2011

Linguistic Alignment: The Role of Social and Cognitive Variables

Jacqueline M. (Jacqueline Maye) Coyle

THE FLORIDA STATE UNIVERSITY

COLLEGE OF ARTS AND SCIENCES

LINGUISTIC ALIGNMENT: THE ROLE OF SOCIAL AND COGNITIVE VARIABLES

By

JACQUELINE M. COYLE

A Dissertation submitted to the
Department of Psychology
in partial fulfillment of the
requirements for the degree of
Doctor of Philosophy

Degree Awarded:
Summer Semester, 2011

The members of the committee approve the dissertation of Jacqueline Coyle defended on June 15, 2011.

_____
Michael Kaschak
Professor Directing Thesis

_____
Gretchen Sunderman
University Representative

_____
Colleen Kelley
Committee Member

_____
Jon Maner
Committee Member

_____
E. Ashby Plant
Committee Member

The Graduate School has verified and approved the above-named committee members.

To my family

ACKNOWLEDGMENTS

I would like to thank my advisor, Dr. Michael Kaschak, for his instruction, mentorship, and advice throughout my graduate school career.

I would also like to express gratitude to my fellow psychology graduate students—who have aided my research by providing many valuable suggestions and have made my time in graduate school a lot more enjoyable than it otherwise would have been.

Lastly, and most importantly, I would like to thank my parents for always encouraging and motivating me, and my husband, Eric, for his support, encouragement, and persistent confidence in me.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABSTRACT

The current study uses two experiments to explore how a range of social and cognitive variables affect linguistic alignment. Experiment 1 examines the effects of a number of individual difference variables (inhibitory control, pattern learning, creativity, trait conformity, and the need to belong), while Experiment 2 focuses on one specific social variable—female fertility. In order to look at linguistic alignment (or a lack thereof), the study employs a picture description task in which dyads (each dyad is comprised of one participant and one confederate) take turns describing pictures to each other. Both experiments measured the degree to which participants aligned with confederates on sentence structure, and Experiment 2 also measured alignment of vocal pitch within the dyads. The results of Experiment 1 suggest that individual differences do not affect the amount of alignment of sentence structure. However, the results of Experiment 2 reveal that the fertility level of a female conversational partner affects the degree to which men align with women on sentence structure. Specifically, men were less likely to align with the sentence structure of a woman who was at high fertility than with the sentence structure of a woman who was at a lower level of fertility. Experiment 2 also demonstrates that men and women in conversation do align on vocal pitch. Possible explanations and implications are discussed.

CHAPTER 1

INTRODUCTION

When people interact, they align with each other on a number of levels. For example, previous research has shown that we align with or mimic the facial expressions (Blairy, Herrera, & Hess, 1999), postures (Berger & Hadley, 1975; Bernierie, 1988; La France, 1979, 1982; La France & Broadbent, 1976), gestures (Bavelas et al., 1988), and other behaviors (e.g., foot shaking or face rubbing, Chartrand & Bargh, 1999) of others. Additionally, people in conversation align linguistically with those they are talking to in terms of accents (Giles & Powesland, 1975), tone of voice (Neumann & Strack, 2000), rate of speech (Webb, 1969, 1972), speech rhythms (Cappella & Panalp, 1981), lexical choices (Brennan & Clark, 1996), and sentence structure (Bock, 1986; Branigan, Pickering, & Cleland, 2000).

Recent research suggests that the occurrence of these types of alignment may be useful and beneficial in many ways. In fact Lakin, Valerie, Jefferis, Cheng, and Chartrand claim that behavioral alignment or mimicry "binds people together and creates harmonious relationships" (2003). In accord with this, Pickering and Garrod (2004) argue that alignment of sentence structure may have important social functions too. For example, alignment may be important for affiliation (Lakin et al., 2003, Lakin & Chartrand, 2003; Shepherd et al., 2001, Giles, Coupland, & Coupland,, 1991). Support for this idea comes from the fact that mutual liking is associated with greater similarity between people (Tenney, Turkheimer, & Oltmanns, 2009), and that alignment between people may lead to perceptions of increased similarity.

Mimicry not only increases liking, but liking increases mimicry (Bernieri, 1988; Bernieri, Davis, Rosenthal, & Knee, 1994; Chartrand & Bargh, 1999; La France & Ickes, 1981; Lakin & Chartrand, 2003; Stel, Blascovich, McCall, & Vonk, 2005; Chartrand & Jefferis, 2003). Additionally, people are more likely to (behaviorally) mimic in-group

members than out-group members (Yabar, Johnston, Milles, & Peace, 2006), and are less likely to mimic those with stigmas than those without stigmas (Johnston, 2002). Furthermore, higher rates of alignment and mimicry occur in situations in which people have been made to feel distinct from their peer group (Uldall, Hall, & Chartrand, 2003), and among people in collectivist cultures compared to those in individualist cultures (van Baaren, Maddux, Chartrand, de Bouter, & van Knippenberg, 2003). Alignment may also aid in social situations by helping to repair social damage (Balcetis & Dale, 2005). Balcetis and Dale (2005) found that people were more likely to align (on sentence structure) with a (confederate) conversational partner who acted mean and insulting than with a partner who acted nice. Therefore, it is not surprising that many social and evolutionary psychologists believe, "our ancestors lived in an environment in which social isolates did not survive and reproduce (e.g., Buss & Kendrick, 1998; Johnson & Edgar, 1996)…failure to facilitate positive interactions, using mechanisms such as mimicry, may have led to social isolation and hence an evolutionary disadvantage" (Yabar, Johnston, Miles, & Peace, 2006, 98; Caporael, 1997, 2001; Lewin, 1943; Poirier & McKee, 1999).

Despite the extant studies of mimicry and alignment, however, there are still a plethora of unanswered questions about behavioral and linguistic alignment. In the current study, I address some of these questions by examining how certain social and cognitive variables affect the degree to which people align linguistically. The paradigm I used to study linguistic alignment is structural priming—the tendency to repeat the sentence structure across utterances (e.g., Bock, 1986; Coyle & Kaschak, 2008). For example, if one hears a sentence employing the double object (DO) construction, such as "The students showed their teacher a picture," one is more likely to use the DO construction (as in "The girl tossed the boy a ball") rather than an alternative construction (i.e., the prepositional object—PO—construction, such as "The girl tossed a ball to the boy") on subsequent productions.

There are several reasons I believe structural priming is a good paradigm to use for studying linguistic alignment: First, structural priming occurs below conscious awareness. People are usually not aware of how they structure their sentences, do not consciously choose to align their sentence structures with conversational partners, and

often do not notice when structural priming occurs (Bock & Griffin, 2000; Pickering & Garrod, 2004). Second, structural priming is very pervasive. It occurs in both laboratory experiments (e.g., Branigan et al., 2000) and naturally occurring speech (e.g., Gries, 2005), from comprehension to production (e.g., Branigan et al., 2000), both within and between people (e.g., Potter & Lombardi, 1998; Branigan, et al., 2000), in both children (Savage, Lieven, Theakston, & Tomasello, 2003) and adults (e.g., Bock, 1986), in both spoken (e.g., Bock, 1986) and written (e.g., Pickering & Branigan, 1998) language, in both picture description (e.g., Coyle & Kaschak, 2008) and stem completion (e.g., Kaschak, Kutta, & Schatschneider, 2011) tasks, it transfers across different tasks (e.g., Kaschak, 2007), it is found in many different languages (e.g., English, Dutch, Japanese, and Spanish; e.g., Bock, 1986; Hartsuiker & Westenberg, 2000; Hartsuiker, Pickering, & Veltkamp, 2004), across languages within the same speaker (e.g., Loebell & Bock, 2003; Hartsuiker, Pickering & Veltkamp, 2004), among people with Broca's aphasia (Hartsuiker & Kolk, 1998) and amnesia (Ferreira, Bock, Wilson, & Cohen, 2005), and can persist for long periods of time (e.g., Kaschak, Kutta, & Schatschneider, 2011). For these reasons, I believe structural priming is an ecologically valid paradigm ideal for examining linguistic alignment. Beyond this, researchers have suggested that structural priming plays a role in language acquisition (e.g., Savage et al., 2003) and language change (e.g., Chang, 2008). The tendency to repeat recently encountered structures can strengthen the representation of a given sentence structure (furthering the acquisition process; Tomasello, 2006), and over time may work to alter the probability of using a given structure (contributing to language change; Chang, 2008). Furthermore, very few studies have examined how social variables affect structural priming, and few studies of alignment have examined the effects of cognitive variables.

Therefore, in the current study, I conducted two experiments designed to assess how a wide range of social and cognitive variables affect linguistic alignment. To do this, I had participants engage in a picture matching task developed by Branigan, et al. (2000) with a (confederate) partner. Importantly, engaging in the picture matching task gives participants the opportunity to linguistically align (or not) with another person. Additionally, I used a number of measures to examine other social and cognitive

variables, such as inhibitory control, conformity, and female fertility. The current experiments are discussed below in more detail.

CHAPTER 2

EXPERIMENT 1

Although many researchers have examined how individual differences affect explicit processes, most researchers have ignored the effects individual differences have on implicit processes such as structural priming, or assume that implicit processes are only minimally affected by individual differences (e.g., Reber, 1993; Stanovich, 2009). However, recent research by Kaufman et al. (2010) demonstrates that individual differences (e.g., differences in verbal reasoning, processing speed, and self-reported levels of openness) do in fact affect implicit learning. This research suggests that although structural priming is largely implicit (Chang, Dell, & Bock, 2006), individual differences may play an important role in the degree to which participants align with the sentence structure of a conversational partner.

Because the role of individual differences in linguistic alignment has not yet been examined, it is important to do so. Thus, in Experiment 1, I investigated if and how a range of social and cognitive variables affect alignment of sentence structure. To do this, I tested whether individual differences in inhibitory control, pattern learning, creativity, trait conformity, and the need to belong affect structural priming. These variables and their possible relations to structural priming are explained below. (The specific measures used to assess these individual difference variables are discussed in the Materials.)

2.1 Inhibitory Control

Inhibitory control involves ignoring or blocking certain information from one's attention while still processing other information. A choice to not repeat or align on sentence structure (i.e., a lack of structural priming) might require inhibiting the previous sentence structure—such as ignoring the sentence construction used by one's

conversational partner—simply because processing (or comprehending) an utterance typically leads one to repeat or align on sentence structure (i.e., structural priming; Bock, 1986). So if individual differences in inhibitory control relate to structural priming, I would expect this relationship to be negative. That is, people who align more (i.e., those who demonstrate more structural priming) would be expected to be worse at inhibitory control than people who align less.

2.2 Pattern Learning

Pattern learning, at least the type of pattern learning addressed in the current study, involves implicit probability learning (Conway, Bauernschmidt, Huang, & Pisoni, 2010). (In the pattern learning task I use, participants must learn what sequences of stimuli are probable in order to succeed in the task.) Structural priming also reflects implicit learning (Chang et al., 2006), and involves implicitly detecting and tracking probabilistic information (e.g., of structural and lexical content). Thus if individual differences in pattern learning affect structural priming, I would expect people who are better at pattern learning to demonstrate higher rates of structural priming.

2.3 Creativity

Creativity requires being unique or different from others—which may involve adjusting one's behavior (and/or thoughts) to *mis*match that of others. If individual differences affect structural priming, creativity would most likely have a negative relationship with structural priming—highly creative people would be expected to exhibit less structural priming. This would be expected because structural priming involves aligning with and repeating the sentence structure of a conversational partner—that is, reusing or mimicking the sentence structure of another rather conveying the message with a different (and perhaps creative or unique) construction.

2.4 Conformity & the Need to Belong

Conformity is basically the opposite of creativity. Conformity involves adjusting one's behavior (and/or thoughts) to go along with or match that of others. The need to belong is related to conformity in that being motivated to fulfill the need to

belong might lead to conformity. The need to belong is the need to feel socially connected, attached to, and accepted by others (Baumeister & Leary, 1995). Because structural priming (and other types of alignment) helps us form social bonds and functions to increase affiliation (e.g., Lakin et al., 2003), it would make sense for people who are more conforming and for those who have a stronger need to belong to exhibit more structural priming.

Investigating the effects of individual differences on social and cognitive variables, such as those listed above, is important because doing so may provide insight into the nature of psychological mechanisms that underlie linguistic alignment as well as the representations that underlie comprehension and production of language (Bock, Dell, Chang & Onishi, 2007; Pickering & Ferreira, 2008). Furthermore, studying how individual differences in social and cognitive variables affect structural priming is also important because doing so can help us understand *other types* of alignment—which may reflect the general process of learning and may serve important roles in communication and other types of social interaction (Pickering & Ferreira, 2008). Additionally, very few studies have examined how social variables affect structural priming, and few studies of alignment have examined the effects of cognitive variables.

