter. After corresponding for 4 months, they met for the first time in 1845. Robert proposed to Elizabeth immediately after this first meeting (Kennedy & Hair, 2007). Shaken, she refused to respond and demanded that he never broach the subject again. Robert acquiesced, and their friendship recommenced. Elizabeth was somewhat more receptive when Robert proposed again a few months later. They debated the subject for several months, primarily due to Elizabeth's doubts about her health and her father. Robert persisted, and after a 20-month courtship Elizabeth accepted Robert's marriage proposal. The poets eloped in the fall of 1846. By all accounts their marriage was a happy one, and the two never spent a day apart. The only dark time in their 15-year marriage came during the years prior to Elizabeth's death at age 55.

Robert and Elizabeth wrote poetry during four main time periods in their lives: before they met, during their courtship, while they were happily married, and during Elizabeth's last years when her health declined sharply. Generally, LSM was expected to be highest when the couple were happiest and most in sync, in terms of health and emotions, and lowest during more disharmonious times. To the extent that writing style, particularly in professional work, is shaped in part by a person's education and training, we predicted that LSM at baseline, before the poets met, would be moderately high. Recall that Robert and Elizabeth had similar backgrounds in terms of education, nationality, and socioeconomic status and that they traveled in similar literary circles prior to meeting. Using biographical information culled from the Brownings' letters (R. Browning & Barrett, 1900/2005) and poetry (e.g., E. B. B. Browning, 1845/1906) and from authoritative biographies (e.g., Kennedy & Hair, 2007), we were able to observe changes in LSM over time and to determine whether synchrony in professional writing is related to real-life events.

Method. The study had two main goals: (a) to test the hypothesis that LSM in the authors' poetry was higher when the authors' health and emotions were most in sync and (b) to determine which author was primarily responsible for style matching observed in their writing. For each of these goals, different strategies were used to analyze the same large corpus of professional work.

Poems and plays. Nearly 235,000 words of the authors' professional work were collected using online poetry and literature archives (e.g., The Poetry Foundation, at www.poetryfoundation.org, and Project Gutenberg, at www.gutenberg.org). The corpus includes nearly 111,000 words of Robert's poetry and plays in verse and 124,000 words of Elizabeth's poetry. Texts from each of the four eras in the poets' lives, ranging from poetry composed at the beginning of their careers in the mid-1830s to work written prior to Elizabeth's death in 1861, were analyzed (see Table 5).

Each poet's work was grouped into four broad categories: the decade prior to their correspondence, their 20-month courtship, the first 9 years of their marriage, and the last 5 years of their life together. Although the authors' letters serve as sources of infor-

mation about their emotional and psychological states during their courtship, only their professional work—including poetry, dramatic monologues, and plays—is analyzed for LSM. Biographical information rather than publication dates were used to categorize poetry by time period (R. Browning & Barrett, 1900/2005; Chesterton, 1903; Kennedy & Hair, 2007).

Although the poets are known to have proofread and discussed each other's work during the writing process, this mutual influence was consistent over the three time periods that follow the first baseline segment, from the beginning of their courtship until Elizabeth's death (Kennedy & Hair, 2007). As a result, their mutual editing and advice is not likely to have systematically influenced LSM in any particular time period or periods.

Analytic strategies. Determining whether Elizabeth matched Robert's language style more than he matched hers is not as straightforward as in the previous study. Unlike with dated correspondence in the Freud–Jung study, it is impossible with published work to use sequential LSM analyses to directly determine whether an author tends to be a linguistic leader or follower. Poems, even when explicitly intended for another poet, are rarely annotated specifically enough to determine the exact sequence of a series of poems written by two authors. Therefore, estimates of each poet's tendency to match with the other were based on whether, on average, the author matched more with their partner than with themselves over the course of their careers. For this purpose, aggregate scores were more appropriate than the alternate poem-by-poem matching method, because the target of this analysis is each writer's average writing style during each time period and not poem-by-poem LSM. Using aggregate scores for each time period, LSM was calculated between every possible pair of comparisons within and between authors. Then *t* tests determined whether, across their lives together, the poets matched more with themselves or their spouse.

