Cognitive and Affective Consequences of Language Alignment in Dyadic Coping

by

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ABSTRACT

Dyadic coping is a couple level coping strategy, where partners respond to relationship external stressors as a unit. Dyadic coping behaviors have the ability to strengthen the relationship and improve both partners' mental health outcomes in the face of adversity. Verbal communication is one of the primary channels of dyadic coping processes. As such, psycholinguistic investigations of predictors of successful dyadic coping comprise a growing body of research within the field of cognitive psychology and psycholinguistics. Aspects of language such as pronoun use and emotion word use are common areas of study. In this study, I examined the effects of language alignment on dyadic coping outcomes among a sample of heterosexual couples. Specifically, I postulated that lexical and semantic alignment would lead to positive outcomes in the cognitive domain of dyadic coping, while alignment in function word use – also referred to as language style matching – would lead to positive outcomes in the affective domain of dyadic coping. I also explored the effect of the temporal dynamics of language alignment on the relevant outcomes. Findings suggest that while function word alignment is weakly predictive of the hypothesized outcomes, no detectable relationships exist between lexical and semantic alignment and cognitive outcomes relating to dyadic coping among my sample. This study also shows a potential weak recency effect of language style matching on one affective outcome of dyadic coping. The absence of statistically significant effects in this study should not be taken to mean that no such effect exists, but that a more sensitive approach with a larger sample may be necessary to uncover the subtle effects of language alignment on dyadic coping outcomes.

TABLE OF CONTENTS

Page

Page

LIST OF TABLES

Table Page

Table		Page

Table Page

INTRODUCTION

Healthy romantic relationships are an important element of life satisfaction for most people. Indeed, not only do romantic relationships play a role in safeguarding against mental illnesses like depression, anxiety, and alcoholism (Cacioppo et al., 2006; O'Farrell et al., 1998; Wei et al., 2005), they also reduce the occurrence and severity of physical illnesses like high blood pressure, heart disease, and rheumatoid arthritis (Carels et al. 1998; Hawkley et al., 2003; Hawkley & Cacioppo, 2010; Kiecolt-Glaser & Newton 2001; Rankin-Esquer et al. 2000; Zautra et al. 1998). Because romantic relationships play such an important role to individuals' wellbeing, research on predictors of healthy relationships comprise an important part of social science research (e.g., Barnes et al., 2007; Lapierre & Custer, 2021; Malouff et al., 2014; Stackert & Bursik, 2003).

One notable aspect of relationship health is couples' communication behaviors, particularly those related to stress communication such as dyadic coping. Dyadic coping refers to the joint response of romantic partners to relationship external stressors experienced initially only by one person (Bodenmann, 2005). Examples of relationship external stressors include work stress, daily hassles, and illness (Falconier et al., 2015; Fallahchai et al., 2019; Langer et al., 2018; Martos et al., 2019; Randall & Bodenmann, 2009; Tkachenko et al., 2019). Some predictors of successful dyadic coping that have been identified are positive emotion words, "we-talk," and language alignment. Although language alignment has been linked to dyadic coping success, there are many ways to characterize alignment that may have differential effects on outcomes.

In what follows, I examine the various possibilities and their theoretical relevance, eventually converging on four main areas of analyses. To preview, these areas include:

i) The relationship between content word alignment in couples' speech and cognitive success in dyadic coping.
ii) The relationship between change over time in content word alignment and cognitive success in dyadic coping.
iii) The relationship between function word alignment in couples' speech and affective success in dyadic coping.
iv) The relationship between change over time in function word alignment and affective success in dyadic coping.

Language Use and Dyadic Coping

Dyadic coping is multimodal and involves both linguistic and paralinguistic behaviors. However, because the primary communication channel is verbal, language use is one of the most fundamental areas of research in this context. One linguistic index that has been studied in relation to dyadic coping is the use of personal pronouns. For example, Meier et al. (2021) found that asymmetric patterns of second-person pronoun use ("you-talk") is indicative of positive dyadic coping processes and is facilitative of stress reduction. That is, when the non-stressed partner (NP) uses second person pronouns such as "you" or "your" significantly more frequently than the stressed partner (SP), both partners report being happier at the end of the conversation. They elaborate on this finding by noting that such asymmetry points towards NP focusing their mental resources on SP. Other studies that have investigated the link between pronoun use and dyadic coping include Badr et al. (2016), Karan et al. (2017), and Lau et al. (2018).

Another linguistic index that has been studied in relation to dyadic coping is the use of both positive and negative emotion words (Badr et al., 2016; Karan et al., 2017; Lau et al., 2018). Specifically, Karan et al. found that the use of positive emotion words by one partner is positively correlated with the other partner’s relationship satisfaction in the dyadic coping context. Karan et al. also found that the use of negative emotion words was negatively correlated with both partners’ relationship satisfaction. This result contradicts Lau et al.'s finding that the use of negative emotion words has a facilitative effect on dyadic coping and stress reduction. Although the effects of pronoun use and emotion words on dyadic coping are interesting, natural language use is a rich and multifaceted area of research and offers many more avenues of investigation.

Another area of interest within natural language use is that of language alignment. One study that addresses the impact of linguistic alignment on dyadic coping quality is Bowen et al. (2017). In that study, the authors randomly assigned participants to either a conflict condition or a social support (what is referred to in this paper as dyadic coping) condition. The authors then used the transcripts from the videotaped natural conversations among the couples to analyze the degree of language style matching (LSM). In their study, LSM was shown to intensify the affective tone of the interaction - whether negative or positive. Specifically, the authors found that increased LSM was indicative of negative affect in the conflict condition and positive affect in the social support condition.

Although Bowen et al. (2017) is a valuable initial study on the impact of language style matching in dyadic coping conditions, the study did not account for the presence of homophily among couples. Danescu-Niculescu-Mizil et al. (2011) define homophily as the phenomenon by which conversation partners that know each other use similar language in their everyday life because of their shared history and coevolution of speech habits. That is, homophily refers to the degree of language alignment between conversation partners at baseline. This paper expands on Bowen et al.'s work by focusing on the development of language alignment over the course of a conversation to control for homophily. In my study, I will be taking inspiration from reciprocal language style matching (rLSM) in order to assess this unfolding of language style matching over time. rLSM is a metric that assesses "reciprocal adaption [in language style] throughout the dynamic process of a conversation" (Müller-Frommeyer et al., 2019, p. 1343).

Communication Accommodation Theory

Communication accommodation theory was the first comprehensive theory that proposed a relationship between communicative (both linguistic and paralinguistic) alignment and interpersonal rapport. Communication accommodation theory posits that individuals adjust various aspects of their communicative behaviors (including but not limited to volume, pitch, accent, and register) in order to maximize similarity between themselves and their interlocutor (Giles et al., 1973; Giles, 2016). This type of communicative accommodation is referred to as *convergence*. According to this theory, communicative convergence reflects higher levels of interpersonal harmony and empathy, leading to greater feelings of closeness between interlocutors[1].