I entertained two alternative hypotheses for the outcome of Experiment 1. One possibility is that linguistic alignment (i.e., structural priming) reflects implicit learning that is not affected by individual differences in abilities such as pattern learning and inhibitory control or personality factors such as creativity, trait conformity, and the need to belonging. If this is the case, I would expect individual differences (such as those listed above) to be irrelevant to the amount of structural priming that occurs. This finding would be consistent with traditional views that although individual differences often play a large role in explicit and conscious processes, implicit processes are much less affected (if at all) by individual differences (Reber, 1993; Stanovich, 2009). However, an alternative possibility is that individual differences do play an important role in the degree of structural priming that occurs. If individual differences do influence structural priming rates, I would expect higher pattern learning scores, higher belongingness scores, higher levels of trait conformity, lower creativity scores, and lower inhibitory control scores to be associated with increases in structural priming. These findings would lend

further support to Kaufman et al.'s (2010) claim that even implicit tasks can be affected by individual differences.

2.5 Method

2.5.1 Participants

The participants were 89 undergraduates (67 females, 20 males, and 2 participants who did not indicate their sex) from Florida State University. Participants received partial course credit in exchange for their participation.

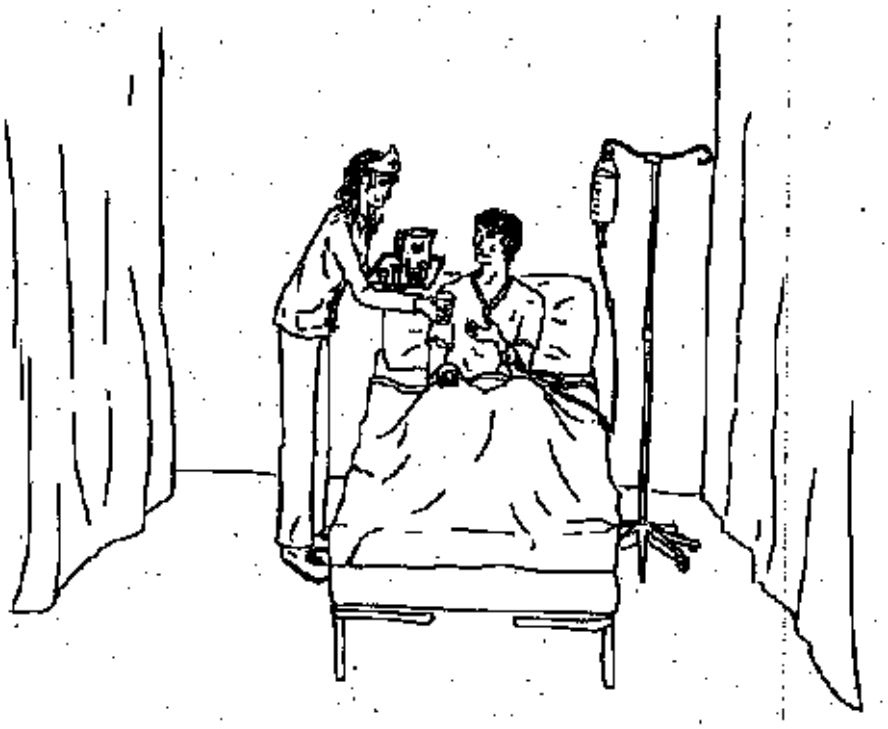
2.5.2 Confederates & Experimenters

Three undergraduate women served as confederates and seven undergraduate women served as experimenters.

2.5.3 Materials

Using pictures from Bock (1986), two sets of pictures ("description sets;" one for the confederate and one for the participant) were constructed. Each set consisted of 17 pictures—8 critical pictures and 9 filler pictures. Each picture had a verb typed above it, which was to be used in generating a sentence to describe the picture (see Figure 1). The critical pictures in Set 1 were the prime items. They depicted a scene that was designed to elicit a DO or PO construction, and the confederates were scripted to describe each critical item with a specific utterance (the prime sentence; see Figure 1). Critical pictures in Set 2 were also pictures designed to elicit the DO or PO construction, and provided the participant with the opportunity to use either construction (the "target" items). (Confederates always used Set 1 to produce picture descriptions, while participants always used Set 2 to produce the descriptions.) Filler pictures were designed to elicit descriptions that were neither DO nor PO constructions. Confederates produced the same set of picture descriptions for every participant. (Scripted descriptions were typed at the bottom of each picture in Set 1 to ensure that each participant was exposed to the exact same prime sentences.) Half of the primes used the DO construction, and half used the PO construction. Half of the prime-target sequences employed the same verb, and half employed different verbs between trials. The pictures in both description sets

were put into a fixed order, such that each critical (prime) picture in Set 1 was immediately followed in the trial sequence with a critical (target) picture from Set 2. The prime and verb manipulations were organized across trials using the following pattern: DO same verb, PO different verb, DO different verb, PO same verb. A duplicate of each description set was created to be used for identifying the picture one's partner had just described (the "matching sets"). Matching sets were shuffled before each use.



The nurse gave the patient some water.

Figure 1: Example picture from the picture description task.

Note: Participants and confederates saw the picture and the verb printed on top of the page. Only confederates saw the scripted description at the bottom of the page.

Audacity sound recording software (GNU General Public License, 2006) was used to record the participants' and confederates' picture descriptions.

Eprime (Psychology Software Tools, Inc., 2001) was used to administer several tasks designed to assess the individual differences mentioned above. Inhibitory control

was measured using the Simon effect task (Simon, 1969) and the flanker task (Eriksen & Eriksen, 1974; Eriksen & Schultz, 1979). In each trial of the Simon effect task, a red or blue square appears on the right or left side of the computer screen. Participants are instructed to respond to the color of the square (and meanwhile ignore its location) by pressing one key when they see a red square and a different key when they see a blue square. Importantly, one response key is on the left side of the keyboard while the other is on the right side of the keyboard. That is, the locations of the response keys correspond to the location of the stimulus. Generally, participants are faster at responding correctly when the location of the response is consistent with the location of the stimulus. However, participants who are better at inhibitory control are better at ignoring the location information (and thus focusing solely on the color of the stimulus), and therefore are generally just as quick or nearly as quick in responding in stimulus-response inconsistent trials as in stimulus-response consistent trials (Simon, 1969). Both accuracy and response time differences between consistent and inconsistent trials provide an index of individual differences in inhibitory control.

In the flanker task which also measures inhibitory control (Eriksen & Eriksen, 1974; Eriksen & Shultz, 1979), participants are instructed to respond to the direction of a visual stimulus in the center of the computer screen (the "target;" i.e., they press one response key when they see a "<," and a different response key when they see a ">"). During critical trials in this task, distracting stimuli appear on both sides of the target (and participants are instructed to ignore the distracting stimuli). On some critical trials, distracting stimuli are facing the same direction as target (as in "> > > > > > >"), while on other critical trials, distracting stimuli are facing the opposite direction as the target (as in "< < < > < < <"). Participants are typically faster at responding correctly when distracting stimuli are facing the same direction as the target than when they are facing the opposite direction as the target. However, this difference in response time is not as evident in people who are better at inhibitory control (Eriksen & Eriksen, 1974; Eriksen & Shultz, 1979). As in the Simon effect task, both accuracy and response time differences between consistent and inconsistent trials of this task provide an index of individual differences in inhibitory control.

In the Simon game (Baer & Horrison, 1978), which measures pattern learning abilities (Conway et al., 2010), participants see different colored squares light up one-at-a-time. (There are four squares arranged in two rows of two in the center of the computer screen.) Participants are instructed to watch the squares and pay attention to and remember the order in which they light up. When the lights stop, participants are asked to indicate the pattern of lights they saw. (There are four response keys and the location of each response key corresponds to the location of one of the stimulus squares, so participants basically use these keys to replicate the pattern they saw.) Importantly, the sequence of the lights is probabilistic, and some trials are more probabilistic ("grammatical trials"), than others ("ungrammatical trials"). Participants who are better at pattern learning (or probability learning) typically perform better on grammatical trials than on ungrammatical trials, and this discrepancy is less apparent in people who are worse at pattern learning. The difference in performance between grammatical and ungrammatical trials provides and index of one's pattern learning ability (Conway et al., 2010).

Creativity was assessed using a task developed by Mednick (1962) called the Remote Associates Test (RAT). In each trial of this task, participants are presented with three words ("problem items") that are remotely-associated (three remotely-associated words = one "problem"). That is, all three problem items are related to each other through one other word (the "solution"). For example, participants may be presented with "sleeping/bean/trash." (In this example, the solution is "bag," as in sleeping bag, bean bag, and trash bag.) Generally, participants are limited in the amount of time they are given for trying to generate the solution to each problem, though any number of problems and a number of different time limits can be used. In the version of the RAT that I used, participants were given 7 seconds to come up with the solution to each of 20 problems items (Bowman & Jung-Beeman, 2003). (The problem items I used were developed by Bowman and Jung-Beeman (2003). In these problems, each problem item is related to the solution in that it can be combined with the solution to form a compound word, as in the example above.) Performance on the RAT has been shown to correlate reliably with performance on classic insight problems, and the RAT is often used to study creativity in problem solving (Bowden & Beeman, 1998; Schooler & Melcher, 1995).

Thus, RAT scores are believed to reflect creativity—in that participants who are more creative are typically better at identifying remote associations (and thus, solve more RAT problems) (Bowman & Jung-Beeman, 2003).

Trait conformity was measured using the Conformity Scale (Mehrabian & Stefl, 1995). The Conformity Scale consists of 11 items intended to assess general tendencies toward conforming with others (e.g., "I often rely on, and act upon, the advice of others" and "Basically, my friends are the ones who decide what we do together."). Responses are made using a scale ranging from -4 (very strong disagreement) to +4 (very strong agreement). Higher scores on the Conformity Scale indicate higher levels of trait conformity (Mehrabian & Stefl, 1995).

I used the Belongingness Scale (Leary, Kelly, Cottrell, & Schreindorfer, 2005) to measure belongingness. The Belongingness Scale consists of 10 items intended to assess one's general need to belong (e.g., "I try hard not to do things that will make other people avoid or reject me" and "It bothers me a great deal when I am not included in other people's plans"). Responses are made using a scale ranging from 1 (strongly disagree) to 5 (strongly agree). Higher scores on the Belongingness Scale indicate higher levels of belongingness (Leary et al., 2005).

A questionnaire packet was used to assess participants' demographic information (e.g., sex and age).

2.5.4 Procedure

At the start of each session, an experimenter arrived at a participant waiting room and said that she was looking for "[participant name] and [confederate name]." If the participant was present, the experimenter guided him/her to a lab room and asked him/her to sit at a desk with two chairs side-by-side. During this time, the confederate was in a separate room and out-of-sight. The experimenter told the participant she was going to check the waiting room again to see if the other participant had shown up, and would return shortly. The experimenter closed the door and left, returning with the confederate a few minutes later. The experimenter asked the confederate to sit in the open chair. After having the participant and confederate fill out consent forms, the experimenter explained that the purpose of the study was to examine how people work together, and

that the two of them would work together to complete a picture matching task. The experimenter asked the participant and confederate to move to the other side of the room and sit at desks separated by a divider. The experimenter then explained the picture matching task (Branigan et al., 2000). The pair was told that they would take turns describing pictures to each other, and that they would have two goals—to create a sentence to describe each picture, and to find the picture that matches the description given by their partner. The participant and confederate were each given two stacks of pictures—a "description stack" for them to describe pictures to their partner and a "matching stack" for them to use to find the pictures described to them. The confederate always went first in this task. The confederate was asked to begin by creating a sentence describing the first picture in her description stack, using the verb written at the top of the picture. She was told to say this sentence aloud. The participant was told that he/she was to find the picture his/her partner described in his/her matching stack. The participant was then instructed to create a sentence for the first picture in his/her description stack, using the specified verb. The confederate was instructed to find the picture in her matching stack. The pair was instructed to keep taking turns until all pictures had been described and matched. The experimenter asked if the participant or confederate had any questions, reminded them to listen carefully to what their partner said so that they could find the right picture, and started the audio recorder. The task was completed as described, except that the confederate used a script to describe each picture.

After the picture matching task, participants (individually) completed several tasks on a computer (the tasks used as individual difference measures, described above—both the instructions for the tasks and tasks themselves were administered via a computer) and filled out the questionnaire packet. Participants completed these tasks in a fixed order: they did the Simon effect task first, then they did the RAT task, next they did the flanker task, then they completed the questionnaire packet, the Conformity Scale, and the Belongingness Scale, and finally they did the Simon game last. Upon completion of the Simon game, participants were debriefed.

2.5.5 Design & Analysis

Audio files from the picture match task were transcribed, and the participants'

responses to the critical pictures were scored as DO, PO, or "other," following the criteria described in Kaschak (2007) by research assistants blind to the hypotheses of the current study. Trials on which an "other" response was made (5% of trials) were excluded from subsequent analyses. The dependent measure in this experiment was Match, which coded whether participants used the same sentence structure to describe the target picture as the confederate used in the directly preceding prime sentence (i.e., whether participants showed structural priming on a given trial). A trial was coded as "1" if the participant matched constructions (e.g., the participant produced a DO target description after hearing a DO prime sentence), and a "0" if the participant produced the alternative construction (e.g., producing a PO target following a DO prime sentence).