Results and discussion. To address whether LSM in the authors' poetry varied as a function of harmony in their relationship, LSM between Elizabeth's and Robert's poetry was calculated for each time period by comparing the authors' language on a poem-by-poem, rather than aggregate, basis. A repeated measures ANOVA tested the effect of time period on LSM. Mauchly's test showed that the assumption of sphericity failed; consequently, Greenhouse–Geisser corrected degrees of freedom were used. Results revealed a significant effect of time period on LSM, $F(2.76, 1333.59) = 106.98, p < .001$. Using the Bonferroni correction for multiple comparisons, paired *t* tests demonstrated that LSM during Time Period 3 ($M = .81, SD = .08$) was significantly higher than during the other three time periods: Time Period 1 ($M = .75, SD = .09$), $t(839) = -11.63$; Time Period 2 ($M = .69, SD = .09$), $t(877) = -28.72$; and Time Period 4 ($M = .70, SD = .11$), $t(485) = 11.67$, all $ps < .001$. Further, LSM during Time Period 1, calculated between poems written before the poets met, was significantly higher than in Time Period 2, $t(837) = 14.85$, and Time Period 4, $t(485) = 8.19$, both $ps < .001$. The lowest LSM, during Time Periods 2 and 4, were nonsignificantly different from each other ($p > .10$; see Figure 1, middle section).

To determine whether Elizabeth appeared to match Robert's language use more than he matched hers, aggregate LIWC output for each author in each time period was used to calculate LSM for every possible pairwise comparison, both within and between authors. Within-person LSM scores were averaged to yield a

self-matching score for each author, and between-person comparisons were averaged to compute LSM between the two authors across the four time periods. A repeated measures ANOVA revealed significant differences between these three groups of LSM scores, $F(2, 10) = 5.42, p < .05$. Using Bonferroni correction for three comparisons, pairwise *t* tests showed that Robert matched marginally significantly more with himself ($M = .95, SD = .01$) than Elizabeth matched with herself ($M = .91, SD = .02$), $t(5) = -2.34, p < .05$, and also marginally more than the two matched with each other ($M = .92, SD = .02$), $t(5) = -2.48, p < .10$. Elizabeth matched with herself less than she and Robert matched with each other, but the effect was nonsignificant ($p > .10$). The pattern of results suggests that LSM was highest when the Brownings were mutually happy and healthy and was lowest when the pair diverged in terms of health, personal goals, or both.

The aim of this study was to demonstrate that LSM can provide researchers with practical information about close relationships in real life. Although a case study of only one couple, the study benefitted from a large corpus of each poet's life's work and vast biographical information from reliable sources. Further, LSM was measured at four times over the course of 15 years, which adds the dimension of time to a phenomenon normally seen only in brief snapshots during lab studies. Style matching was highest when the poets were happiest and most in sync in terms of health and living situation. Finally, Elizabeth appeared to gradually entrain to Robert's writing more than he changed to match her writing style, following the trend established in Projects 1 and 2 of women matching more than men.

The Poetry of Sylvia Plath and Ted Hughes

Sylvia Plath's and Ted Hughes' lives began and ended very differently, but for a period of about 10 years the two led parallel lives. Hughes was born in a village in Yorkshire, England, in 1930, and Plath was born 2 years later in Boston, Massachusetts. Both were recognized for their literary talent at a young age, and both went on to win scholarships to prestigious universities. In 1956, the two met at the launch party of a literary journal and married 4 months later. They separated in late 1962, and Plath committed suicide 6 months later at age 30. She became most famous for *Ariel* (Plath, 1965), a posthumously published book of confessional poetry written during the end of her marriage. Hughes most successfully wrote about nature and myth, writing about his relationship with Plath only in the year of his death in 1998.

When Ted Hughes first met her, Sylvia Plath was young, successful, and seemingly happy. She had recently graduated summa cum laude from Smith College and had begun her studies at Cambridge on a Fulbright scholarship. Hughes had graduated from Cambridge 2 years before and was a cofounder of the journal the party was celebrating. The couple's happiness was short-lived. Due to a toxic combination of Hughes's infidelity and Plath's mental health problems and professional frustration, their marriage was brief and largely unhappy, faltering after 4 years and finally ending after 6 (Malcolm, 1995).

Ted Hughes and Sylvia Plath's life together can be divided into three main periods: the time before they met (ca. 1944–1956), the first 4 years of their marriage (1956–1960), and the decline of their marriage, beginning in the year preceding their separation and

ending with Plath's death (1961–1963). In the first 4 years of their marriage, from 1956 to 1960, the couple experienced some personal and professional happiness. Hughes particularly enjoyed significant literary successes early in their marriage and was enormously prolific throughout. Plath also benefitted professionally from her marriage, although success and productivity came more slowly to her and she frequently felt frustrated with her work output relative to her husband's. Hughes's work was well received early on. During this period he won several awards, including a Guggenheim fellowship, and was widely published in both the United States and England.