This theory has been tested by researchers from various disciplines and with regard to a wide range of linguistic and paralinguistic attributes (e.g., Buller & Kelly, 1992; Danescu-Niculescu-Mizil et al., 2011; Farzadnia & Giles, 2015; Goode & Robinson, 2013; Patrice et al., 1996; Pines et al., 2021; Pretorius, 2018; see Soliz & Giles, 2014 and Soliz & Bergquist, 2016 for meta-analyses). Individuals may engage in communicative convergence to fulfill either *cognitive* or *affective* motivations (Giles et al., 1973; Giles, 2016)

Communication Accommodation for Cognitive Reasons. Cognitive motivations for communicative accommodation refer to the speaker's desire to maximize the effectiveness and efficiency of communication. In the interest of conciseness, the constructs of communicative effectiveness and efficiency will be referred to under the joint term of 'communicative quality' throughout this paper. An example of communicative accommodation to improve communicative quality is that of a native speaker of a language adopting simpler words and syntactic structures when interacting with a non-native speaker of that language. One specific form of alignment that has been linked to communicative quality is lexical alignment. Lexical alignment refers to the alignment of exact words by interactants in a conversation. Lexical alignment in conversation can perform several functions including "to initiate repair, express surprise,

[1] Giles (2016) also notes that communication accommodation is not solely about maximizing similarity. Sometimes, individuals engage in a communicative *divergence*, where they modify their communicative behaviors to emphasize the differences between themselves and their conversational partner to signal disaffiliation.

answer a question, or accept a formulation" (Rasenberg, 2020, p. 13), most of which can lead to better communicative outcomes in contexts like dyadic coping.

Interactive Alignment Model. An influential theory of the mechanism behind lexical alignment is the interactive alignment model (IAM). According to the IAM, language alignment between interlocutors happens at all levels of language (including lexical and syntactic levels) through reciprocal priming. The model also contends that this automatic alignment is further extended into an alignment in their situation models (Pickering & Garrod, 2004). A situation model is each individual's mental representation of the conversation at hand (Zwaan & Radvansky, 1998). Pickering and Garrod argue that this automatic alignment of linguistic and, thereby mental, representations of the topic at hand is a necessary and automatic aspect of successful communication.

The interactive alignment model conceptualizes alignment as an automatic phenomenon. Although it has received some empirical support (Branigan et al., 2000; Gries, 2005), recent studies have pointed out the limitations of the interactive alignment model. For example, Mills and Healey (2008) raise an objection regarding the supposed automaticity of the alignment mechanism proposed by Pickering and Garrod (2004). Specifically, Mills and Healey point out that if the mechanism behind linguistic alignment was truly automatic, then linguistic conventions converged upon by interlocutors would be fixed and thus not open to renegotiation. However, the authors note that speakers do in fact change the terms used to refer to a given concept as a conversation proceeds.

In addition to claiming that alignment is automatic, the IAM also depicts language alignment as simultaneously happening at various levels of language. That is, according to the IAM, speakers align lexically, semantically, and syntactically during conversation. However, Healey et al. (2014) provides empirical evidence that, after accounting for lexical repetition, natural conversations do not, in fact, exhibit structural alignment at a rate greater than chance. This conclusion was based on a study using the Diachronic Corpus of Present-Day Spoken English (DCPSE). This corpus contains samples of face-to-face conversations in both formal and informal situations as well as telephone conversations. The extent of structural alignment in conversations within this corpus was compared with the extent of alignment within fake dialogs in a control corpus. The control corpus was created from the DCPSE by interleaving conversational turns from non-interacting speakers. That is, an utterance by Speaker A of dialog 1 was followed by an utterance by Speaker B of dialog 2 and so on. The authors found that the degree of structural alignment in the natural corpus was not statistically greater than the degree of alignment within the control corpus. As such, there is some debate regarding the cognitive factors underlying language alignment in conversation.

Input-Output Coordination Theory. According to the theory of input-output coordination, speakers develop common ground in conversation through the intentional coordination of reference-referent pacts (Garrod & Anderson, 1987). Reference-referent pacts are unspoken mutual agreements to assign a specific label to a concept or idea within the conversation. These reference-referent (also called conceptual pacts) are ephemeral and open to renegotiation (Brennan & Clark, 1996). Lexical overlap is a natural consequence of the establishment and recurrent use of conceptual pacts within conversation The key difference between the above models is the element of intentionality. That is, while neither model of language alignment considers this phenomenon and explicitly agreed upon behavior, the input-output coordination theory emphasizes that lexical alignment results from intentional behaviors by interlocutors to align their mental representations.

In addition to lexical alignment, semantic alignment is an important linguistic index with regard to communication quality in dyadic coping. Semantic alignment is the term used to describe conceptual alignment through the use of similar but not identical words. Higher levels of semantic alignment tend to result from highly involved reciprocal information exchange (Babcock et al., 2014), which should contribute to greater communicative success. Semantic alignment is conceptualized as the alignment of words that are statistically more likely than dictated by chance to occur in similar contexts. Although there is no clear theoretical framework for the relationship between semantic alignment and communicative quality, it should be noted that conceptual overlap as a result of common ground development should result in a greater than chance likelihood of the use of synonyms in a conversation. Indeed, research does show such a trend. For example, Angus et al. (2012) show that increased semantic alignment between doctors and patients during routine consultations was one of the factors that led to improved communicative effectiveness.

Overall, while the IAM and the theory of input-output coordination differ in terms of proposed mechanism of lexical alignment, they are in agreement that such alignment does benefit communication quality. Similarly, despite not having a strong theoretical framework, semantic alignment has also been shown to relate to communicative quality. However, there is a threshold beyond which content word alignment can be counterproductive. Indeed, Doyle and Frank (2016) notes that content word alignment is, by definition, retrospective. That is, content word alignment depends on interlocutors referring back to previously discussed concepts and issues. However, for a conversation to progress, interlocutors need to introduce and discuss new concepts over time. This observation is corroborated by the findings of Fusaroli et al (2012) that extensive, indiscriminate lexical matching during collaborative discussions is negatively correlated with dyads' ability to solve a joint task. As such, any correlation between content word alignment and communicative quality should be considered with a nuanced and balanced perspective.

Communication Accommodation for Affective Reasons. Individuals also align linguistically to their conversation partners in order to reduce the social distance between them. By reducing social distance, the speaker will be able to increase feelings of rapport and social cohesion between themselves and their conversational partner.

A form of communication accommodation that has been shown to fulfill affective motivations is that of language style matching (LSM). LSM focuses on the relationship between the alignment of function word use by interlocutors and the development and maintenance of interpersonal rapport (Ireland and Pennebaker, 2010). One of the main advantages of measuring LSM over measuring lexical and semantic alignment is that the former is "context independent" (Gonzales et al., 2010, p. 5). That is, LSM scores can be calculated using conversations from different contexts and compared *across* contexts.