Mixed logit model analysis of the target descriptions was performed to predict the logit-transformed likelihood of a target using the same syntactic construction as the confederate's prime sentence. I performed the analysis with Match as the dependent measure, and participants and items as crossed random factors. The following variables were also included as predictors: Conformity Score, Belongingness Score, Creativity (RAT score), Inhibitory control A (response time and accuracy in the Simon effect task), Inhibitory control B (response time and accuracy in the flanker task), Pattern learning (score in the Simon game), Prime type (DO vs. PO), Verb repetition (Same verb vs. Different verb on prime and target trials), and the Prime type x Verb repetition interaction. (Note that the pattern learning data was entered into a separate analysis from that of the other individual difference variables to avoid problems with missing data due to computer error.) To avoid issues with collinearity, all variables were grand-mean centered before being entered into the analyses. The regression analyses were performed using the HLM statistical package (Raudenbush, Bryk, & Congdon, 2004).

2.6 Results & Discussion

The results of the mixed logit regression predicting the log odds of the participant matching the confederate's sentence structure are presented in Table 1. None of the individual difference variables predicted Match (all p's > .113). This finding is consistent with traditional views that although individual differences often play a large role in explicit and conscious processes, implicit processes are much less affected (if at

all) by individual differences (e.g., Reber, 1993; Stanovich, 2009). This finding is counter to Kaufman et al.'s (2010) claim that implicit tasks can be affected by individual differences. It is important to note; however, that certain social and cognitive factors (and even other individual differences, such as verbal reasoning abilities) may affect structural priming and that other types of nonconscious alignment (e.g., behavioral mimicry) may be affected by these or other individual differences. Further research is needed to further examine this.

Table 1: Results of Analysis from Experiment 1

Mixed Logit Model Results

Predictor	Coefficient	SE	*t*-value	df	*p*-value	Odds Ratio
Intercept	.294	.321	.917	473	.360	1.342
Creativity	.007	.029	.253	473	.801	1.007
Belongingness	.140	.223	.630	473	.529	1.151
Conformity	-.064	.147	-.432	473	.666	.938
Simon RT	.003	.003	1.000	473	.318	1.003
Simon Acc	-1.678	1.940	-.865	473	.501	.388
Flanker RT	.000	.001	.083	473	.934	1.000
Flanker Acc	1.879	1.187	1.583	473	.114	6.547
Pattern Learn	-.006	.005	-1.155	597	.249	.994
Prime	2.308	.907	2.545	473	.012	10.062
Verb	2.416	.904	2.673	473	.008	11.203
Prime X Verb	-1.225	1.283	-.954	473	.341	.294

Note: Simon RT = response time difference in Simon effect task, Simon Acc = accuracy difference in Simon effect task, Flanker RT = response time difference in flanker task, Flanker Acc = accuracy difference in flanker task, Pattern Learn = pattern learning

One might be concerned that the null results for the effects of the individual differences variables examined might simply reflect that poor measures were selected for assessing these social and cognitive variables. However, all of the measures employed in this experiment are standard for assessing the respective social and cognitive variables (Simon, 1969; Eriksen & Eriksen, 1974; Eriksen & Schultz, 1979; Conway et al., 2010; Bowman & Jung-Beeman, 2003; Mehrabian & Stefl, 1995; Leary et al., 2005). Additionally, Pearson correlations revealed relationships among the individual differences as would be expected. For example, as expected, scores on the

Belongingness Scale and the Conformity Scale were significantly correlated, $r = .383$, $p = .001$. Participants who had a higher need to belong also tended to conform more. Additionally, scores on the RAT were related to scores on the Conformity Scale, $r = -.350$, $p = .002$. Those who were more creative also tended to be less conforming. I therefore conclude that the lack of effects these variables had on structural priming was not due to merely choosing poor individual difference measures, but instead that the individual difference variables examined do not affect structural priming.

However, it may also be the case that individual differences only affect structural priming when one believes these abilities will be observed by others or if more implicit or subjective measures of personality traits are used (e.g., when participants are not directly asked to indicate how creative or conforming they tend to be). Indeed previous research suggests that subjective and objective measures of conformity may be affected differently by task dynamics (Griskevicius, Goldstein, Mortensen, Cialdini & Kenrick, 2006). Thus further investigation is necessary for determining if and how linguistic alignment can be affected by social and cognitive factors.

Although, as noted above, none of the individual differences variables affected Match, Prime type [$t(473) = 2.545$, $p = .012$] and Verb repetition [$t(473) = 2.673$, $p = .008$] were both significant predictors of Match. Structural priming was stronger when confederates produced a DO construction than when they produced a PO construction. I interpret the effect of Prime type as indicative of the fact that the items used in the picture matching task have a general bias toward eliciting the DO construction (see Kaschak 2007, Experiment 3, which used a similar set of pictures). The bias of the materials toward eliciting the DO construction functioned to raise the likelihood of participants matching a DO prime, and worked against the likelihood of participants matching a PO prime. Additionally, the effect of Verb repetition replicates the well-established "lexical-boost," in which participants are more likely to match the structure of the prime sentence when a lexical item (in this case, the verb) is repeated between prime and target trials (e.g., Pickering & Branigan, 1998; Hartsuiker, Bernolet, Schoonbaert, Speybroeck, & Vanderelst, 2008). The Prime type by Verb repetition interaction was not significant ($p = .341$).

CHAPTER 3

EXPERIMENT 2

The results of Experiment 1 suggest that individual differences do not affect the degree of structural priming that occurs. However, this does not mean that the level of linguistic alignment (as well as other types of alignment) cannot be affected by certain social and cognitive factors. Thus, in Experiment 2, I followed-up with examining how social and cognitive variables affect linguistic alignment by focusing primarily on one specific social variable—female fertility—and how it affects men's level of sentence structure alignment.

Female fertility is one social variable of potential influence on linguistic alignment. Support for the notion that female fertility may affect linguistic alignment comes from research in social and evolutionary psychology showing that women display several cues to their fertility level (e.g., body scent (e.g., Havlicek, Dvorakova, Bartosi, & Flegrs, 2006; Miller & Maner, 2010); facial skin tone (Roberts et al., 2004); tone of voice (Pipitone & Gallup, 2008); body symmetry (Manning, Scutt, Whitehouse, Leinster, & Walton, 1996); and waist-to-hip ratio (Kirchengast & Gartner, 2002)), that men can detect these cues to female fertility (e.g., Pipitone & Gallup, 2008; Miller & Maner, 2010), and that the detection of such cues can affect men's cognitions (e.g., Gangestad, Thornhill & Garver, 2002; Thornhill et al., 2003; Miller & Maner, 2011) and behaviors (e.g., Haselton & Gangestad, 2006; Miller & Maner, 2011). Additionally, female fertility is believed to be a particularly strong influence on the behavior of college-aged males, as the initiation of sexual and/or romantic relationships is a salient concern for young adult men (e.g., Rowland et al., 1993). Despite this, however, linguistic effects of female fertility have not yet been explored.

Although linguistic effects of female fertility have not yet been explored, there is additional reason to believe that such effects exist. Support comes from research on

behavioral mimicry, attraction, and mating. For example, van Straaten, Engles, Finkenaur, & Holland (2008) found that men mimic behavior (pen playing and posture) of a female task partner more when they perceive the woman to be attractive. Also, Miller and Maner (2011) found that men who interacted with a fertile woman were more likely to mimic the behavior of the woman than men who interacted with a less fertile woman. Furthermore, Ireland et al. (in press) found that alignment of lexical items correlated positively with both the initiation and stability of romantic relationships. Additionally, even though alignment (or a lack thereof) is important in general social situations (Pickering & Garrod, 2004), the presence and degree of alignment might be particularly important in mating situations (Ireland & Pennebaker, 2010).

Although, alignment during social interactions may promote affiliation (e.g., Lakin et al., 2003) and mutual romantic interest has been found to be associated with increases in alignment (Ireland et al., in press), there are reasons to expect that men who detect higher levels of female fertility may actually exhibit lower, rather than higher, levels of linguistic alignment. Support for this idea comes from the fact that creativity is an attractive quality in mates (Li, Bailey, Kenrick, & Linsenmeier, 2002). Additionally, evidence suggests that priming males with mating goals leads to displays of creativity (Griskevicius, Cialdini, & Kenrick, 2006), non-conformity (Griskevicius et al., 2006b), or other signs of fitness as a mate (e.g., increased willingness to spend on luxury items; Griskevicius et al., 2007). Similarly, Rosenberg and Tunney (2008) demonstrated that males tend to use more lower frequency words when primed with a mating motivation as compared to when they are primed with a friendship motivation. These data suggest that males may respond to fertility cues by producing displays of linguistic creativity or non-conformity, which may lead to lower levels of structural priming (i.e., creativity/conformity may be shown by producing different sentence structures than those produced by the confederate). Thus, males may use linguistic non-conformity or creativity—different sentence structures—as a means of standing out to attract attention. Therefore, the effect of (cues to) female fertility on linguistic alignment of men might not be as straightforward as it appears.

Thus, I entertained two hypotheses for how female fertility might affect the amount of structural priming in men. From the view that detection of cues to high levels

of fertility will lead male participants to find the female confederates as more attractive and thus to align their linguistic structure with the confederates for affiliation, (1) higher levels of female fertility might be associated with an *increase* in structural priming. However, from the view that detection of cues to high levels of fertility will lead male participants to find the females confederates as more attractive and thus to be creative or nonconforming in their linguistic structure in attempt to stand out in order to be perceived as more attractive by fertile females, (2) higher levels of female fertility might be associated with a *decrease* in structural priming.

In addition to examining how female fertility affects linguistic alignment, I also investigated (1) whether men and women in conversations align on vocal pitch and (2) if female fertility affects the amount of vocal pitch alignment that occurs. Although previous studies have shown that alignment occurs on a number of linguistic elements (e.g., sentence structure (Bock, 1986; Branigan et al., 2000), accents (Giles & Powesland, 1975), rate of speech (Webb, 1969, 1972), tone of voice (Neumann & Strack, 2000), and lexical choices (Brennan & Clark, 1996)), alignment of vocal pitch has not yet been explored. Because extant evidence has demonstrated linguistic alignment on so many other levels, I predicted that vocal pitch alignment would also occur between conversational partners (male participants and female confederates). In terms of looking at how female fertility might affect vocal pitch alignment, I was particularly interested in testing whether the voices of men interacting with fertile women become either (a) lower in pitch/more masculine (e.g., evidence of the fact that men were trying to show off their masculinity to fertile women), or (b) higher in pitch/more feminine (e.g., providing more evidence of (linguistic) alignment intended to facilitate affiliation; Lakin et al., 2003) than the voices of men interacting with less fertile women.

Indeed previous studies on female fertility have found that the vocal pitch of women fluctuates with changes in their fertility (Bryant & Haselton, 2009), that men can detect this change (Abitbol et al., 1999), and that they rate the voices of fertile women as being more attractive than the voices of less fertile women (Pipitone & Gallup, 2008). However, extant research has not examined if or how men's vocal pitches change in response to the detection of cues to female fertility. Data showing that men's vocal pitches change in response to the detection of cues to female fertility would provide

additional evidence that interacting with a fertile woman can lead to physiological changes in men (Miller & Maner, 2010). Additionally, previous studies of how female fertility affects vocal pitch have not examined vocal pitch in the context of social interactions (e.g., Bryant & Haselton, 2010) that may be more generalizable to real-life conversations. Thus, it is important to look at how vocal pitch and alignment of vocal pitch are influenced by female fertility in social communication tasks. Importantly, if the results of Experiment 2 show that female fertility affects linguistic and/or vocal pitch alignment, these findings would lend additional support to the idea that linguistic alignment can indeed be affected by social variables.

3.1 Method

3.1.1 Participants

The participants were 123 male undergraduates from Florida State University. Due to the purposes of this study, two participants were excluded from the analysis for reporting a homosexual orientation. Another participant was eliminated because of missing data. Thus, a total of 120 participants were included in the data analysis. Participants received partial course credit in exchange for their participation.

3.1.2 Confederates

Because my primary goal was to examine the effects of female fertility, 5 undergraduate women (ages 18-22) not taking hormonal contraceptives served as confederates. Confederates interacted with male participants throughout their menstrual cycles. Confederates' menstrual cycles were tracked by having the confederates email me the onset and end dates of each menses during the time that they were involved in data collection. The training and handling of the confederates followed the procedures of Miller and Maner (2011, Study 3). Additionally, to minimize extraneous odors that might mask olfactory cues to fertility, confederates showered with unscented soap and shampoo, and refrained from using deodorant before each session. Furthermore, to minimize variability between sessions, confederates wore jeans and a t-shirt when collecting data and maintained the same hairstyle throughout the course of data collection. They also refrained from wearing make-up to the sessions. Confederates

knew that the study involved tracking their menstrual cycle, but were unaware of the exact hypotheses being investigated.