Early in 1961, Plath endured bouts of what was probably the flu, an appendectomy, and a miscarriage (Moses, 2003). Soon after this period of poor health, she became pregnant with her second child. Plath's suspicions that Hughes was unfaithful began to increase, causing her to fly into violent fits of rage. The same year, the couple moved from London to a village near Dartmoor and fatefully met David and Assia Wevill. The following year, Hughes left Plath for Assia, precipitating Plath's suicide in February 1963. Plath had suffered from severe depression for many years before meeting Hughes, attempting suicide only 3 years before their first meeting. In terms of both Plath's declining mental health and Hughes's increasingly blatant affair with Wevill, the poets were in very different mind-sets for the last 2 years of their marriage.

Method. The primary aims of these analyses are the same as those of the previous two studies. The first goal was to determine whether, as found in the previous two studies, LSM fluctuates with synchrony and asynchrony in the writers' personal relationship and mental health. The second goal of this study was to assess consistency in each author's language use over time in order to determine whether Plath appeared to match more with Hughes's language than he matched with hers.

LSM was expected to be relatively lower for poetry written in Time Periods 1 and 3, before they met and during the last few years of Plath's life, respectively. The poets were from different countries and were very different in terms of mental health prior to meeting; in the last few years of Plath's life, they were similarly distant from one another both physically and psychologically. Plath's and Hughes's poems were expected to be most closely matched during the first few years of their marriage, when they were relatively happy. Finally, Plath's language use was expected to be more similar to Hughes's writing than to her own across the three time periods, suggesting that she matched more with Hughes's writing than he matched with hers.

Poems. Using online and print editions of the authors' poetry, 244 poems (Hughes $n = 66$, Plath $n = 178$), encompassing nearly 49,000 words, were collected from three time periods (see Table 5). Poems were sorted into three categories by the date they were written: before meeting (ca. 1944–1955), during the happier years of their marriage (1956–1960), and during the last 2 years of their relationship and the last 3 years of Plath's life (1961–1963). Category membership was determined by the date biographical sources indicate poems were written rather than by publication date. Due to the large amount of scholarly interest that the poets have attracted, specific information about when poems were composed was generally available.

Although Hughes was responsible for editing and publishing all but one of Plath's books of poetry, his role was limited to choosing which poems to publish and organizing the collection (Churchwell,

2001; Hughes, 1970). Further, due to her fame, poems by Plath that Hughes originally excluded from publication are now available and were included in our data set. On Hughes's part, he oversaw the publication of his own poetry and has not noted that any publishers have censored or otherwise changed his work.

Analytic strategies. As in the analysis of the two previous historical pairs, the first research question, whether LSM was higher during more harmonious periods of the poets' relationship, was answered using the most comprehensive LSM strategy. Using this method, the language used in each poem by Plath was compared with every poem by Hughes within the same time period. Mean LSM for each time period was then compared with biographical information to determine whether LSM tends to correspond to changes in the couple's relationship. The second question, regarding whether each of the authors tended to match more with the other writer than with themselves over time, was answered using aggregate LSM calculations. These LSM scores were computed by comparing aggregate LIWC results for each author within each time period.

Results and discussion. To test the prediction that the couple matched most during the first years of their marriage, mean LSM was first calculated for each time period using the comprehensive poem-by-poem method. Mauchly's test of sphericity failed, and the Greenhouse–Geisser corrected degrees of freedom were used. Results reveal that LSM in Plath's and Hughes's professional work varies significantly as a function of the time period, $F(1.98) = 42.12$, $p < .001$. Bonferroni post hoc tests for multiple comparisons show that LSM in each time period was significantly different from that in the others (all $ps < .001$). The pair's poetry was most linguistically similar during Time Period 2, the happier period of their life ($M = .68$, $SD = .10$), and declined significantly during Time Period 3, the final years of their marriage and Plath's life ($M = .65$, $SD = .12$). Further, LSM during Time Period 1, before the poets met ($M = .62$, $SD = .11$), was significantly lower than that during both Time Periods 2 and 3 (see Figure 1, right section).