Additionally, function words comprise over half of the words spoken during the average communicative exchange despite making up a very small fraction of the English lexicon (Danescu-Niculescu-Mizil et al., 2011). The content independence of LSM measurement also helps circumvent the retrospective nature of content word alignment as noted by Doyle and Frank (2016). Finally, the use of function words is often less likely to be under a speaker's conscious control (Ireland and Pennebaker, 2010). As such, LSM is more likely than measures of lexical or semantic overlap to tap into speakers' underlying mental states.

Studies have provided support for the relationship between LSM and rapport in a variety of contexts. For example, Gonzales et al. (2010) show that within the context of group work, where verbal communication is essential to the successful completion of a task, an increase in language style matching is correlated with higher self-reported group satisfaction both in face-to-face communication and in computer mediated communication. Additionally, in the context of romantic attraction, Ireland et al. (2011) demonstrated that increased language style matching is a reliable predictor of both initial attraction and relationship stability. Finally, Bowen et al. (2017) note that an increase in LSM is correlated with an increase in interpersonal rapport within the context of dyadic coping.

By contrast to the above studies, Babcock et al. (2014) found that higher LSM was correlated with a lack of desire to communicate and lower levels of engagement among dyads. The authors explained this finding by noting that an increase in LSM was correlated with strong emotion, which may have compromised speakers' ability to articulate their thoughts and rather caused them to "mindlessly' repeat each other's words and phrases" (Babcock et al., 2014, p. 85). Another possible explanation for this seemingly contradictory result is the observation put forth by Bowen et al. (2017) and Yilmaz (2016) that language style matching indicates an intensification of the existing sentiment within an interaction - whether positive or negative. That is, if an interaction consists of negative coping behaviors such as placing blame, invalidating emotions etc., then an increase in language style matching would signify an intensification of these counterproductive behaviors. Another factor to consider when contextualizing the results of Babcock et al. (2014) is that the dyads in that study were not romantically involved or interested, and there was no consistent conversation prompt. Therefore, it is also possible that the relationship between LSM and affect is present primarily in dyads with the specific communicative goals of interpersonal closeness.

Although most of the available evidence indicates that LSM is a reflection of interpersonal rapport, this measure does not seem to have an equivalently reliable effect on communicative quality. For example, Gonzales (2010) shows unreliable effects of language style matching on task performance. Specifically, in their study, LSM and task performance were significantly positively correlated with task performance in groups that interacted face to face ($b = .58$, $p < .01$) but no significant effect in a computer mediated context. By contrast, the affective impact of LSM has been documented to exist even in computer mediated settings (Rains, 2016).

One of the possible weaknesses of using LSM as a predictor of dyadic coping is the presence of homophily among couples. One way to address the concern of homophily in couples' language would be to investigate the development of language style matching as the conversation progresses. To this end, Müller-Frommeyer et al. (2019) have recently proposed a modification to the LSM model to further probe the degree of linguistic matching over time within a dyadic interaction referred to as reciprocal language style matching (rLSM). rLSM measures the extent to which one unit of dialog – a speaker's utterance and their fellow interlocutor's direct response to that utterance – are matched in terms of language style. As such, rLSM provides insight into the progression of language style matching during the dyadic coping, controlling for the homophily expected among couples.

To summarize, verbal measures of communication accommodation can provide meaningful insight into the interpersonal dynamics of interlocutors. Specifically, measures of lexical and semantic alignment can provide insight into the degree of common ground developed by interlocutors, which in turn is an indicator of communication quality. On the other hand, measures of rLSM can provide insight into the interpersonal rapport developed by interlocutors, which can be considered an indicator of higher levels of positive affect. Based on these theoretical frameworks, I propose the following hypotheses:

Hypothesis 1: **Cognitive Effects of Lexical Alignment.** Within the context of dyadic coping, lexical overlap in content words (nouns, verbs, adjectives, and adverbs) will positively predict outcomes of communicative quality.

Hypothesis 2: **Cognitive Effects of SemanticAlignment.** Within the context of dyadic coping, semantic overlap in content words (nouns, verbs, adjectives, and adverbs) will positively predict outcomes of communicative quality.

Hypothesis 3: **Affective Effects of Function Word Alignment**. Within the context of dyadic coping, function word alignment will will positively predict outcomes of interpersonal rapport and warmth.

METHOD

This project is a secondary analysis of data collected through a study conducted at Arizona State University. This project will use a set of analytical approaches that have not been used on this dataset to explore questions that are as yet unanswered.

Participants, Procedures, and Dataset

Participants in this study were recruited through a variety of social platforms including craigslist, Facebook, and professional mailing lists in Southwestern United States. The total number of participants recruited for this study equaled 54 couples, of which, only data from 38 couples who completed all the phases of the study was used in the analyses. All of the couples reported being in heterosexual relationships. Within the final participant pool of 38 couples, the average relationship length was 5.45 years with a standard deviation of 5.25 years. The average age of both male and female participants was 30.4 years with standard deviations of 6.9 years and 7.4 years respectively.

The study consisted of three phases - an initial eligibility screening, a baseline questionnaire, and a laboratory based dyadic interaction session. The screening survey and the baseline questionnaire were administered remotely. Prospective participants were only considered eligible to take part in the study if they met three criteria:

i) Both members of the couple were over the age of 18.

ii) Both members of the couple consented to taking part in the study.

iii) The partners had been in a relationship for at least six weeks prior to the start of the study.

Following the screening, eligible participants were sent the baseline questionnaire. Participants were instructed to complete the questionnaire alone, without discussing any of the questions with their partner. The questionnaire collected demographic information, information regarding the general functioning of each couple’s relationship at baseline, and topics of stress - both internal and external to the relationship - as well as topics of mutual enjoyment/ pleasure. Sources of external stress for each individual participant were measured using the Multidimensional Stress Scale for Couples (Bodenmann, 2006).

Couples who filled out the baseline questionnaire were then invited to Arizona State University to complete the laboratory-based session. During this session, each couple first watched a nature documentary to ensure that they were at similar levels of emotional arousal. After watching the documentary, couples were told that they had six minutes to discuss a relationship-external stressor, which was experienced by one of the partners but not the other. Whether the chosen topic of conversation was about the female partner’s stressor or the male partner’s stressor was randomly counterbalanced across couples. The transcripts of the audio-recordings of these discussions will be used to generate predictors for all analyses in this project.

The experimental procedure also included other conditions, the data for which will not be used in this study. These conditions included discussions on a source of mutual relationship-internal stressor and a topic of mutual enjoyment/pleasure for each couple. The topics of discussion were assigned based on their responses to the baseline questionnaire.

After each discussion, each participant was instructed to fill out measures of relationship satisfaction. These measures are Likert scales with a range of 1 – 7. Their responses to these measures comprise the outcome variables in this project.

Variables of Interest

Linguistic Indices

Lexical and semantic alignment will be measured using the Natural Language Processing tool "ALIGN" (Duran et al., 2019). ALIGN can be used to generate utterance by utterance indices of lexical, semantic, and syntactic overlap over the course of a conversation. That is, ALIGN quantifies the degree to which each utterance aligns with the utterance immediately preceeding it, and thus provides insight into the temporal pattern of alignment for each linguistic index. Additionally, higher scores indicate higher levels of alignment.