3.1.3 Experimenters

To prevent the participants from being exposed to fertility cues from the experimenters, only females using hormonal birth control (and thus not presenting cues to fertility) were selected to serve as experimenters.

3.1.4 Materials

The picture sets from Experiment 1 were used for the picture matching task. As in Experiment 1, Audacity (GNU General Public License, 2006) was used to record all picture descriptions. Also, a questionnaire packet was used to assess several variables. First was a demographic form asking participants to report their age, sex, sexual orientation, and relationship status. The next form was an "Impressions of Partner" form, which required participants to indicate their impression of their (confederate) partner (from 1 = "not at all" to 5 = "extremely") on several dimensions: intelligent, flirtatious, outgoing, attractive, happy, sad, angry, and sexually aroused. The Impressions of Partner form was used as a manipulation check to make sure that any changes in participants' degree of structural priming did not depend on their impression of the confederates. I also used the Chemical Sensitivity Scale (CSS; Nordin et al., 2003), which contains 21 items designed to measure sensitivity to odors or pungent substances (e.g., "I would not mind living on a street with odorous/pungent car exhausts if the apartment I had was nice"). Given that changes in scent are a cue to fertility, I was interested in whether any observed effects depend on the participants' sensitivity to smells (see Miller and Maner, 2011). The last form in the questionnaire packet was the Revised Sociosexuality Orientation Inventory (RSOI; Penke & Asendorph, 2008). The RSOI is a 9-item scale that tests orientation toward uncommitted sex. It is comprised of 3 3-item subscales, and responses are made using 9-point scales. The behavior subscale asks about sexual behavior (e.g., "with how many different partners have you had sex within the past 12 months"), and responses are made using a scale ranging from "0 partners" to "20 or more partners." The attitude subscale asks about sexual attitudes (e.g., "How much do you

agree with this statement: 'Sex without love is ok.'"), and responses are made using a scale ranging from 1 (strongly disagree) to 9 (strongly agree). The desire subscale asks about sexual desire (e.g., "How often do you have fantasies about having sex with someone you are *not* in a committed romantic relationship with?") and responses are made using a scale ranging from "never" to "at least once a day."

I also included a measure of state conformity in this experiment. As in Experiment 1, a measure of conformity was included largely because I was interested in whether the participants' tendency toward conformity might affect their level of alignment with female confederates. However, the measure of conformity employed in this experiment is different in a number of potentially important ways from the one used in Experiment 1. Contrary to the conformity measure used in Experiment 1, the conformity measure used in the current study is more implicit and subjective and more of a trait measure of conformity. One final potentially important difference between the conformity measure used in the current experiment and that of Experiment 1 is that before completing the measure of state conformity in the current experiment, participants were led to believe that their partner (i.e., the confederate) would be observing their responses, whereas this was not the case in Experiment 1. Indeed these features may lead to different results, as previous research suggests that mate priming situations only affect conformity when it is measured subjectively (Griskevicius et al., 2006b). The state conformity measure I used was a very slightly modified version of the conformity measure used by Griskevicius et al. (2006b, Study 2), and consists of six subjective choices requiring participants to indicate their preference between two similar items. That is, participants are asked to indicate which of two similar items they prefer (e.g., (a) a Mercedes-Benz or (b) a BMW) for each of six choices. Importantly, participants indicate their preferences on a form that has already been "filled out by two other participants." In reality, the form was completed by research assistants, and the indicated preferences were scripted so that there was apparent consensus between the two "other participants" as to four of the preferences (the *critical items*). The other two choices were merely included as fillers as it was expected that agreement on all the choices may not be as plausible to the participants. State conformity is ascertained from this measure by

calculating the proportion of conforming responses on the critical items by each participant.

A speech analysis software program called PRAAT (Boersma & Weenink, 2011) was used to measure the average pitch (in hertz) of each picture description produced by all of the participants and confederates.

Fertility status of one's task partner (operationally defined as conception risk, e.g., Miller & Maner, 2010) based on day of the menstrual cycle was determined using the table of conception risk values from Wilcox et al. (2001). Higher conception risk values indicate higher levels of fertility (Wilcox et al., 2001).

3.1.5 Procedure

The procedure from Experiment 1 was used for greeting participants, directing participants and confederates to the lab, explaining the purpose of the study, and explaining and conducting the picture matching task. When the picture matching task was completed, the experimenter stopped the audio recorder and gave the participant and confederate each a questionnaire packet and then administered the state conformity measure. Once these forms were completed, the participants were debriefed.

3.1.6 Design & Analysis

The IV of primary interest was fertility level of the confederates. Following previous research (e.g., Navarrete, Fessler, Fleischman, & Geyer, 2009, Miller & Maner, 2010), fertility level was operationalized as *conception risk,* with conception risk values (from Wilcox et al., 2001) being estimated according to the day of the confederate's menstrual cycle on which the interaction took place.

Audio files from the picture match task were transcribed, the participants' responses were scored as DO, PO, or "other," and match scores for each participant were calculated, as in Experiment 1. (Trials in which a description other than a DO or PO was produced (4% of trials) were excluded from the analysis.) The dependent measure in this experiment, as in Experiment 1, was Match. (Matches were coded as in Experiment 1.) Mixed logit model analysis of the target descriptions was performed to predict the logit-transformed likelihood of a target using the same sentence structure as that of the

confederate's directly preceding prime sentence. I performed an initial analysis with Match as the dependent measure, and participants and items as crossed random factors. The following variables were also included as predictors: conception risk, relationship status, the interaction of conception risk and relationship status, smell sensitivity, the interaction of smell sensitivity and conception risk, conformity, the interaction of conformity and conception risk, Prime type (DO vs. PO), Verb repetition (Same verb vs. Different verb on prime and target trials), the Prime type x Verb repetition interaction, RSOI-Behavior, RSOI-Attitude, RSOI-Desire, RSOI-Total average, and the 8 variables on which the participant rated the confederate. To avoid issues with collinearity, all variables were grand-mean centered before being entered into the analysis. Because participants' individual differences on the RSOI (and its subscales) and their ratings of the confederates were generally not significant predictors of match, I subsequently ran a simpler model including only those variables which seemed to be reasonably good predictors of Match. To yield more interpretable coefficients for conception risk, I multiplied the conception risk values by 100 to convert them to a percentage (ranging from 0 to 10) for the final analysis. The regression analyses were performed using the HLM statistical package (Raudenbush et al., 2004). Whereas the regression analysis was performed on the single-trial level, for ease of presentation, the scatterplots of the data display each participant's total of proportion of matching responses on the y-axis and the predictor variables of interest on the x-axis. Note that conception risk is presented as a proportion (rather than percentage) in the figures.

3.2 Results & Discussion

3.2.1 Structural Priming

I began by analyzing participants' ratings of the confederates to ensure that changes in conception risk were not accompanied by other changes that might account for the effects of conception risk on structural priming. As in Miller and Maner's (2011) Experiment 3 (on which this experiment was modeled), a regression analysis in which participants' ratings were used to predict conception risk revealed that none of the rating variables were significant predictors of risk (all p's > .11), as well as that the combination

of all the variables did not account for a significant amount of variability in conception risk [$F < 1$].

The results of the mixed logit regression predicting the log odds of the participant matching the sentence structure of the confederate are presented in Table 2[1].

Table 2: Results of Analysis from Experiment 2

Mixed Logit Model Results

Predictor	Coefficient	SE	*t*-value	df	*p*-value	Odds Ratio
Intercept	.467	.339	1.374	932	.170	1.594
Conception Risk	-.080	.028	-2.889	932	.004	.932
Intelligence	.124	.148	.835	932	.404	1.132
Flirtatious	.213	.095	2.236	932	.026	1.237
Angry	.352	.169	1.090	932	.037	1.422
Smell	000.	.009	.013	932	.990	1.000
Rel. Status	.378	.216	1.751	932	.080	1.459
Risk X Smell	-.005	.003	-1.645	932	.100	.995
Conformity	.658	.339	1.940	932	.052	1.930
Prime	1.618	.678	2.385	932	.017	5.044
Verb	1.663	.679	2.451	932	.015	5.276

Note: Rel. Status = relationship status, Smell = smell sensitivity, Risk X Smell = conception risk X smell sensitivity

Conception risk had a significant effect on the likelihood of the participant matching the construction produced by the confederate [$t(932) = -2.889$, $p = .004$]. As the conception risk of a confederate increased, the participant became less likely to linguistically align with the confederate (i.e., structural priming decreased; see Figure 2). This relationship between conception risk and structural priming is consistent with the second possibility considered in the introduction, namely that detection of fertility cues is associated with higher levels of creative or non-conforming behavior (such as not aligning one's linguistic choices with those of a conversational partner). I follow the claims of Miller and Maner (2011) in making the following proposal for how conception risk interacts with structural priming: (1) detection of fertility cues activates mating goals in men, (2) the activation of mating goals in turn leads to displays of fitness as a mate (such as creative or non-conforming behavior), and (3) creativity and non-conformity

within the current task manifested itself as the participants not aligning their sentence structure choices with those of their conversational partner.

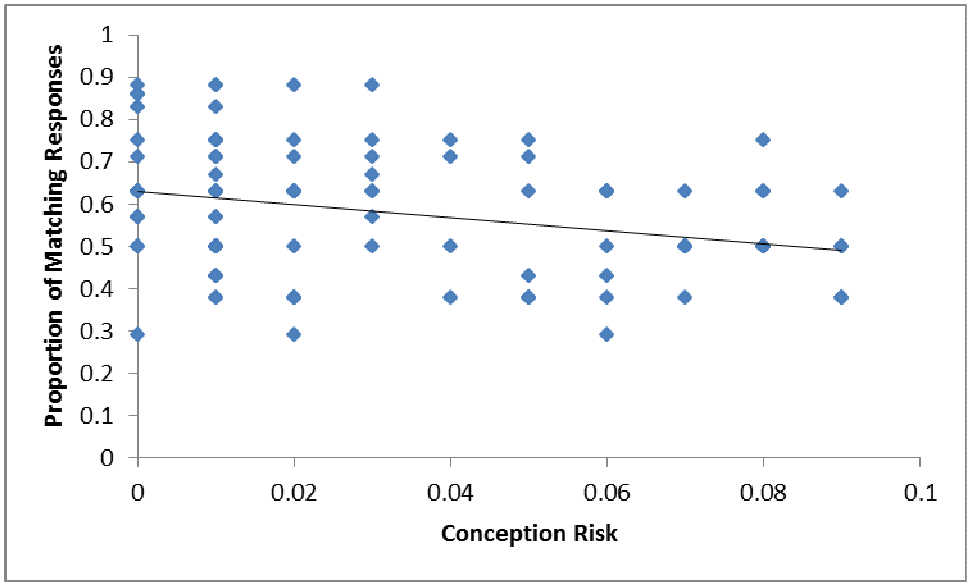


Figure 2: Proportion of trials on which participants matched the sentence structure of the confederate as a function of conception risk.

Aside from conception risk, I also found that participants' perceptions of the confederates' flirtatiousness and anger, and participants' state conformity and relationship status were related to structural priming. (Note that none of these variables were related to the conception risk of the confederate.) Participants' ratings of the flirtatiousness of the confederates had a significant effect on structural priming [$t(932) = 2.236$, $p = .026$]. As participants' ratings of the confederates' flirtatiousness increased, structural priming also increased (see Figure 3). The participants did not find the confederates to be especially flirtatious (mean rating = 1.94 out of 5), but those who did showed stronger structural priming. This result is consistent with the broad literature showing that conversational partners signal affiliation by aligning their linguistic behavior (e.g., Giles et al., 1991). Given that flirtatiousness and conception risk are both relevant to mating goals, it raises the question of why conception risk and flirtatiousness affected structural priming in opposite directions. I propose the following answer: when a participant perceives the confederate as flirtatious (i.e., he perceives interest on the part of the confederate), there is no need to signal fitness as a mate—the woman has already

signaled her interest. As such, the appropriate social strategy is to reciprocate the affiliation shown by the confederate. Within the context of the present task, this can be accomplished by matching the structure of the utterances produced by the confederate. However, when the participant does not perceive the confederate as particularly flirtatious (as was the case for many of the participants in this study), the confederate has not signaled any particular interest in the participant. As such, when cues to fertility activate mating goals in the participant, the appropriate social strategy is to signal fitness as a mate in an effort to increase interest on the part of the confederate.