Aggregate LIWC results per time period for each author were used to assess Plath's and Hughes's general writing style in each time period. Pairwise t tests compared the LSM scores that were calculated using these average patterns of language use. Approaching significance, results indicated that Plath matched with herself ($M = .86$, $SD = .06$) less than Hughes matched with himself ($M = .91$, $SD = .04$), $t(2) = -2.68$, $p < .12$. Plath also tended to match with herself less than the poets matched with each other ($M = .91$, $SD = .01$), although the difference was nonsignificant, $t(2) = 1.95$, $p > .15$.

Linguistic synchrony between Sylvia Plath's and Ted Hughes' poetry mirrors that found in the much happier literary couple, Elizabeth Barrett and Robert Browning. When Plath and Hughes were relatively happier, LSM in their professional work was higher. When their relationship fell apart and the authors began to separate, their language use also became more discrepant.

As expected, aggregate analyses showed that Plath matched more with Hughes than with herself. Although later adopted as a feminist icon, for most of her professional and personal life Plath subordinated herself to her husband. For example, Hughes often explicitly managed her work, giving her writing assignments (e.g., composing a poem about the yew tree outside her window) in order to encourage productivity (Moses, 2003). Plath (1965) her-

self wrote that she did not come into her own as an independent writer until her separation from Hughes.

Similarity between Plath's and Hughes's writings differs from the Brownings' results in two respects. First, even at its highest point, LSM for Plath's and Hughes's poetry was much lower than the Brownings' average degree of matching. Taking into consideration the relative happiness of each couple, this should not come as a surprise. Although Hughes and Plath's courtship was passionate, even during the happier years of their marriage Plath was often frustrated with her difficulty in both producing poetry and conceiving a child. She also suffered from depression intermittently throughout her adult life, and she suspected Hughes of infidelity throughout nearly their entire relationship.

The second point at which Plath's and Hughes's LSM differs from the Brownings' is in the discrepancy between the first and final time periods. LSM was lower for work completed prior to meeting than for poetry written during the approximately 2 years preceding Plath's death, whereas the reverse was true of the Brownings. Two explanations are possible. First, Hughes strongly influenced Plath's poetry during their marriage, making an imprint that, despite their disparate living situations and psychological states, may not have faded completely in the 6 months that fell between their separation and her suicide. Second, unlike the Brownings, Plath and Hughes had very different childhoods, possibly resulting in lower LSM in their first time period relative to the Brownings'. Individuals from different cultures use language differently (Boroditsky, 2001; Chung & Pennebaker, 2010; Tsai, Simeonova, & Watanabe, 2004). It follows that poetry written by Plath during her early years in Boston would be very different from poetry written by Hughes during his youth in England. In other words, we can guess provisionally that cultural differences had a greater impact than psychological differences on LSM, resulting in lower LSM for the first time period than for the third.

General Discussion

Language style matching occurs across contexts ranging from those that are relatively asocial and controlled (e.g., class assignments and online experiments) to those that are highly social and naturalistic (e.g., real-life letters and poetry). The LSM metric itself is internally consistent: Matching in one of the nine LSM word categories is correlated with matching in the others. There also appear to be individual differences in LSM. Women, individuals of higher SES, and participants with better exam grades consistently matched with target texts more than did others. LSM itself appears to be the outcome of both traitlike tendencies to style-match and contextual effects. Participants matched more with certain writing styles, suggesting that situational variables, such as an author's implicit ingroup membership, contribute to differences in matching. However, there was also evidence that some participants had a general tendency to chronically match more or less than their fellow participants did, irrespective of contextual effects on matching. Consistent with our conception of LSM as a traitlike individual difference, people failed to increase their degree of style matching when instructed to do so, suggesting that LSM is generally automatic and not subject to intentional control. Finally, in a case study of real-life pairs, style matching in both professional writing and letters mapped onto critical relationship changes and differed dramatically between the three pairs, indi-

cating that LSM can serve as an unobtrusive measure of dyad-level personality over time.

Psychometrics of LSM

LSM is comparably reliable across each of the settings examined. The studies show that when people mimic the pronouns in a text, they also tend to match the text's articles, prepositions, and so on. This covariance cannot be explained by linguistic constraints. Although English grammar guarantees that certain kinds of words will be used together (e.g., articles are followed by nouns), this is only the case with content-function word pairs. There are no such rigid constraints between types of function words (see Quine, 1964). Because LSM is made up of exclusively function word categories, the internal consistency of the LSM metric is not a necessary condition of language itself and is likely a product of psychological processes external to the nature of grammatical rules.