Function word indices will be measured using the Tool for the Automatic Analysis of Cohesion (TAACO, available from: https://www.linguisticanalysistools.org/), which was developed by Crossley et al. (2016). TAACO quantifies the rate of occurrence of words that fall into specific language categories at various levels for each utterance by each partner in a text in terms of proportion scores. The indices of function words provided by TAACO differ from those provided by the Linguistic Inquiry and Word Count (LIWC) tool, which is predominantly used in such analyses. I chose to use TAACO in this study for a variety of reasons. First, TAACO, unlike LIWC, is free to download and thus more accessible to those interested in this area of research. Second, the use of a different tool, allows the inclusion of a slightly different set of indices than LIWC does. Although my hypotheses regarding the effect of function word alignment are derived from previous studies using the construct of "language style matching," because I used a different NLP tool and a different set of indices in my analyses, I will refer to this type of alignment simply as "function word alignment."

Proportion scores will be generated using TAACO for every distinct utterance by each member of the dyad in order to see the temporal pattern of alignment. These proportion scores will be analyzed using a modified version of the reciprocal Language Style Matching (rLSM) analysis code written by Müller-Frommeyer et al. (2019). This code will be modified to optimize for data generated by TAACO, instead of for data generated by the Linguistic Inquiry and Word Count (LIWC) tool used by the original authors.

Hypothesis 1: Cognitive Effects of Lexical Alignment. For Hypothesis 1, there is only one primary predictor variable, which is lexical alignment. However, other variables will be added to the model to account for their confounding effects on the outcome variables. These variables, or covariates, include semantic alignment, number of words spoken by the participant that a given lexical alignment score is associated with (utterance length aligner), and number of words spoken by their partner in a previous turn, which is the utterance the participant in aligning to (utterance length target).

Hypothesis 2: Cognitive Effects of Semantic Alignment. For Hypothesis 2, there is only one primary predictor variable, which is semantic alignment. However, other variables will be added to the model to account for their confounding effects on the outcome variables. These variables, or covariates, include lexical alignment, utterance length aligner, and utterance length target.

Hypothesis 3: Affective Effects of Function Word Alignment. The indices available through TAACO that will be included in the analyses in this paper are as follows: basic connectives, lexical subordinators, addition, sentence linking, determiners, demonstratives, all additive connectives, all logical connectives, all positive connectives, and all connectives (see Table 1 for a list of the indices and examples of words that comprise each index). A clearer picture of what these indices mean is provided on this webpage: https://www.linguisticanalysistools.org/. Because many of these indices are conceptually closely related, the correlation between them will be checked, and indices that are highly correlated with others will be dropped. Additionally, utterance length aligner and utterance length target will be included as covariates in all statistical models.

Table 1: Examples of Words That Comprise Each Function Word Category

Index Name	Examples
Basic connectives	For, And, Nor
Lexical subordinators	Although, As
Addition	Also, Besides
Sentence linking	Nonetheless, Therefore
Determiners	A, An, The
Demonstratives	This, That, These
All additive connectives	All In All, As Well
All logical connectives	After All, Admittedly
All positive connectives	Actually, Again
All connectives	After, Alternatively

*Note: The indices are not mutually exclusive. As such the resultant correlations will be assessed and highly correlated indices will be dropped

Outcome Variables

All outcome variables in this study were collected through self-reports to either Likert scale items or semantic differential measures.

Hypothesis 1: Cognitive Effects of Lexical Alignment. Hypothesis 1 will be tested in this study using the following post-conversation survey items:

i) "In the previous interaction, I felt that I understood what my partner was saying."

ii) "In the previous interaction, my partner: thought like me a lot ______ did not think like me at all."

The survey items used to test Hypothesis 1 relate to the concepts of comprehension (item i) and alignment in mental representations (item ii). These two items were chosen to test

Hypothesis 1 based on theoretical considerations. Specifically, the insight provided by both the IAM and the input-output coordination theory suggest that lexical alignment leads to lower ambiguity in communication, and thus higher comprehensibility as well as greater alignment of mental models (Garrod & Anderson, 1987; Pickering & Garrod, 2004).

Hypothesis 2: Cognitive Effects of SemanticAlignment. Hypothesis 2 will be tested in this study using the following post-conversation survey items:

i) "In the previous interaction, my partner was: highly involved ______ not at all involved"

ii) "In the previous interaction, my partner gave superficial rather than in-depth responses."

The survey items used to test Hypothesis 2 relate to the degree to which the respondent thought their partner was involved in the conversation. These two items were chosen to test Hypothesis 2 because of insight provided by Babcock et al. (2014). Specifically, the authors noted that greater semantic alignment tends to result from increased information exchange and highly involved discussion.

Hypothesis 3: Affective Effects of Function Word Alignment. Hypothesis 3 will be tested in this study using the following post-conversation survey items:

i) "In the previous interaction, my partner communicated warmth rather than coldness"

ii) "In the previous interaction, my partner was: very cold ______ very warm"

iii) "In the previous interaction, I felt close to my partner"

iv) “In the previous interaction, my partner: created closeness ______ created a sense of distance”

Hypothesis 3 tests the concept of perceived warmth (items 1 and 2) and perceived closeness (items iii and iv). These concepts were chosen as both of them relate to interpersonal rapport and positive affect based on insight provided by studies like Ireland et al. (2011) and Bowen et al. (2017).

Overview of Analyses

There are several attributes of the data collected using the tools detailed above that make analysis less straightforward. First, the data violate the assumption of independence of observations. That is, because the interactants are couples and thus share many contextual commonalities, each set of partners will be more similar to each other than they are to the rest of the participant pool. As such, all else being equal, their outcomes will be more similar to each other than to the outcomes of the other participants. This kind of data are called clustered data.

Clustered data are typically analyzed using multilevel models. However, multilevel models are not the only answer to clustered data and can be unnecessarily complex when the research questions are not explicitly multilevel (i.e., when there are no cluster level predictors). An alternative to using multilevel analyses is the use of cluster-robust standard errors in analyses. Cluster-robust standard errors correct for the artificially lowered standard errors and *p*-values caused by clustering in data without adding to the complexity of analysis (Primo et al., 2007). Indeed, cluster-robust standard errors are frequently used in the analysis of dyadic data (e.g., Fafchamps & Gubert, 2007;

Mancosu & Vezzoni, 2018; Tachibana et al., 2018). As such, in this study, I will correct for the clustering of data by using cluster-robust standard errors.

Clustering is not the only attribute of this dataset that deems it non-traditional. In this dataset, there is a greater granularity in the predictor variables than in the outcome variables. That is, for each participant, there are multiple values for each predictor since alignment scores are computed at the level of each and every pair of utterances, while there is only value per outcome variable since outcomes were measured once at the end of the conversation. Because of this non-traditional data structure, the data were analyzed in multiple ways to test the relationships between the predictors and outcomes across different levels of granularity.