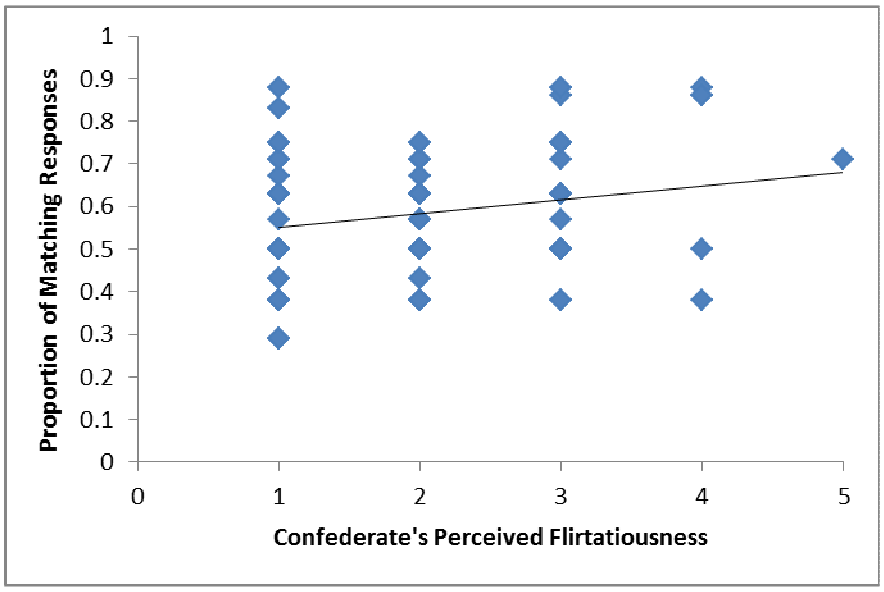


Figure 3: Proportion of trials on which participants matched the sentence structure of the confederate as a function of the participants' ratings of the confederates' flirtatiousness.

Likewise, participants' ratings of the confederates' anger was a significant predictor of structural priming—as perceptions of the confederates' anger increased, structural priming also increased [$t(932) = 1.090$, $p = .037$]. That is, participants were more likely to match the sentence structure of a confederate when they perceived the confederate to be angry (see Figure 4). Similarly, Balcetis and Dale (2005) report that participants showed stronger structural priming when they interacted with a mean confederate than when they interacted with a nice confederate. They interpret this outcome as being indicative of efforts toward social repair: when the confederate is perceived as mean or impatient, participants match the confederate's sentence structures

as a means of showing affiliation with the confederate, which is meant to facilitate the interaction. Although most participants in the current study did not find the confederates to be particularly angry (mean rating = 1.17 out of 5), the few participants who did may have been more likely to match the constructions produced by the confederate in an effort toward social repair.

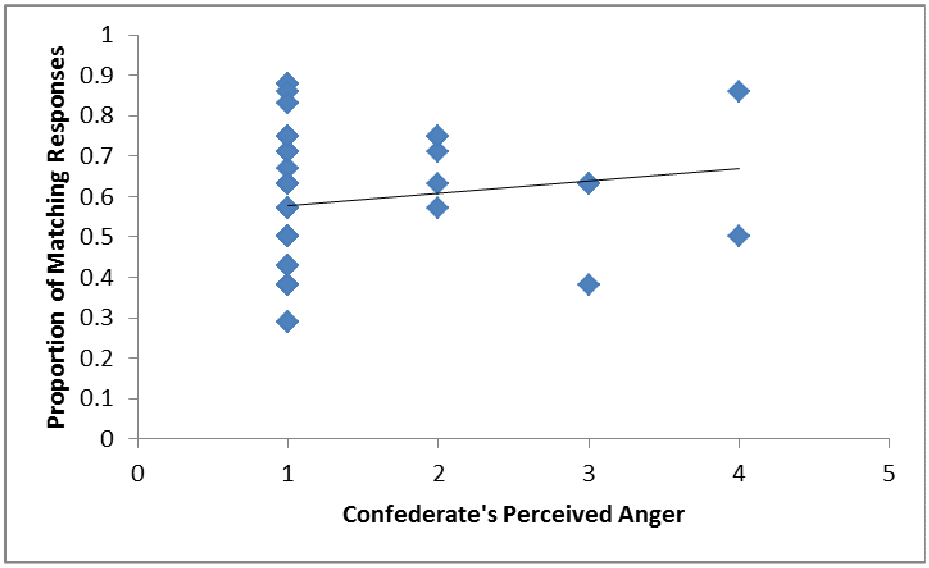


Figure 4: Proportion of trials on which participants matched the sentence structure of the confederate as a function of the participants' ratings of the confederates' anger.

Additionally, participants' level of state conformity was a marginally significant predictor of structural priming [$t(932) = 1.940$, $p = .052$], with higher levels of state conformity associated with an increase in structural priming (see Figure 5). This pattern is consistent with the notion that individuals with a tendency toward conformity may show a greater degree of alignment to their conversational partners (i.e., they will show greater conformity to the norms of the conversation). On a broader level, there is a parallel between this finding and Labov's (2001) claim that the individuals most responsible for driving linguistic change within a community tend to have a non-conformist streak. Leading a linguistic change requires departing from the linguistic norms of one's speech community, and it may well be the case that individual differences on personality characteristics play a role in determining who drives language change and how quickly changes move through a community.

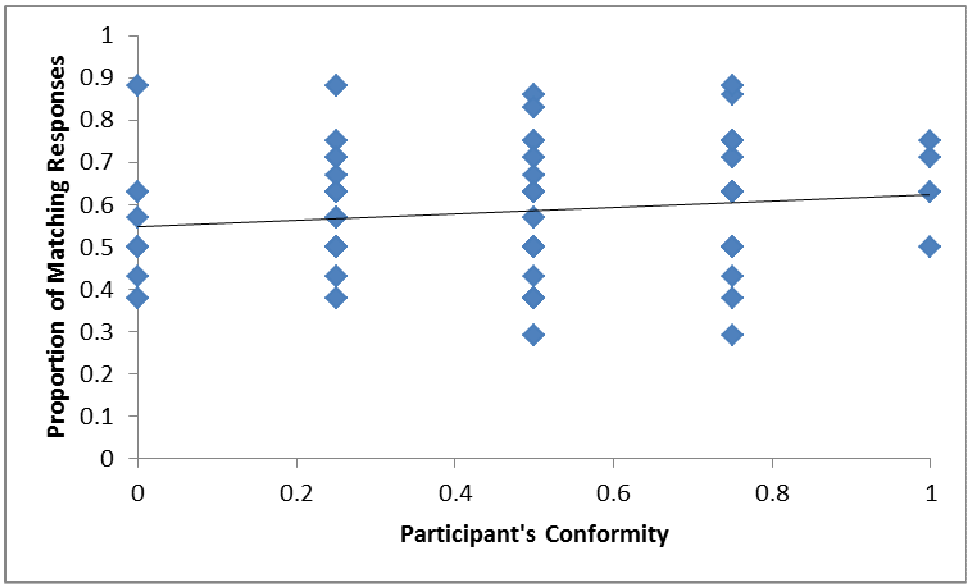


Figure 5: Proportion of trials on which participants matched the sentence structure of the confederate as a function of participants' level of conformity.

I have an additional comment about the effects of flirtatiousness, anger, and conformity on structural priming. Although the reported effect of conception risk on structural priming is consistent with some elements of the literature on romantic relationships (particularly the idea that men may use non-conforming behavior to stand out to female conversation partners), the effect would appear to be at odds with a wide range of data suggesting that attraction to a conversational partner should lead to an increase in matching behavior (e.g., Giles et al., 1991; Ireland et al., 2011). The contradiction between the current data and previous work on alignment in conversation raises the possibility that there may be something unusual about the current interaction task that is driving the nature of the relationship between conception risk and structural priming. This concern is ameliorated to an extent by the finding that flirtatiousness, anger, and conformity all lead to an increase in matching, as would be predicted on the "affiliation = alignment" view. The present conversational task does reveal these established social effects on alignment, but it appears that conception risk and the associated activation of mating goals may motivate speakers' behavior in a different way than the other social variables seen to affect structural priming in this study.

Ireland et al. (2011) note the shortage of research on linguistic behavior in relationships, and further note the importance of linguistic alignment (or a lack thereof) as a signal of the promise and stability of a relationship. The current data add to this literature by suggesting that the role of linguistic behavior in the development of romantic relationships may not be as simple as the idea that people will align their linguistic behavior with that of attractive potential mates. Indeed, conversational partners may align their linguistic behavior (or not) based on a range of factors. If the potential mate has signaled interest in you, linguistic alignment may be a means of reciprocating that interest and developing a social bond. If the potential mate has not signaled an interest in you, non-alignment of linguistic choices may be a means of displaying one's fitness as a mate—and thereby attracting the potential mate's interest (Rosenberg & Tunney, 2008).

Furthermore, the lack of an interaction between relationship status and conception risk (i.e., the effect of conception risk was the same whether or not the male was in a committed relationship) suggests that this effect reflects unconscious, implicit changes in linguistic behavior. Miller and Maner (2010, 2011) demonstrated that relationship status affects men's responses to fertility cues when explicit behaviors are examined (e.g., providing ratings of the attractiveness of a woman), but not when implicit behaviors are examined (e.g., assessing the priming of concepts via a stem completion task). The idea that the effects of conception risk on structural priming reflect implicit, unconscious behaviors on the part of the participant is consistent both with the theory that structural priming reflects implicit learning in the language production system (e.g., Chang et al., 2006), and with claims that many sorts of behavioral and linguistic mimicry during interpersonal interaction occur on an unconscious level (e.g., Miller & Maner, 2011; Giles et al., 1991; Pickering & Garrod, 2009).

Relationship status was also a marginally significant predictor of structural priming [$t(932) = 1.751$, $p = .080$], with participants in committed relationships exhibiting more structural priming than those who were not in committed relationships (see Figure 6). Although the idea that men in relationships would align more with women (other than their romantic partner) than would men not in relationships may initially appear to be at odds with prior expectations, there is a possible explanation for

this effect. In the context of the current conversation task, a man only has two options: to align with the woman's sentence structure or to not align with her sentence structure. Since, as discussed above, choosing to *not* align on sentence structure might be a strategy motivated by the desire to attract more attention from women (by displaying creativity and non-conformity), it makes sense that men in relationships would instead chose to align (i.e., would not chose to misalign) with the sentence structure of their conversational partner.

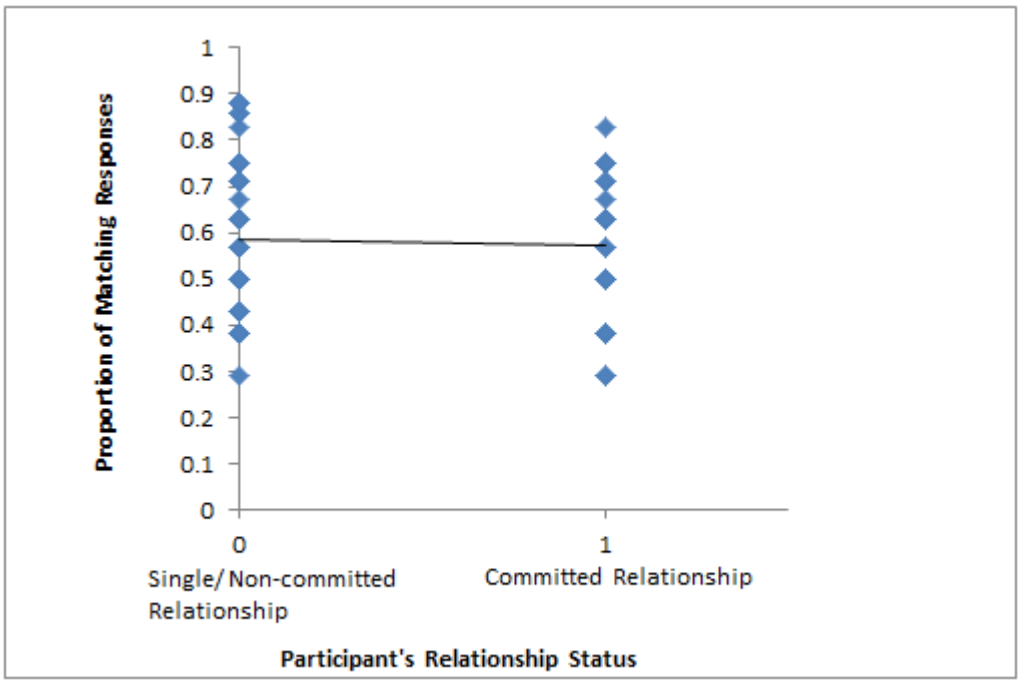


Figure 6: Proportion of trials on which participants matched the sentence structure of the confederate as a function of participants' relationship status.

Beyond the effects noted above and as in Experiment 1, Prime type [$t(932) = 2.385$, $p = .017$] and Verb repetition [$t(932) = 2.451$, $p = .015$] both had significant effects on structural priming. Structural priming was stronger when confederates produced a DO construction than when they produced a PO construction. As in Experiment 1, I interpret the effect of Prime type as indicative of the fact that the items in the picture matching task have a general bias toward eliciting the DO construction (see Kaschak, 2007, Experiment 3). Also as in Experiment 1, the effect of Verb repetition

replicates the well-established "lexical-boost" effect, in which participants are more likely to match the structure of the prime sentence when lexical items (e.g., the verb) is repeated between prime and target trials (e.g., Pickering & Branigan, 1998; Hartsuiker et al., 2008). However, ratings of the confederates' intelligence, participants' reported smell sensitivity, the interaction of conception risk and smell sensitivity, and the interaction of Prime type and Verb repetition were not significant predictors of Match (p's > .16).