A psychological explanation for LSM's internal consistency is that different classes of function words are not produced independently of each other but are the mostly automatic (Pulvermüller & Assadollahi, 2007) output of a coherent internal milieu. In the same way that mimicry tends to be a holistic process, with people who mimic a person's nonverbal behavior also matching their emotional state (de Waal, 2007; Moody, McIntosh, Mann, & Weisser, 2007), LSM in one category is mirrored by matching in the other eight.

The LSM score's psychometric validity was further investigated by measuring how consistently a person matches the language style of different prompts. In experimental studies, reliability was low, and style matching with one prompt was weakly correlated with matching with the others. In Study 1a, each question was written in the same style for each participant; as a result, variance in LSM could be attributed to differences in the prompts' topic or style. In Study 1b, however, questions were counterbalanced for content and style, allowing us to examine the effects of style and content separately. Students matched more with the youthful, valley-style questions than with the drier control, pedantic, and convoluted prompts. Thus, LSM is not constant regardless of contexts but rather varies as a function of target texts' writing style.

Although we found that LSM changes significantly across writing prompts and likely also varies between conversation partners and writing contexts in everyday language use, there is also evidence that LSM is a stable behavioral tendency. Although participants matched differently with different writing styles, those in Project 1 tended to be chronically high or low style matchers relative to other individuals in the sample. In this respect, LSM appears to parallel personality traits, such as extraversion, that vary significantly across situations but remain stable when averaged across situations (see Funder, 2006).

Individual Differences

LSM stands to help researchers understand, assess, and predict the influence of individual differences on human behavior on two levels: a finer grained micro level, at which differences in LSM correspond to specific demographic and personality differences, and a macro level, at which LSM represents a holistic assessment of the degree to which two individuals are aligned along several personality and individual difference variables.

First, there were hints that some individual differences may underlie LSM. Traditional self-reported personality measures largely failed to yield consistent patterns. Across the two large samples in Study 1, there was mixed evidence to suggest that people lower in conscientiousness and higher in extraversion were better at style matching. The exception was neuroticism, which was subtly negatively correlated with LSM across Studies 1a and 1b (Cohen's $d = -0.10$; see Table 3). The negative relationship between neuroticism and style matching is consistent with the self-focused nature of neuroticism (Teasdale & Green, 2004) and the argument that LSM indicates the degree to which a person is engaged in a conversation (Niederhoffer & Pennebaker, 2002).

Findings linked to individual differences in demographic variables were more compelling. Across Study 1b and Project 2, women matched significantly more than did men (Cohen's $d = 0.27$; see Table 3). In the Brownings' longitudinal case study, Elizabeth's language converged with Robert's more than his did with hers. Sylvia Plath, too, matched more with Ted Hughes's language than she matched with her own, although the effect was modest. Depending on one's theoretical predilection, the sex effects are consistent with findings suggesting greater social sensitivity (van Honk & Schutter, 2007), imitation (Sonnby-Borgström et al., 2008), or empathic tendencies (Baron-Cohen & Wheelwright, 2004) among women relative to men.

On the surface, the sex effects could be attributed to social power or dominance differences as well (Dovidio, Ellyson, Keating, Heltman, & Brown, 1988). However, the social class findings tend to undermine this view. Across both student studies, measures of social class were consistently—and modestly—related to LSM levels (Cohen's $d = 0.16$; see Table 3). Students whose parents had more education were generally higher in LSM. The sex differences and social class effects may simply reflect more interest in and familiarity with traditional reading and writing. On average, parental education is associated with more reading in the home and in childhood in general (Aikens & Barbarin, 2008; Sénéchal & LeFevre, 2002). Similarly, female children and adolescents are more likely than boys to read in their leisure time (Nippold, Duthie, & Larsen, 2005), a trend that lasts into adulthood (Harris Interactive, 2008).