All analyses were conducted using R software (version 4.2.2). The code used to perform the analyses described below is included in Appendix B. For each type of analysis, certain steps were taken to maximize model fit. First, the alignment scores at each utterance were standardized so as to make all comparisons more seamless and interpretable. Second, indices that were highly correlated with others were dropped from the model. The second step was conducted separately for each analysis type since alignment scores behaved slightly differently in each type of analysis.

Analysis 1: Analysis of the Magnitude of Alignment

The simplest way to address the non-traditional structure of such a dataset is to calculate the mean of alignment across utterances per participant for each index. To be more specific, since the dataset was initially structured in such a way that there is one alignment score for every single utterance spoken by a participant, calculating the mean of this set of scores will reduce the predictors to one score per index per participant. These mean values, along with their relevant covariates, were then included as predictors in a multiple regression with cluster-robust standard errors.

This strategy can be a useful illustration of the effect of the total magnitude of language alignment on various outcomes. However, it does not allow us to understand the effect of the change in alignment over the course of a conversation. Specifically, the means of alignment values only allow us to know **whether** total alignment in various forms impact communicative outcomes (either cognitive or affective). It does not provide any insight into how the **change** in alignment over the course of a conversation impacts communicative outcomes. For example, if a couple starts out with high levels of language alignment, and experience lower levels of alignment by the end, does that have a different impact on the outcome variables than the opposite pattern?

Analysis 2: Analysis of the Rate of Change in Alignment

As an alternative way of exploring the effect of change in alignment on the various outcomes, the rate of change in each predictor was calculated for each participant. This was done by conducting a series of regressions with the alignment scores as outcomes and time as the predictor variable. The coefficients – also known as the slopes - resuting from these regressions were saved in a separate dataset. The computed slopes were then used as predictors along with relevant covariates in a cluster-robust error multiple regression. This analytic strategy will provide insight into the effect of rate of change in alignment across the conversation.

Analysis 3: Analysis of Serial Position Effects in Alignment

To address the more specific question of the role of change in alignment over time, alignment values were divided into three bins and mean values were computed for each predictor in each bin of the conversation per participant. These binned mean values were then included as separate predictors along with relevant covariates in a cluster-robust multiple regression.

This strategy, which is a popular choice when working with time series data (Mirman, 2014; Mörchen, 2005), will provide insight into the specific effects of alignment during the beginning, middle, and end phases of a conversation. Specifically, it will allow me to investigate potential primacy or recency effects (collectively known as serial position effects) on language alignment.

Although dividing each predictor into bins provides more clarity in terms of how the temporal dynamics of language alignment affects the outcomes, it introduces another potential source of concern: a threefold increase in the number of predictors. This issue does not have much of an impact on hypotheses 1 and 2, since there is only one primary predictor for each of those hypotheses. However, Hypothesis 3 already features 10 predictors, and this increase in the number of predictors can affect the reliability of the results.

This issue of number of predictors for Hypothesis 3 is further exacerbated by the sample size. Indeed, keeping in mind the recommendation of having at least 10 participants for every additional predictor in a multiple regression model (Miller &

Kunce, 1973), the minimum required sample size to conduct the binned analysis using function word predictors would be 300 participants.

Analysis 3b: Analysis of Serial Position Effects in Alignment Using a Composite Index

As noted above, the large number of predictors in the multiple regression model when testing Hypothesis 3 necessitates a much larger sample size than what is available. An alternative analysis method to circumvent this issue is to create a composite index from all available function word indices for each phase of the conversation. First, to ensure that all the function word indices do indeed comprise a consistent index, it is important to confirm that Cronbach's alpha is greater than 0.7 for the set of variables in each phase of the conversation.

Once reliability of internal consistency was established for each phase, composite alignment scores were computed by summing the values across all columns. This yielded a total of three final predictors: one composite function word alignment score for each of the three distinct phases of the conversation. These composite variables and the relevant covariates were then included as predictors in a multiple regression with cluster-robust standard errors.

RESULTS

Hypothesis 1: Cognitive Effects of Lexical Alignment

The first hypothesis proposed a relationship between the degree of lexical alignment in conversation and communicative outcomes. A simple correlation analysis showed that lexical alignment was not highly correlated ($r > .7$) with any of the covariates included in the model, so no variables were dropped in the final regression. The specific outcome variables chosen for this hypothesis are as follows:

i) ESGII3: In the previous interaction, I felt that I understood what my partner was saying.

ii) ESAP29: In the previous interaction, my partner thought like me a lot ______ did not think like me at all.

The first outcome variable leads the respondent to introspect on their own perception of the success of the conversation and how well they understood their partner. By contrast, the second outcome variable shifts the respondent's focus to their partner's mental state, and how well it aligned with their own mental state during the conversation.

Overall, lexical alignment did not have statistically significant effects on either of the outcome variables. Results for all analyses with ESGII3 (comprehension of partner) as the outcome variable are reported in Appendix A (Table A.1, Table A.2, and Table A.3). Similarly, detailed results for all analyses with ESAP29 (perceived alignment of mental representations) as the outcome variable are reported in Appendix A (Table A.4, Table A.5, and Table A.6).

Hypothesis 2: Cognitive Effects of Semantic Alignment

The second hypothesis proposed a relationship between the degree of semantic alignment in conversation and communicative outcomes that relate to the depth of the discussion between couples. A simple correlation analysis showed that semantic alignment was not highly correlated ($r > .7$) with any of the covariates included in the model, so no variables were dropped in the final regression. The specific outcome variables chosen for this hypothesis are as follows:

i) ESAP27: In the previous interaction, my partner was: highly involved ______ not at all involved.

ii) ESBCS15: In the previous interaction, my partner gave superficial rather than in-depth responses.

Both of the outcome variables used to test this hypothesis were partner focused. That is, both items shift the respondent's focus to how involved they perceived their partner to have been during the conversation. However, the first item (ESAP27) relates to the partner's overall demeanor and engagement, while the second item focuses specifically on the quality of the partner's verbal communication during the conversation.

Similarly to Hypothesis 1, the primary predictor (in this case, the degree of semantic alignment) does not seem to have had a detectable impact on participants' responses to the outcome variables. However, the covariate of lexical alignment did appear to have a marginally significant effect on the perceived depth of conversation in the slope analysis. Specifically, higher levels of lexical alignment seem to be correlated with lower levels of perceived depth of conversation. Detailed statistical results for all analyses with ESAP27 (perceived partner involvement) as the outcome variable are reported in Appendix A (Table A.7, Table A.8, and Table A.9) and results with ESBCS15 (perceived depth of interaction) as the outcome variable are reported in Appendix A (Table A.10, Table A.11, and Table A.12).

Hypothesis 3: Affective Effects of Function Word Alignment

The third hypothesis proposed a relationship between the degree of function word alignment in conversation and affective outcomes in dyadic coping. As there was a large number of function word indices, some highly correlated predictors were dropped before the final analyses were conducted. Specifically, for analysis 1, the indices “all_connective” and “all_additive” were found to be highly correlated ($r > .7$) with others and were thus removed from the final model. For analysis 2, only the index “all_connective” was removed from the final set of predictors due to collinearity. Finally, for analysis 3 and analysis 3(b), only the alignment scores associated with the second and third phases for the index of “basic_connectives” were removed from the model along with the alignment scores associated with all three phases for the index of “all_connective.” These five predictors were removed because they were highly correlated ($r > .7$) with other predictors.