3.2.2 Vocal Pitch

I conducted follow-up analyses to assess the effect of vocal pitch on linguistic alignment. Due to computer error, pitch information from 7 participants was not available; therefore, data from 113 participants was included in the analyses. Pearson correlations revealed a significant correlation between female (confederate) vocal pitch and male (participant) vocal pitch, $r = .252$, $p < .001$. As the vocal pitch of females increased, so did the vocal pitch of males—that is, consistent with my prediction, males and females in conversation aligned on vocal pitch. This finding is consistent with the results of previous studies which provide evidence of speakers aligning on a number of linguistic elements, such as sentence structure (Bock, 1986; Branigan et al., 2000), accents (Giles & Powesland, 1975), and rate of speech (Webb, 1969, 1972), and is among the first to demonstrate that linguistic alignment also occurs at the level of vocal pitch.

Additionally, female vocal pitch was significantly correlated with conception risk, $r = -.104$, $p = .002$. As conception risk increased, female vocal pitch decreased. Although this finding is consistent with previous accounts that the vocal pitch of a women fluctuates along with her own menstrual cycle (e.g., Abitbol et al., 1999), it is counter to a previous finding that female vocal pitch *increases* as fertility increases (Bryant & Haselton, 2009). However, there is one major methodological difference may help explain the apparent discrepancy between these results. The current study employs a social communication task whereas other extant studies that examine the effects of female fertility on vocal pitch (e.g., that of Bryant & Haselton, 2009) do not involve social communication or any type of interaction. Instead, previous studies have measured women's vocal pitch in solitude by having a woman speak a scripted sentence, a few

individual words, or even isolated vowel sounds while she is alone in a quiet room (e.g., Bryant & Haselton, 2009; Piptone & Gallup, 2008). Furthermore, as women in these previous studies did not interact with others during the vocal task, their vocal pitches could not have been affected by that of a conversation partner. Due to the nature of the *current* study, however, it is possible that changes in female vocal pitch were affected by male vocal pitch. That is, perhaps female vocal pitch was negatively related to female fertility because at high fertility, *women* were aligning with the vocal pitch of men more than when they were at low fertility. Indeed previous studies have not examined how the vocal pitch of fertile women is affected by the vocal pitch or mere presence of a (male) conversational partner. Additional research is needed to further explore the interactions between female fertility, vocal pitch, and vocal pitch alignment in social communication tasks.

Male vocal pitch was not correlated with conception risk ($p = .389$). Additionally, neither male vocal pitch, female vocal pitch, nor the difference between male and female vocal pitch was correlated with match (p's > .182).

To further explore the effects of vocal pitch on structural alignment, mixed logit model analysis of the target descriptions was performed to predict the logit-transformed likelihood of a target using the same sentence structure as that of the confederate's prime sentence. I included Match as the dependent measure, and participants and items as crossed random factors. The following variables were also included as predictors: female vocal pitch, conception risk, the interaction of female vocal pitch and conception risk, conformity, the interaction of female vocal pitch and conformity, relationship status, the interaction of female vocal pitch and relationship status, flirtatiousness, the interaction of female vocal pitch and flirtatiousness, attractiveness, the interaction of female vocal pitch and attractiveness, anger, the interaction of female vocal pitch and anger, Prime type, Verb repetition, and Prime type x Verb repetition. Note that male vocal pitch and the difference in vocal pitch between men and women were excluded from the analysis (as were the corresponding interactions) because male vocal pitch, female vocal pitch, and the difference in vocal pitch between men and woman were all highly correlated—thus including more than one of these variables would have resulted

in problems with collinearity. Female vocal pitch was not a significant predictor of match (p = .150).

However, as when vocal pitch was not included in the analysis, several of the other variables were found to be predictors of match when female vocal pitch was included. Conception risk had a significant negative relationship with match. As the conception risk of a confederate increased, the participant became less likely to linguistically align with the confederate (i.e., structural priming decreased) [t(859) = -2.482, p = .014]. Relationship status, Prime type, and Verb repetition all had positive relationships with match. Participants who were in committed relationships were more likely to align with the sentence structure of the confederates [t(859) = 2.148, p = .032]. The effect of Prime type reveals that structural priming was stronger when confederates produced a DO construction than when they produced a PO construction [t(859) = 2.376, p = .018]. The effect of verb repetition reveals that participants were more likely to match the structure of a prime sentence when lexical items (e.g., the verb) was repeated between prime and target trials [t(859) = 2.438, p = .015]. Also, flirtatiousness was a marginally significant predictor of match. As participants' ratings of the confederates' flirtatiousness increased, structural priming also increased [t(859) = 1.906, p = .057]. Additionally, the interaction of female vocal pitch and anger was a significant predictor of match. As female vocal pitch increased, participants' perceptions of the confederates' anger had less of an effect on structural priming [t(859) = -2.508, p = .040].

I also conducted additional HLM analyses to examine predictors of the difference in vocal pitch between men and women across trials. Flirtatiousness was a significant predictor of the difference in vocal pitch across trials, [t(849) = 2.580, p = .010]. As the conversation progressed (i.e., as the men and women spoke more), flirtatiousness had a greater effect on the vocal pitch difference between men and women such that higher levels of perceived flirtatiousness were associated with a grater convergence in vocal pitch between men and women as the conversation progressed. However, neither match, conception risk, anger, nor conformity were significant predictors of the difference in vocal pitch between men and women across trials (all p's > .109).

CHAPTER 4

GENERAL DISCUSSION

The current study explores how a range of social and cognitive factors affect the level of linguistic alignment that occurs. The results of Experiment 1 suggest that individual differences in pattern learning, inhibitory control, creativity, trait conformity, and the need to belong do not affect the degree to which one aligns with the sentence structure of a conversational partner. These results imply that some types of implicit learning (e.g., structural priming) may not be subject to individual differences in certain abilities and personality traits. These results are consistent with traditional views that although individual differences often play a large role in explicit and conscious processes, implicit processes may be much less affected by individual differences (e.g., Reber, 1993; Stanovich, 2009).

However, the results of Experiment 2 indicate that linguistic alignment *can* be affected by certain social and cognitive factors. This experiment demonstrates that socially-relevant characteristics of one's conversational partner (e.g., fertility level, flirtatiousness, and anger) and even select individual differences (e.g., state conformity and relationship status) can affect one's degree of structural priming. Conception risk was negatively related to structural priming—as the conception risk of a confederate increased, participants became less likely to linguistically align with the confederate (i.e., structural priming decreased). Flirtatiousness, anger, state conformity, and relationship status were all positively related to structural priming. As participants' ratings of the confederates' flirtatiousness and anger increased, structural priming also increased. Also, participants who were conforming and those who were in committed relationships were more likely to align with the sentence structure of the confederates compared to participants who were less conforming and those who were not in committed relationships. As argued by Kaufman et al. (2010), these results imply that individual

differences can indeed play an important role in implicit learning tasks. Additional research is needed to further explore the impact that individual differences, as well as other social and cognitive factors, have on the level of structural priming that occurs and on performance in other implicit processes.

Not only does the current study identify a couple social variables in particular that affect the degree of language structure alignment, but methodological differences between the two experiments also provide insight into the conditions in which other social and cognitive variables may affect the amount of language structure alignment that occurs. For example, it may be the case that individual differences in personality characteristics only affect structural priming when one believes these abilities will be observed by others or if more implicit or subjective measures are used (e.g., when participants are *not* directly asked to indicate how creative or conforming they tend to be). Indeed previous research suggests that conformity scores on subjective and objective measures are affected differently by social dynamics and that perhaps only subjective measures of conformity are affected by mate priming situations (Griskevicius et al., 2006b).

Additionally, the results of the experiments suggest that the social dynamics between two people in a conversation may play an important role in determining how social and cognitive factors affect the amount of structural priming that occurs. Experiment 1 examined female-female and male-female dyads. Thus, I investigated both within-sex and same-sex effects within this experiment. The results of this experiment (and the results of the combined analysis using data from both experiments) suggests that whether or not participants and confederates were of the same sex affected both (1) the amount of structural priming that occurred and (2) the impact that conception risk had on structural priming (see the footnote). Thus, it is possible that the importance of other social and cognitive factors may depend on the social dynamics at hand. Additionally, differences in the social dynamics between the two experiments (Experiment 1 focused on same-sex dyads, whereas Experiment 2 focused on opposite-sex dyads) may help explain why individual differences in conformity affected structural priming in Experiment 2 but not in Experiment 1.

Furthermore, the lack of an interaction between relationship status and conception risk (i.e., the effect of conception risk was the same whether or not the male was in a committed relationship) suggests that the effect of conception risk on structural priming reflects unconscious, implicit changes in linguistic behavior. Miller and Maner (2010, 2011) demonstrate that relationship status affects men's responses to fertility cues when explicit behaviors are examined (e.g., providing ratings of the attractiveness of a woman), but not when implicit behaviors are examined (e.g., assessing the priming of concepts via a stem completion task). The idea that the effect of conception risk on structural priming reflect implicit, unconscious behaviors on the part of the participant is consistent both with the theory that structural priming reflects implicit learning in the language production system (e.g., Chang et al., 2006), and with claims that many sorts of behavioral and linguistic mimicry during interpersonal interaction occur on an unconscious level (e.g., Miller & Maner, 2011; Giles et al., 1991; Pickering & Garrod, 2009).

Although there are several well-developed theories of structural priming (e.g., Pickering & Branigan, 1998; Chang et al., 2006), none of these theories currently consider the role that social or cognitive variables might play in affecting the strength of structural priming effects. In my view, the current data does not represent a detailed enough look at the effects of social and cognitive variables on structural priming to provide an effective assessment of how extant theories might incorporate the influence of social factors. Nonetheless, I feel that continued investigation of these effects (and other social and cognitive effects on structural priming) will be an important step in developing and evaluating theories of structural priming.

On a broader level, the current results have implications for the representations that underlie acquisition, comprehension, and production of language (Bock et al., 2007; Pickering & Ferreira, 2008). If the mechanisms that give rise to structural priming also underlie language acquisition, comprehension, and production (Chang et al., 2006), the fact that structural priming can be affected by individual differences and other social and cognitive factors suggest that these factors may also play an important role in the acquisition, comprehension, and production of language. These factors may also be important to the occurrence of other types of alignment (e.g., behavioral alignment)

(Pickering & Ferreira, 2008). Previous studies of these phenomena which ignore the effects of social and cognitive variables may be overlooking important aspects of understanding how we develop and use language as well as other aspects of our social cognition and behaviors. Further exploration of the effects of social and cognitive factors could be helpful in advancing these current theories.

Furthermore, the results of Experiment 2 provide evidence that not only do speakers align on sentence structure (Bock, 1986; Branigan et al., 2000), lexical choices (Brennan & Clark, 1996), accents (Giles & Powesland, 1975), tone of voice (Neumann & Strack, 2000), rate of speech (Webb, 1969, 1972), and speech rhythms (Cappella & Panalp, 1981), but instead, demonstrate that linguistic alignment extends to the level of vocal pitch. That is, the current study indicates that conversational partners also align on vocal pitch. Beyond this, the results provide further evidence that a woman's fertility level (i.e., conception risk) affects her vocal pitch and also imply that female fertility may affect vocal pitch differently in social communication tasks as compared to tasks that simply require one to recite a sentence or word (e.g., Bryant & Haselton, 2009). Additional research is needed to further explore the interactions between female fertility, vocal pitch, and vocal pitch alignment in social communication tasks.

Several limitations of the current research provide valuable opportunities for further investigation. The current study only employed one paradigm to look for effects on linguistic alignment—a picture description task (Branigan et al., 2000). Future research should follow-up by examining if and how social and cognitive factors affect alignment at other linguistic (e.g., lexical choice) and nonlinguistic (e.g., behavioral) levels. This research is also limited by the fact that I only examined a handful of social and cognitive variables. There are many other social and cognitive factors (e.g., extroversion, dominance, and intelligence) that might affect the degree to which one aligns with a conversational partner. Further research could also explore the role of social and cognitive variables in male-male dyads and among larger groups of people.

4.1 Conclusion

For decades, social and cognitive approaches to language have had very little interaction (see Pickering & Garrod, 2004, for a discussion). The present demonstration

that a well-studied psycholinguistic phenomenon (structural priming) can be affected by social variables, combined with recent work on social aspects of language use (e.g., Ireland et al., in press), suggests that it may be profitable for researchers in both fields to pursue work at the intersection of cognitive and social approaches to language. Although I am only beginning to scratch the surface with respect to understanding how social and cognitive factors affect structural priming, it is my hope that findings such as these will arouse interest in bridging together these long-standing traditions of language research.

APPENDIX A

FOOTNOTE

[1]I conducted a follow-up to this analysis using data from Experiment 1. Although the primary purpose of Experiment 1 was to examine the effects of individual difference variables on linguistic alignment, conception risk information was available on two of the confederates in Experiment 1. Both of these confederates were undergraduate women (ages 21 and 23) who were not taking hormonal contraceptives. The training and handling of the confederates followed the procedures of Experiment 1 (and of Miller and Maner, 2011, Study 3). Additionally, following Experiment 2, only experimenters using hormonal birth control (and thus not presenting cues to fertility) served as experimenters—so fertility cues displayed by the confederates were not confounded with fertility cues of the experimenters.