Perhaps the most robust LSM correlate was the average grade that students earned across the course exams (Cohen's $d = 0.35$; see Table 3). Note that these relationships held after controlling for both sex and parental education. Again, this could reflect some kind of "psychological literacy." However, on a broader level, it could also reflect the degree to which good students are more entrained with the course and the instructors. Better students are more likely to internalize the ways the instructors are teaching. If the LSM effects in the current study reflect literacy skills, future studies must compare LSM for people involved in writing tasks with their language use in natural interactions. We know that on the basis of previous studies, LSM occurs across interactions, both in speaking and in online chats. A critical question will be to learn whether LSM is a skill that transcends reading and writing to real-world conversation and, more broadly, the degree to which individuals influence and are influenced by everyday language use in, for example, close relationships and the media.

At a more global level, however, LSM can be used as a single holistic assessment of interpersonal similarity between a complex of personality and individual difference variables. As noted earlier, function word use is reliably related to a variety of individual differences

and personality variables, ranging from sex to leadership styles (Newman et al., 2008; Slatcher, Chung, Pennebaker, & Stone, 2007; for a review, see Tausczik & Pennebaker, 2010). Given that function words represent fundamental individual differences between groups of people, LSM may indicate that dissimilar speakers have temporarily converged in terms of thinking styles, including what people attend to in a conversation and how they organize their thoughts.

Measuring Style Versus Content

Recall that function words define the style rather than the content of an individual's language use. Akin to Gordon Allport's (1961) argument that stylistic aspects of behavior offer more insight into dispositional differences between people than do other characteristics of behavior, we argue that function words are better indicators of individual differences than are content words in the majority of situations in which language use might be studied to assess personality (Fast & Funder, 2008). In contexts ranging from naturalistic conversation to experimental writing tasks, content is heavily constrained by situational factors. Two people in a conversation rarely simultaneously discuss different topics. Indeed, one of Grice's (1975) conversational maxims is that individuals only make contributions that are relevant to the topic at hand. The content of conversations is often constrained in experiments as well. For example, in experiments, group members assigned to solve a series of math problems are bound to use a large number of content words related to math. Content words can clearly reveal a great deal about individuals in situations in which the topic of conversation or writing is less constrained, such as in the picture story exercise (see Schultheiss, Liening, & Schad, 2008). However, function words allow researchers to assess individual differences in thinking styles irrespective of context, under conditions in which content is minimally variable due to situational constraints.

A key motivation for creating the LSM metric was to devise a method of simply and automatically measuring a complex process that is virtually impossible to monitor using traditional methods of text analysis. Content-coding methods typically require specially trained raters to hand-code texts for key words and phrases related to a number of motivational themes, such as need for power or intimacy (Woike, 1994). Although manual coding is more labor-intensive than is computerized text analysis, raters are able to code content themes reliably and relatively quickly once trained (Schultheiss et al., 2008). Function words, on the other hand, are processed more fluently and automatically than are content words and are consequently less salient. As a result, they are more difficult to code by hand, particularly when the goal is to assess minor fluctuations in the degree to which pairs of texts match across several function word categories.

In Project 2, we tested our assumptions about the ratibility of style matching by comparing LSM and a common computational measure of content similarity with judges' ratings of similarity between texts. With minimal training, judges turned out to be relatively good at reliably and accurately estimating the similarity between two sets of fictional stories when content matching was used as the criterion. Judges' ratings of similarity were uncorrelated with LSM, however. These results, along with psycholinguistic data on the nature of function word processing, suggest that the LSM metric represents a unique contribution to a field that till

now has been unable to rapidly and easily compute function word-level stylistic similarity between individuals' language use.

LSM in Real Life

The second study of Project 1 offers a glimpse into what variables might impact LSM outside the lab. Across three different essay topics, participants matched significantly more with the valley-style questions than with questions written in pedantic, convoluted, or control styles. This may simply be because participants identified with, liked, and as a result were more motivated to mimic the youthful valley author than the stuffy professor, the absentminded professor, or the textbook author. People mimic those they like, like those who mimic them (Chartrand & Bargh, 1999), and mimic more after being socially excluded, theoretically in an effort to regain social acceptance (Lakin et al., 2008). Mimicry is both a means to and product of affiliation, and LSM may serve similar functions. Primary goals of future research are to determine the degree to which LSM reflects and fosters ingroup membership and to assess the role that LSM plays in group-level personality and ingroup identity.