The outcome variables chosen to test this hypothesis fall into two overarching categories: a sense of warmth, and a sense of closeness. The two items that comprise the category of warmth are:

i) ESBCS2: In the previous interaction, my partner communicated warmth rather than coldness.

ii) ESAP35: In the previous interaction, my partner was: very cold ______ very warm.

The first item elicits a response that targets the communicative behaviors of the respondent's partner. By contrast, the second item asks the respondent to reflect on their partner's overall demeanor.

Communicated Warmth: Analysis of the Magnitude of Alignment

Overall, when it comes to respondent's perception of their partners' communication of warmth, alignment in certain indices of function words seem to have a weak predictive effect. Specifically, aggregate analyses how that alignment in the indices of logical connectives (β = - 4.94, p = .01) and sentence linking connectives (β = 4.49, p = .01) are significant predictors of the outcome. Interestingly, these two predictors, while very similar in magnitude, are opposite in direction. That is, according to this analysis, an increase in alignment of logical connectives is correlated with lower levels of warmth communicated by the respondent's partner, while an increase in alignment of sentence linking connectives is correlated with higher levels of perceived warmth communication by the partner. Refer to Table 2 for a detailed report of statistical effects of alignment of each function word index in aggregate forms on respondents' perception of the degree of warmth communicated by their partners.

Table 2: Effect of Function Word Alignment on Communicated Warmth (Aggregate Analysis)

	β	SE	tstat	df	p
(Intercept)	9.62	1.62	5.93	13.53	0.00**
Basic connectives	1.84	1.34	1.37	14.79	0.19
All logical	-4.94	1.77	-2.79	18.11	0.01*
Lexical subordinators	-0.25	1.08	-0.23	17.50	0.82
Addition	0.50	1.13	0.44	19.82	0.66

Sentence linking	4.49	1.52	2.95	14.83	0.01*
Determiners	2.33	1.28	1.82	14.48	0.09
All demonstratives	-0.01	1.33	-0.01	15.24	0.99
All positive	1.78	1.41	1.26	20.83	0.22
Utterance length (aligner)	0.00	0.01	0.48	8.38	0.64
Utterance length (target)	-0.02	0.01	-2.43	8.08	0.04*

Note: * indicates statistical significance at p =< .05, ** indicates statistical significance at $p < .01$ and ^ indicates approaching statistical significance at p =< .07

Communicated Warmth: Analysis of the Rate of Change in Alignment

The trends reflected in the aggregate analysis were not reflected in the results of the slopes analysis. Indeed, none of the linguistic indices showed a statistically significant effect on the outcome variable of perceived warmth communication in this analysis. A detailed report of statistical effects of the slopes analysis in provided in Appendix A (Table A.13).

Communicated Warmth: Analysis of Serial Position Effects in Alignment

The effect of the function word indices is best illustrated by the results of the binned analysis (see Table 3), where alignment of logical connectives have negative coefficients with $p < .05$ in all three phases, and alignment of sentence linking connectives have positive coefficients with $p < .05$ in all three phases. Binned analyses also show other indices that are significant predictors only when present in one or two phases of the conversations. For example, alignment in the proportion of lexical subordinators used by the two speakers in the first third of the conversation shows no detectable effect on the outcome, but in the second and third phases of the conversation, such alignment seems to have a strong predictive effect, with β = -2.06 and p = .03 in phase 2 and β = 2.99 and p = .02 in phase 3.

Binned analyses also shed light on the non-linear relationships of some predictors with the outcome, which explains the non-significant results those predictors yielded in the mean analyses. Refer to Table 3 for a detailed report of statistical effects of alignment of each function word index in distinct phases of the conversation on respondents' perception of the degree of warmth communicated by their partners.

Table 3: Effect of Function Word Alignment on Communicated Warmth (Binned Analysis)

	β	SE	tstat	df	p
(Intercept)	11.42	2.08	5.49	6.25	0.00**
Basic connectives phase 1	3.26	0.83	3.91	8.59	0.00**
Lexical subordinators phase 1	0.74	0.53	1.41	7.19	0.20
Lexical subordinators phase 2	-2.06	0.79	-2.61	8.46	0.03*
Lexical subordinators phase 3	2.99	0.93	3.23	4.90	0.02*
Addition phase 1	-1.75	0.75	-2.33	7.21	0.05*
Addition phase 2	0.61	0.80	0.75	7.60	0.47
Addition phase 3	-0.23	0.71	-0.32	7.79	0.76
Sentence linking phase 1	3.62	0.77	4.71	7.65	0.00**
Sentence linking phase 2	2.88	0.96	3.00	7.77	0.02*
Sentence linking phase 3	2.28	0.74	3.10	6.50	0.02*
Determiners phase 1	1.62	0.70	2.33	5.44	0.06^
Determiners phase 2	1.26	0.70	1.81	5.85	0.12
Determiners phase 3	5.18	0.71	7.27	6.47	0.00**
All demonstratives phase 1	1.23	0.66	1.86	6.68	0.11
All demonstratives phase 2	1.83	0.60	3.06	6.18	0.02*
All demonstratives phase 3	-0.62	1.46	-0.42	7.46	0.68
All additive phase 1	-3.38	1.09	-3.10	6.97	0.02*
All additive phase 2	-1.86	0.88	-2.12	5.73	0.08

All additive phase 3	2.35	0.82	2.86	8.61	0.02*
All positive phase 1	1.49	1.00	1.49	8.36	0.17
All positive phase 2	1.30	0.99	1.31	7.48	0.23
All positive phase 3	-1.90	0.90	-2.10	7.30	0.07^
All logical phase 1	-3.88	0.80	-4.85	6.19	0.00**
All logical phase 2	-1.88	0.67	-2.82	8.14	0.02*
All logical phase 3	-6.89	1.22	-5.64	8.25	0.00**
Utterance length (aligner) phase 1	0.00	0.01	-0.04	6.97	0.97
Utterance length (aligner) phase 2	-0.03	0.01	-3.71	7.42	0.01*
Utterance length (aligner) phase 3	0.00	0.00	0.99	5.64	0.36
Utterance length (target) phase 1	0.02	0.01	1.25	8.31	0.25
Utterance length (target) phase 2	-0.02	0.01	-1.52	7.80	0.17
Utterance length (target) phase 3	0.01	0.01	0.65	4.98	0.55

Note: * indicates statistical significance at p =< .05, ** indicates statistical significance at $p < .01$ and ^ indicates approaching statistical significance at p =< .07

It is also important to consider, given the insight provided by the binned analysis strategy, the pattern of predictive effects of alignment in various phases of the conversation. As such, Table 4 reports on whether an index was found to be a statistically significant predictor of the outcome variable ESBCS2 (communicated warmth) in each phase of the conversation. This table highlights which indices of alignment had significant effects on the outcome variable in multiple phases of the conversation. Table 4 also highlights the finding that out of the three phases, the third phase had the highest number of indices with significant effects on the outcome variable with 6 out of 8 indices being significant. Phase 1 closely follows phase 3, with 6 out of 9 indices being significant. Evidently, there is some indication that weak serial position effects (primacy and recency effects) may be apply to the relationship between function word alignment and respondents' perception of communicated warmth.