Thus, as a follow-up to the results of Experiment 2, mixed logit model analysis of the target descriptions in Experiment 1 was performed to predict the logit-transformed likelihood of a target using the same sentence structure as the prime. As in Experiment 2, Match was included as the dependent variable, and participants and items were included as crossed random factors. The following variables were included as predictors: conception risk, sex, relationship status, Prime type, Verb repetition, the Prime x Verb interaction, and the 8 variables on which the participants rated the confederates. As in Experiment 2, conception risk values were multiplied by 100 to yield more interpretable coefficients. For consistency between the two analyses, 4 participants who reported a homosexual orientation were excluded from this analysis. Thus, data from 61 participants (14 males, 45 females, and 2 participants who did not indicate their sex) were included in the analysis. Also as in Experiment 2, all variables were grand-mean centered before being entered into the analysis to avoid problems with collinearity. Sex was found to be a marginally significant predictor of match, [$t(430) = 1.716$, $p = .086$].

Male participants were more likely than female participants to match the sentence structure of (female) confederates.

Pearson correlations were examined to further explore the relationship between match and conception risk, separately for male and female participants. As in Experiment 2, the relationship between conception risk and match was negative among the male participants; however, this relationship was not significant ($p = .306$). The relationship between conception risk and match among female participants was positive; however, this relationship was also not significant ($p = .573$).

Prime type [$t(430) = -2.309$, $p = .021$] was also a significant predictor of match; and verb repetition [$t(430) = 1.922$, $p = .055$] was a marginally significant predictor of match. None of the other variables, including conception risk, were significant predictors of match (all p's $> .324$).

Due to the small number of male participants in Experiment 1 (and because Experiments 1 and 2 used the same methods and the same items in the picture description task), I ran additional analyses using the data from both experiments to increase the chances of detecting between-sex effects. As when only analyzing the Experiment 1 data, Pearson correlations of the combined analysis revealed a marginally significant positive relationship between conception risk and match, $r = .133$, $p = .055$. Male participants were more likely than female participants to match the sentence structure of (female) confederates.

Likewise, Pearson correlations were examined to further explore the relationship between match and conception risk, separately for male and female participants. Pearson correlations of the combined analysis revealed a significant negative relationship between conception risk and match for male participants, $r = -.310$, $p < .001$—which is consistent with the results found when the analysis only included data from Experiment 2. Males were less likely to align with the sentence structure of a female conversational partner when she was at high levels of fertility than when she was low levels of fertility. Since the combined data set did not increase the number of female participants in the analysis (there were no female participants in Experiment 2), it was unnecessary to re-assess the (lack of a) relationship between conception risk and structural priming among females.

APPENDIX B

IRB APPROVAL LETTER

Office of the Vice President for Research
Human Subjects Committee

APPROVAL MEMORANDUM

Date: 3/11/2011

To: Jacqueline Coyle

From: Thomas L. Jacobson, Chair

Re: Use of Human Subjects in Research
Pictures and Social Interaction

The application that you submitted to this office in regard to the use of human subjects in the research proposal referenced above has been reviewed by the Human Subjects Committee at its meeting on 03/02/2011. Your project was approved by the Committee.

The Human Subjects Committee has not evaluated your proposal for scientific merit, except to weigh the risk to the human participants and the aspects of the proposal related to potential risk and benefit. This approval does not replace any departmental or other approvals, which may be required.

If you submitted a proposed consent form with your application, the approved stamped consent form is attached to this approval notice. Only the stamped version of the consent form may be used in recruiting research subjects.

If the project has not been completed by 2/29/2012 you must request a renewal of approval for continuation of the project. As a courtesy, a renewal notice will be sent to you prior to your expiration date; however, it is your responsibility as the Principal Investigator to timely request renewal of your approval from the Committee.

You are advised that any change in protocol for this project must be reviewed and approved by the Committee prior to implementation of the proposed change in the protocol. A protocol change/amendment form is required to be submitted for approval by the Committee. In addition, federal regulations require that the Principal Investigator promptly report, in writing any unanticipated problems or adverse events involving risks to research subjects or others.

By copy of this memorandum, the Chair of your department and/or your major professor is reminded that he/she is responsible for being informed concerning research projects involving human subjects in the department, and should review protocols as often as needed to insure that the project is being conducted in compliance with our institution and with DHHS regulations.

This institution has an Assurance on file with the Office for Human Research Protection. The Assurance Number is IRB00000446.

Cc: Michael Kaschak, Advisor
HSC No. 2011.5837

APPENDIX C

INFORMED CONSENT

Consent Form: Pictures and Social Interaction

The purpose of this consent form is to provide you with information about the research study in which you are about to participate, and to provide you with information about your rights as a participant in the study.

Purpose: The purpose of this study is to learn more about how people use language when they engage in activities with a partner. You will be participating in this study with another person. The experiment will require several things of you. The experimental task itself involves you and a partner taking turns describing pictures to each other and finding the pictures that have been described to you. The pictures will depict a range of everyday activities (e.g., a man sitting on a park bench). Additionally, you will be asked to fill out some questionnaires dealing with demographics, sensory sensitivity, and perceptions of the person with whom you interact during this experiment. The experiment will last about one hour.

Notice of Audio Recording: Because we are interested in studying the things that you say during the experiment, we are going to record all of the conversations that take place during the picture description task. We are doing this so that we can study what was said once the experiment is over. The audio tracks will be recorded on the hard drive of a computer, then burned to a CD for storage. We will keep these CDs for 10 years (in keeping with the American Psychological Association's standards for research), after which time they will be destroyed. We will include no identifying information with these audio recordings other than a participant number that will not be tied to your name or identity in any way, such that it will be highly unlikely that anyone will be able to identify your recording. No one will hear the recordings except the researchers working on this project, with the possible exception of some excerpts of your conversations being used in a research presentation. In such cases, the presentation will be done in such a way that it will be highly unlikely that anyone will be able to identify you from the recording.

Risks: This experiment does not in any way constitute risks to participants.

Benefits: There are two main benefits of participating in this experiment. You will receive one research credit for participating in this experiment. Additionally, your experience will allow you to gain some insight into the methods used for conducting psychological research.

Your Rights: You have several rights as a participant in this study. First, you may terminate your participation in the study at any time without prejudice, penalty, or loss of benefits to which you are otherwise entitled. That is, your grade in the course for which

you are participating will not be affected if you choose to withdraw from the experiment, and you will not receive a penalty in terms of experiment credits or extra credits. However, you will still be obliged to fulfill your experiment participation obligation for the General Psychology course (if enrolled in that course). Second, you should be aware that all data collected from you (questionnaires and audio recordings) will be kept confidential to the extent allowed by law. Your data will contain no identifying information that will allow your responses to be tied back to you, and reports of the data will involve aggregating the data over all the participants in the study; thus, your individual data will never be reported publicly.

You may contact Jackie Coyle [redacted] or Dr. Michael Kaschak [redacted] if you have a question about this project, or if you have any ill feelings about your participation in the study. If you have any questions about your rights as a participant in this research, or if you feel you have been placed at risk, you can contact the chair of the Human Subjects Committee, Institutional Review Board, through the Vice President for the Office of Research at 644-8633.

By signing below, you acknowledge that you have read the above consent form, and freely and voluntarily assent to participating in this study and having your conversations recorded for data collection purposes.

Name (signature): _____

Name (printed):_____

Date: _____

REFERENCES

Abitbol, J. de Brux, J., Millot, G., Masson, M. F., Mimoun, O. L., & Pau, H. (1999). Does a hormonal vocal cord cycle exist in women? Study of vocal premenstrual syndrome in voice performers by videostoboscopy-glottography and cytology on 38 women. *Journal of Voice*, 13, 424-446.

Baer, R. & Morrison, H. J. (1978). *Simon*. Milton Bradley.

Balcetis, E. & Dale, R. (2005). An exploration of social modulation of syntactic priming. In *Proceedings of the 27th Annual Meeting of the Cognitive Science Society*.

Baumeister, R. F. & Leary, M. R. (1995). The need to belong: Desire for interpersonal attachments as a fundamental human motivation. *Psychological Bulletin*, 117, 497-529.

Bavelas, J. B., Black, A., Chovil, N., Lemery, C. R., & Mullet, J. (1988). Form and function in motor mimicry: Topographic evidence that the primary function is communicative. *Human Communication Research*, 14, 275-299.

Berger, S. M. & Hadley, S. W. (1975). Some effects of a model's performance on an observer's electromyographic activity. *American journal of Psychology*, 2, 263-276.

Bernieri, F. J. (1988). Coordinated movement and rapport in teacher-students interactions. *Journal of Nonverbal Behavior*, 12, 120-138.

Bernieri, R. J., Davis, J., Rosenthal, R., & Knee, C. (1994). Interactional synchrony and rapport: Measuring synchrony in displays devoid of sound and facial affect. *Personality and Social Psychology Bulletin*, 20, 303-311.

Bock, J. K. (1986). Syntactic persistence in language production. *Cognitive Psychology*, 18, 355-387.

Bock, J. K., Dell, G. S., Chang, F., Onishi, K. (2007). Structural persistence from language comprehension to language production. *Cognition*, 104, 437-458.

Bock, J. K. & Griffin, Z. M. (2000). The persistence of structural priming: Transient activation or implicit learning? *Journal of Experimental Psychology: General*, 129, 177-192.

Boersma, P. & Weenink, D. (2001). *PRAAT*. (version 5.2.23).

Bowden, E. M. & Beeman, M. J. (1998). Getting the right idea: Semantic activation in the right hemisphere may help solve insight problems. *Psychological Science*, 9, 435-440.

Bowden, E. M. & Jung-Beeman, M. (2003). Normative data for 144 compound remote associate problems. *Behavior Research methods, Instruments, and Computers*, 35(4), 34-639.

Branigan, H. P., Pickering, M. J., & Cleland, A. A. (2000). Syntactic coordination in dialogue. *Cognition*, 75, B13-B25.

Brennan, S. E. & Clark, H. H. (1996). Conceptual pacts and lexical choice in conversation. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 22(6), 1482-1493.

Bryant, G. A. & Haselton, M. G. (2009). Vocal cues of ovulation in human females. *Biology Letters*, 5, 12-15.

Buss, D. M. & Kendrick, D. T. (1998). Evolutionary social psychology. In D. T. Gilbert, & S. T. Fiske et al. (Eds.), *Handbook of social psychology*, Vol. 2 (4th ed. pp. 982-1026). New York, New York: McGraw-Hill.

Caporael, L. R. (1997). The evolution of truly social cognition: The core configuration model. *Personality and Social Psychology Review*, 1, 276-298.

Caporael, L. R. (2001). Evolutionary psychology: Toward a unifying theory and a hybrid science. *Annual Review of psychology*, 52, 607-628.

Cappella, J. N. & Panalp, S. (1981). Talk and silence sequences in informal conversations: Interspeaker influence. *Human Communication Research*, 7, 117-132.

Chang, F. (2008). Implicit learning as a mechanism of language change. *Theoretical Linguistics*, 34, 115-122.

Chang, F., Dell, G. S., & Bock, K. (2006). Becoming syntactic. *Psychological Review*, 113, 234-272.

Chartrand, T. L. & Bargh, J. A. (1999). The chameleon effect: The perception-behavior link and social interaction. *Journal of Personality and Social Psychology*, 76-893-910.

Chartrand, T. L. & Jefferis, V. (2003). Consequenes of automatic goal pursuit and the case of nonconscious mimicry. In J. P. Forgas, K. D. Williams & W. von Hippel

(Eds.), *Responding to the social world: Implicit and explicit processes in social judgments and decisions*. (pp. 290-305). Philadelphia: Psychological Press.

Conway, C. M., Bauernschmidt, A. Huang, S. S. & Pisoni, D. B. (2010). Implicit statistical learning in language processing: Word predictability is the key. *Cognition*, 114, 356-371.

Coyle, J. M. & Kaschak, M. P. (2008). Patterns of experience with verbs affects long-term cumulative structural priming. *Psychonomic Bulletin and Review*, 15, 967-970.

Eriksen, C. W. & Eriksen, B. A. (1974). Effects of noise letters upon the identification of target letter in a nonsearch task. *Perception & Psychophysics*, 16(1), 143-149.

Eriksen, C. W. & Schultz, D. W. (1979). Information processing in visual search: A continuous flow conception and experimental results. *Perception and Psychophysics*, 25(4), 249-263.

Ferreira, V. S., Bock, J. K., Wilson, M., & Cohen, N. J. (2005). *Structural persistence in anterograde amnesia: Evidence for implicit learning*. Paper presented at the 46th annual meeting of the Psychonomic Society, Toronto, Ontario, Canada.

Fisher, M. L. (2004). Female intrasexual competition decreases female facial attractiveness. *Proceedings of the Royal Society of London*, B, 271, 283-285.