More broadly, it is important to assess the degree to which LSM is a sensitive measure of dyad-level psychological processes over time. The three archival case studies of close relationships suggest that we can determine the degree to which dyads are psychologically in sync at any given time by assessing linguistic similarity in their writing. Despite the fact that the texts for only one pair were direct forms of communication, the similarity of each pair's writing styles covaried with interpersonal harmony. The likelihood that style matching can be used as a measure of dyad-level personality and relationship quality at a distance, even in indirect communication such as poetry, is a critical strength of the LSM method. One could imagine using LSM measures to evaluate the quality of any couple's relationship by analyzing their language across a broad array of relatively public forums, such as blogs or professional writing. A more direct test of LSM's utility as a practical method of assessing dyad-level differences between relationships would be to analyze communication between friends or romantic partners within a large sample of pairs varying in their level of closeness. This article aims only to establish a starting point from which future researchers may be able to launch investigations into the language of harmonious and disharmonious pairs.

Despite the fact that the three pairs analyzed in Project 3 were each intimately involved for a number of years, there are large differences in LSM between each dyad. Although it is difficult to interpret comparisons between LSM in poetry and letters, for the two pairs of poets it is clear that the Brownings' language use was much more closely matched than was Plath's and Hughes's language use overall. Even at the high point of their relationship, Plath and Hughes were less linguistically synchronized than the Brownings were at their lowest point. The overall LSM discrepancy between the two pairs of poets underscores what we already know about the couples: The Brownings overcame steep odds to begin what would be a long and happy marriage, whereas Plath and Hughes' relationship was short, tumultuous, and characterized by sexual jealousy from the beginning. The stark difference between pairs suggests that LSM can be used to assess differences in relationship quality between as well as within couples over time. However, data from the second project do not specify whether

LSM reflects specific components of interpersonal alignment beyond a broad estimate of relationship quality. Further research is needed to determine specifically what factors contribute to the finding that certain couples appear to be more linguistically in sync than others, regardless of contextual fluctuations.

It may not always be the case that greater synchrony is a sign of greater relationship satisfaction or rapport, however. Two people locked in a bitter fight tend to talk (or yell) in similar ways. When one person is attempting to deceive another, the two may actually work harder to read, understand, and thus coordinate with each other (Hancock, Curry, Goorha, & Woodworth, 2008). Similarly, many psycholinguistic theories of linguistic coordination are agnostic on the question of whether it is a sign of rapport or liking. Rather, these theories tend to view coordination or mimicry mechanistically, as a means for improving the fluency of language processing and increasing mutual understanding (Brown-Schmidt & Tanenhaus, 2008; Pickering & Garrod, 2004). Significantly, in the Project 3 analysis of close relationships, the pairs were not engaged in intense fights when LSM was at its lower points. Rather, LSM decreased when each pair was emotionally and psychologically out of sync: When Elizabeth Barrett Browning welcomed death and her husband dreaded it; when Ted Hughes was in love with his mistress and Sylvia Plath remained in love with her husband; and when Freud and Jung no longer belonged to the same psychoanalytic ingroup. As noted elsewhere (Niederhoffer & Pennebaker, 2002), rather than indicating liking, LSM is likely a better indicator that two people in an interaction are paying attention to and seeking to understand one another.

Conclusion

Written language is the external, observable output of private mental processes. Through writing, individuals allow others to simulate and understand their thoughts and feelings—for better or worse (Oatley & Djikic, 2008). The working theory of LSM is that it reflects when two people have adopted similar thinking styles, irrespective of whether the process was triggered by need for affiliation and resulted in greater closeness or was elicited by an engaging fight and resulted in a stalemate. The psychological synchrony that LSM represents can encompass both of these possibilities. The nature of function words implies that dyads that use these words similarly may also be similar in terms of an array of stable personality traits and more transitory behavioral differences.

The LSM metric, which quantifies the function word similarity between two texts, is a psychometrically sound, computationally simple tool for tracking interpersonal synchrony in language. LSM is computed using an absolute difference score that is transparent and easy to use. The ease of implementation may help foster language research in fields that traditionally do not use linguistic measures. Further, because of the automaticity of the function words that make up the LSM metric, LSM is a psychometrically clean measure, free from experimental nuisance variables such as social desirability bias or demand characteristics.

There are several parallels between LSM and other kinds of behavioral matching. Findings from established mimicry research in particular will inform ongoing and future style-matching studies. Future research should focus first on determining the specific precursors of LSM. Like most social psychological phenomena, style matching appears to be affected by both individual differ-

ences and situational variables. The intersection of LSM and affiliation motivation appears to be particularly rife with research questions related to both the person and the situation.

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