Table 4: Pattern of Effects of Function Word Alignment Across Dyadic Coping Conversations

Index	Phase 1	Phase 2	Phase 3
Basic connectives	Sig.	NA	NA
Lexical subordinators	N.s.	Sig.	Sig.
Addition	Sig.	N.s.	N.s.
Sentence linking	Sig.	Sig.	Sig.
Determiners	Marg. Sig.	N.s.	Sig.
All demonstratives	N.s.	Sig.	N.s.
All additive	Sig.	N.s.	Sig.
All positive	N.s.	N.s.	Marg. Sig.
All logical	Sig.	Sig.	Sig.
Total sig. + marg. sig. effects	6/9 indices	4/8 indices	6/8 indices

Note: Sig. refers to significant at p =< .05, Marg. Sig. refers to marginally significant at p =< .07, and N.s. refers to not significant at $p > .07$

Communicated Warmth: Analysis of Serial Position Effects in Alignment Using a Composite Index

None of the phases showed detectable effects on the outcome of the degree of warmth the respondent perceived their partner to have communicated. A detailed report of the results of this analysis is provided in Appendix A (Table A.14).

Warmth of Demeanor: Analysis of the Magnitude of Alignment

With regard to respondent's perception of their partners' overall warmth of demeanor, alignment in certain indices of function words seem to have a weak predictive effect. Specifically, the aggregated analyses show that alignment in the index of all positive connectives ($\beta = 4.32$, $p < .01$) is a significant predictor of the outcome. Specifically, according to this analysis, an increase in alignment of positive connectives is correlated with higher levels of perceived warmth communication by the partner. Refer to Table 5 for a detailed report of statistical results of the aggregate analysis.

Table 5: Effect of Function Word Alignment on Warmth of Demeanor (Aggregate Analysis)

	β	SE	tstat	df	*p*
(Intercept)	10.57	1.24	8.50	13.53	0.00**
Basic connectives	-0.10	1.02	-0.10	14.79	0.92
All logical	-1.20	1.24	-0.97	18.11	0.35
Lexical subordinators	-1.17	0.79	-1.48	17.50	0.16
Addition	0.30	0.79	0.38	19.82	0.71
Sentence linking	0.93	1.06	0.87	14.83	0.40
Determiners	1.73	0.94	1.83	14.48	0.09
All demonstratives	1.46	0.88	1.66	15.24	0.12
All positive	4.32	0.97	4.45	20.83	0.00**
Utterance length (aligner)	0.00	0.01	-0.47	8.38	0.65
Utterance length (target)	-0.01	0.01	-1.93	8.08	0.09

Note: * indicates statistical significance at *p* =< .05, ** indicates statistical significance at *p* =< .01 and ^ indicates approaching statistical significance at *p* =< .07

Warmth of Demeanor: Analysis of the Rate of Change in Alignment

The results of the slope analysis corroborate the results of the aggregate analysis, with $\beta = 14.15$ and $p = .02$ for the index of all positive connectives. This result shows a strong positive relationship between this index and the respondents' perception of their partners' warmth in demeanor. Two other indices were marginally significant in this analysis (see Table 6 for a detailed report).

Table 6: Effect of Function Word Alignment on Warmth of Demeanor (Slope Analysis)

	β	SE	tstat	df	*p*
(Intercept)	4.98	0.34	14.74	16.36	0.00**
Basic connectives	-9.09	4.53	-2.01	10.40	0.07^
Lexical subordinators	-1.11	1.60	-0.69	10.13	0.51
Addition	2.49	0.95	2.63	3.72	0.06^

Sentence linking	-3.01	3.36	-0.89	9.22	0.39
determiners	-1.73	4.21	-0.41	9.23	0.69
All demonstratives	0.00	2.12	0.00	15.08	1.00
All additive	2.00	4.96	0.40	13.63	0.69
All positive	14.15	5.37	2.64	17.30	0.02*
All logical	-8.33	4.77	-1.75	7.47	0.12
Utterance length (aligner)	0.00	0.01	0.38	15.31	0.71
Utterance length (target)	0.02	0.01	2.06	16.14	0.06^

Note: * indicates statistical significance at *p* =< .05, ** indicates statistical significance at *p* =< .01 and ^ indicates approaching statistical significance at *p* =< .07

Warmth of Demeanor: Analysis of Serial Position Effects in Alignment

Unlike the results for the previous outcome variable, the results of the binned analysis are not consistent with the results of the aggregate and slope analyses. Specifically, the binned analysis shows that alignment in all positive connectives does not have an equally detectable effect in all phases of the conversation. To elaborate, only the final phase of the conversation drives the predictive effect of this index on respondents' perception of their partners' warmth. The binned analyses once again shed light on non-linear trajectories of the relationship between alignment and the outcome. For example, for the index of lexical subordinators, the first and third phases are positively related to respondent's satisfaction with their partner, but the second phase is negatively related. See Table 7 for a detailed report of the results of the binned analysis on the outcome variable of respondents' perception of their partners' overall demeanor.

Table 7: Effect of Function Word Alignment on Warmth of Demeanor (Binned Analysis)

	β	SE	tstat	df	*p*
(Intercept)	4.44	2.05	2.16	6.25	0.07^
Basic connectives phase 1	1.95	0.73	2.68	8.59	0.03*
Lexical subordinators phase 1	1.37	0.49	2.82	7.19	0.03*
Lexical subordinators phase 2	-3.10	0.53	-5.86	8.46	0.00**
Lexical subordinators phase 3	3.06	1.03	2.97	4.90	0.03*
Addition phase 1	-1.95	0.69	-2.82	7.21	0.03*
Addition phase 2	2.59	0.63	4.12	7.60	0.00**
Addition phase 3	2.30	0.70	3.29	7.79	0.01*
Sentence linking phase 1	0.54	0.82	0.66	7.65	0.53
Sentence linking phase 2	-0.64	0.70	-0.91	7.77	0.39
Sentence linking phase 3	0.87	0.61	1.43	6.50	0.20
Determiners phase 1	2.17	0.58	3.73	5.44	0.01*
Determiners phase 2	-1.29	0.66	-1.95	5.85	0.10
Determiners phase 3	1.03	1.02	1.01	6.47	0.35
All demonstratives phase 1	0.09	0.42	0.22	6.68	0.83
All demonstratives phase 2	0.70	0.46	1.52	6.18	0.18
All demonstratives phase 3	4.23	1.09	3.87	7.46	0.01*
All additive phase 1	0.19	0.87	0.22	6.97	0.84
All additive phase 2	-3.69	0.86	-4.28	5.73	0.01*
All additive phase 3	-1.69	0.60	-2.81	8.61	0.02*
All positive phase 1	-1.48	0.85	-1.75	8.36	0.12
All positive phase 2	0.46	0.83	0.55	7.48	0.60
All positive phase 3	2.80	0.77	3.65	7.30	0.01*
All logical phase 1	-1.78	0.89	-1.99	6.19	0.09
All logical phase 2	0.85	0.72	1.19	8.14	0.27
All logical phase 3	-7.69	0.75	-10.19	8.25	0.00**
Utterance length (aligner) phase 1	0.02	0.01	3.77	6.97	0.01*
Utterance length (aligner) phase 2	-0.01	0.01	-0.98	7.42	0.36
Utterance length (aligner) phase 3	-0.02	0.01	-2.58	5.64	0.04*