Gangestad, S. W., Thornhill, R., & Garver, C. E. (2002). Changes in women's sexual interests and in their partner's mate retention tactics across the menstrual cycle: Evidence for shifting conflicts of interest. *Proceedings of the Royal Society of London*, B, 269, 975-982.

GNU General Public License. (2006) *Audacity*. (version 1.2.6). Retrieved from http://audacity.sourceforge.net.

Giles, H., Coupland, N., & Coupland, J. (1991). Accommodation theory: Communication, context, and consequence. In H. Giles, J. Coupland, & N. Coupland (Eds.) *Contexts of Accommodation: Developments in Applied Psycholinguistics*. Cambridge University Press.

Giles, H. & Powesland, P. F. (1975). *Speech style and social evaluation*. London: Academic Press.

Gries, S. T. (2005). Syntactic priming: A corpus-based approach. *Journal of Psycholinguistic Research*, 34, 365-399.

Griskevicius, V., Cialdini, R. B., & Kenrick, D. T. (2006). Peacocks, Picasso, and parental investment: The effects of romantic motives on creativity. *Journal of Personality and Social Psychology*, 91, 63-76.

Griskevicius, V., Goldstein, N. J., Mortensen, C. R., Cialdini, R. B., & Kenrick, D. T. (2006). Going alone versus going alone: When fundamental motives facilitate strategic (non)conformity. *Journal of Personality and Social Psychology*, 91, 281-294.

Griskevicus, V., Tybur, J. M., Sundie, J. M., Cialdini, R. B., Miller, G. F., & Kenrick, D. T. (2007). Blatant benevolence and conspicuous consumption: When romantic motives elicit strategic costly signals. *Journal of Personality and Social Psychology*, 93, 85-102.

Hartsuiker, R. J., Bernolet, S., Schoonbaert, S., Speybroeck, S., & Vanderelst, D. (2008). Syntactic priming persists while the lexical boost decays: Evidence from written and spoken dialogue. *Journal of Memory and Language*, 58, 214-238.

Hartsuiker, R. J. & Kolk, H. H. J. (1998). Syntactic facilitation in a grammatic sentence production. *Brain and Language*, 62, 221-254.

Hartsuiker, R. J., Pickering, M. J., & Veltkamp, E. (2004). Is syntax shared or separate between languages? *Psychological Science*, 15, 409-414.

Hartsuiker, R. J. & Westenberg, C. (2000). Word order priming in written and spoken sentence production. *Cognition*, 75, B27-B39.

Havlick, J., Dvorakova, R., Bartos, L., & Flegr, J. (2006). Non-advertised does not mean concealed: Body odour changes across the menstrual cycle. Ethology, 112, 81-90.

Haselton, M. G. & Gangestad, S. W. (2006). Conditional expression of women's desires and men's mate guarding across the ovulatory cycle. *Hormones and Behavior*, 49, 509-518.

Ireland, M. E., Slatcher, R. B., Eastwick, P. W., Scissors, L. E., Finkel, E. J., & Pennebaker, J. W. (in press). Language style matching predicts relationship initiation and stability. *Psychological Science*.

Johnson, D. & Edgar, B. (1996). *From lucy to language*. New York: Simon & Schuster Editions.

Johnston, L. (2002). Behavioral mimicry and stigmatization. *Social Cognition*, 20(1), 18-35.

Kaschak, M. P. (2007). Long-term structural priming affects subsequent patterns of language production. *Memory and Cognition*, 35, 925-937.

Kaschak, M. P., Kutta, T. J., & Schatschneider, C. (2011). Long-term cumulative structural priming lasts for (at least) one week. *Memory and Cognition,* 39(3), 381-388.

Kaufman, S. B., DeYoung, C. G., Gray, J. R., Jimenez, L., Brown, J., & Mackintosh, N. (2010). Implicit learning as an ability. *Cognition*, 116, 321-340.

Kirchengast, S. & Gartner, M. (2002). Changes in fat distribution (WHR) and body weight across the menstrual cycle. *Collegium Antropologicum,* 26, 47-57.

Labov, W. (2001). *Principles of linguistic change: social factors*. Cambridge, MA: Blackwell.

La France, M. (1979). Nonverbal synchrony and rapport: Analysis by the cross-lag panel technique. *Social Psychology Quarterly*, 42, 66-70.

La France, M. (1982). Posture mirroring and rapport. In M. Davis (Ed*.), Interaction rhythms: Periodicity in communicative behavior* (pp. 279-298). New York: Human Sciences Press.

La France, M. & Broadbent, M. (1976). Group rapport: Posture sharing as a nonverbal indicator. *Group and Organization Studies*, 1, 328-33.

La France, M. & Ickes, W. (1981). Posture mirroring and interactional involvement: Sex and sex-typing effects. *Journal of Nonverbal Behavior*, 5, 139-154.

Lankin, J. L. & Chartrand, T. L. (2003). Using nonconscious behavioral mimicry to create affiliation and rapport. *Psychological Science*, 14, 334-339.

Lankin, J. L., Jefferis, V. E., Cheng, C. M., & Chartrand, T. L. (2003). The chameleon effect as social glue: Evidence for the evolutionary significance of nonconscious mimicry. *Journal of Nonverbal Behavior*, 27, 145-162.

Leary, M. R., Kelly, K. M., Cottrell, C. A., & Schreindorfer, L. S. (2005). *Individual differences in the need to belong: Mapping the nomological network.* Unpublished manuscript, Wake Forest University.

Lewin, K. (1943). Psychology and the process of group living. *Journal of Social Psychology,* 17, 113-131.

Li, N. P., Bailey, J. M., Kenrick, D. T., & Linsenmeier, J. A. W. (2002). The necessities and luxuries of mate preferences: Testing the tradeoffs. *Journal of Personality and Social Psychology*, 82, 947-955.

Loebell, H. & Bock, K. (2003). Structural priming across languages. *Linguistics*, 41, 791-824.

Manning, J. T., Scutt, D., Whitehouse, G. H., Leinster, S. J., & Walton, J. M. (1996). Asymmetry and the menstrual cycle in women. *Ethology and Sociobiology*, 17, 129-143.

Mednick, S. A. (1962). The associative basis of the creative proves. *Psychological Review*, 69(3), 220-232.

Mehrabian, A. & Stefl, C. A. (1995). Basic temperament components of loneliness, shyness, and conformity. *Social Behavior and Personality*, 23(3), 253-264.

Miller, S. L. & Maner, J. K. (2010). Scent of a woman: Men's testosterone responses to olfactory ovulation cues. *Psychological Science*, 21, 276-283.

Miller, S. L. & Maner, J. K. (2011). Ovulation as a male mating prime: Subtle signs of women's fertility influence men's mating cognition and behavior. *Journal of Personality and Social Psychology,* 100, 295-308.

Navarrete, C. D., Fessler, D. M. T., Fleishman, D. S., & Geyer, J. (2009). Race bias tracks conception risk across the menstrual cycle. *Psychological Science*, *20*, 661-665.

Neumann, R. & Strack, F. (2000). Mood contagion: The automatic transfer of mood between persons. *Journal of Personality and Social Psychology*, 79, 211-223.

Nordin, S., Millqvist, E., Lowhagen, O., & Brende, M. (2003). The Chemical Sensitivity Scale: Psychometric properties and comparison with the Noise Sensitivity Scale. *Journal of Environmental Psychology*, 23, 359-367.

Penke, L. & Asendorph, J. B. (2008). Beyond global sociosexual orientations: A more differentiated look at sociosexuality and its effects on courtship and romantic relationships. *Journal of Personality and Social Psychology*, 95(5), 1113, 1135.

Pickering, M. J. & Branigan, H. P. (1998). The representation of verbs: Evidence from syntactic priming in language production. *Journal of Memory and Language*, 39, 633-651.

Pickering, M. J. & Ferreira, V. S. (2008). Structural priming: A critical review. *Psychological Bulletin*, 134(3), 427-459.

Pickering, M. J. & Garrod, S. (2004). Toward a mechanistic psychology of dialogue. *Behavioral and Brain Sciences*, 27, 169-226.

Piptone, R. N. & Gallup, G. G. (2008). Women's voice attractiveness varies across the menstrual cycle. *Evolution and Human Behavior*, 29, 268-274.

Psychology Software Tools, incorporated. (2001). *Eprime*.

Poirier, F. & McKee, J. (1999) *Understanding human evolution* (4th ed). Upper Saddle River, New Jersey: Prentice Hall.

Potter, M. C. & Lombardi, L. (1998). Syntactic priming in immediate recall of sentences. *Journal of Memory and Language*, 28, 265-282.

Raudenbuch, S., Bryk, A., & Congdon, R. (2004). *HLM statistical package*.

Reber, A. S. (1993). *Implicit learning and tacit knowledge: An essay on the cognitive unconscious*. New York, NY: Oxford University Press.

Roberts, S. C., Havlicek, J., Flegr, J., Hruskova, M., Little, A. C., Jones, B. C., Perrett, D. I., Petrie, M. (2004). Female facial attractiveness increases during the fertile phase of the menstrual cycle. *Proceedings of the Royal Society of London B*, *271*, S270-S272

.

Rosenberg, J. & Tunney, R. J. (2008). Human vocabulary use as display. *Evolutionary Psychology*, 6, 538-549.

Rowland. D. L., Greenleaf, W. J., Dorfman, L. J., & Davidson, J. M. (1993). Aging and sexual function in men. *Archives of Sexual Behavior*, 22, 545-557.

Savage, C., Lieven, E., Theakston, A., & Tomasello, M. (2003). Testing the abstractness of children's linguistic representations: Lexical and structural priming of syntactic constructions in young children. *Developmental Science, 6,* 557-567.

Schooler, J. W. & Melcher, J. (1995). The ineffability of insight. In S. M. Smith, T. B. Ward, & R. A Finke (Eds.), *The creative cognition approach* (pp. 249-268). Cambridge, MA: MIT Press.

Shepherd, C. A., Giles, H., & LePoire, B. A. (2001). Communication accommodation theory. In W. P. Robinson & H. Giles (Eds). *The New Handbook of Language and Social Psychology*.

Simon, J. R. (1969). Reactions towards the source of stimulation. *Journal of Experimental Psychology*, 81, 174-176.

Stanovich, K. E. (2009). Distinguishing the reflective, algorithmic, and autonomous minds: Is it time for a tri-process theory? In J. S. B. T. Evans & K. Frankish (Eds.). *In two minds: Dual processes and beyond* (pp. 55-88). Oxford, UK: Oxford University Press.

Stel, M., Blascovich, J., McGall, C., & Vonk, R. (2005). *When mimicry makes it worse*. Paper presented at the European Association for Experimental Social Psychology 14th General Meeting, Wurzburg.

Tenney, E. R., Turkheimer, E., & Oltmanns, T. F. (2009). Being liked is more than having a good personality: The role of matching. *Journal of Research in Personality*, 43, 579-585.

Uldall, B., Hall, C. & Chartrand, T. L. (2003). *Optimal distinctiveness theory and mimicry: When being distinct leads to an affiliation goal and greater nonconscious mimicry*. (2003). Unpublished manuscript.

van Baaren, R. B., Holland, R. W., Kawakami, K., & van Knippenberg, A. (2003). Mimicry and pro-social behavior. *Psychological Science*, 15, 71-74.

van Straaten, Engles, Finkenauer, & Holland (2008). Sex differences in short-term mate preferences and behavioral mimicry: A semi-naturalistic experiment. *Archives of Sexual Behavior*, 37, 902-911.

Webb, J. T. (1969). Subject speech rates as a function of interviewer behavior. *Language and Speech*. 12, 54-67.

Webb, J. T. (1972). Interview synchrony: An investigation of two speech rate measures in an automated standardized interview. In B. Pope & A. W. Siegman (Eds.), *Studies in dyadic communication* (pp. 115-133.). New York: Pergamon.

Wilcox, A. J., Dunson, D. B., Weinberg, C. R., Trussel, J., & Baird, D. D. (2001). Likelihood of conception with a single act of intercourse: Providing benchmark rates for assessment of post-coital contraceptives. *Contraception*, 63, 211-215.

Yabar, Y., Johnston, L., Miles, L., & Peace, V. (2006). Implicit behavioral mimicry: Investigating the impact of group membership. *Journal of Nonverbal Behavior,* 30, 97-113.

BIOGRAPHICAL SKETCH

Jacqueline Coyle grew up in St. Paul, Minnesota and attended college at Clemson University. Jacqueline graduated summa cum laude from Clemson with a Bachelor's degree in Psychology in the spring of 2006. In the fall of 2006, Jacqueline enrolled in graduate school at Florida State University to study Cognitive Psychology. She received her Master's degree in the summer of 2009 under the advisement of Dr. Michael Kaschak. Upon completing her Master's degree, Jacqueline enrolled in the Doctorate program at Florida State University.

Jacqueline's research interests include the role that fundamental social motivations and emotions play in social-cognitive processes such as language production, decision-making, attention, and memory, and the effects they have on lower-level motor responses.