Utterance length (target) phase 1	0.01	0.01	0.66	8.31	0.53
Utterance length (target) phase 2	0.02	0.01	2.42	7.80	0.04*
Utterance length (target) phase 3	0.01	0.02	0.63	4.98	0.56

Note: * indicates statistical significance at p =< .05, ** indicates statistical significance at p =< .01 and ^ indicates approaching statistical significance at p =< .07

Table 8 reports on whether an index was found to be a statistically significant predictor of the outcome variable ESAP35 (warmth of demeanor) in each phase of the conversation. This table once again provides tentative evidence for a weak recency effect on the relationship between function word alignment and cognitive indices, as the phase with the largest number of significant alignment scores is once again the third phase.

Table 8: Pattern of Effects of Function Word Alignment Across Dyadic Coping Conversations

Index	Phase 1	Phase 2	Phase 3
Basic connectives	Sig.	NA	NA
Lexical subordinators	Sig.	Sig.	Sig.
Addition	Sig.	Sig.	Sig.
Sentence linking	N.s.	N.s.	N.s.
Determiners	Sig.	N.s.	N.s.
All demonstratives	N.s.	N.s.	Sig.
All additive	N.s.	Sig.	Sig.
All positive	N.s.	N.s.	Sig.
All logical	N.s.	N.s.	Sig.
Total sig. + marg. sig. effects	4/9 indices	3/8 indices	6/8 indices

Note: Sig. refers to significant at p =< .05, and N.s. refers to not significant at p > .07

Warmth of Demeanor: Analysis of Serial Position Effects in Alignment Using a Composite Index

In this analysis, the final phase of the conversation seems to have a marginally significant effect on the outcome of the overall warmth expressed by the partner as perceived by the respondent (see Table 9). This result does not support a definitive conclusion that function word alignment at the end of a conversation drives the respondent's perception of their partner. However, it does provide some encouragement for that hypothesis. Furthermore, it should be taken into consideration that the previous analysis, which is also concerned with the concept of perceived warmth, showed some tendency towards the importance of the final phase. Based on these results, we can conclude that function word alignment at conversation endings may have a slightly more influential effect on perceived warmth than other segments.

Table 9: Analysis of the Temporal Effect of a Composite Index on Warmth of Demeanor of Partner as Perceived by the Respondent

	β	SE	tstat	df	p
(Intercept)	8.34	2.79	2.99	14.56	0.01*
Composite Index phase 1	1.92	1.44	1.33	13.17	0.21
Composite Index phase 2	-1.18	1.86	-0.63	11.96	0.54
Composite Index phase 3	3.21	1.56	2.05	15.14	0.06^
Utterance length (aligner) phase 1	0.02	0.01	2.25	8.58	0.05*
Utterance length (aligner) phase 2	-0.01	0.01	-0.61	7.96	0.56
Utterance length (aligner) phase 3	-0.02	0.01	-3.21	8.60	0.01*
Utterance length (target) phase 1	-0.02	0.02	-1.34	12.25	0.20
Utterance length (target) phase 2	0.01	0.02	0.77	8.28	0.46
Utterance length (target) phase 3	0.02	0.01	1.24	8.71	0.25

Note: * indicates statistical significance at p =< .05, ** indicates statistical significance at p =< .01 and ^ indicates approaching statistical significance at p =< .07

The second category of outcome variables chosen to test Hypothesis 3 focus on a sense of closeness. The two items that comprise this category are:

i) ESGII1: In the previous interaction, I felt close to my partner.

ii) ESAP36: In the previous interaction, my partner: created closeness ______ created a sense of distance.

The first item within this category centers the feelings of the respondent. By contrast, the second item shifts the focus to the actions of the respondent's partner. That is, the first item is self-focused, while the second item is partner focused.

Self Focused Closeness: Analysis of the Magnitude of Alignment

With regard to respondent's perception of how close they felt to their partner, aggregated analyses show no detectable effect. A detailed report of results of the aggregate analysis is provided in Appendix A (Table A.15).

Self Focused Closeness: Analysis of the Rate of Change in Alignment

The results of the slope analysis show the influence of alignment in all logical connectives on the outcome variable, with $\beta = -14.89$ and $p < .01$. No other indices were significant predictors of self-focused closeness in the slope analysis. Refer to Table 10 for a detailed report of all results for the slope analysis.

Table 10: Effect of Function Word Alignment on Self-Focused Closeness (Slope Analysis)

	β	SE	tstat	df	*p*
(Intercept)	5.23	0.45	11.64	16.36	0.00**
Basic connectives	2.12	4.47	0.47	10.40	0.65

Lexical subordinators	-0.92	2.63	-0.35	10.13	0.73
Addition	1.87	1.01	1.86	3.72	0.14
Sentence linking	4.77	3.66	1.30	9.22	0.22
determiners	0.31	5.49	0.06	9.23	0.96
All demonstratives	-0.83	4.18	-0.20	15.08	0.84
All additive	-1.28	5.49	-0.23	13.63	0.82
All positive	8.44	6.83	1.24	17.30	0.23
All logical	-14.89	3.49	-4.27	7.47	0.00**
Utterance length (aligner)	0.01	0.01	0.79	15.31	0.44
Utterance length (target)	0.00	0.01	0.23	16.14	0.82

Note: * indicates statistical significance at p =< .05, ** indicates statistical significance at p =< .01 and ^ indicates approaching statistical significance at p =< .07

Self Focused Closeness: Analysis of Serial Position Effects in Alignment

By contrast to the aggregate analysis, the results of the binned analysis show statistically significant relationships between alignment and self-focused closeness. Specifically, the binned analysis shows that alignment in lexical subordinators is a significant predictor of a respondent's sense of closeness to the partner across all three phases of the conversation. An examination of the coefficients shows that the relationship between lexical subordinators and the outcome is curvilinear, where alignment in phases 1 and 3 are positively correlated with positive affect, and alignment in phase 2 is negatively correlated with positive affect. Alignment in other indices show effects in only one or two phases each. It should be noted, however, that considering the results of the slope and binned analyses in conjunction sheds light on the strong driving force of alignment in the index of all logical connectives in the third bin with $\beta = -8.24$ and $p < .01$. The results of the binned analysis are detailed in Table 11.

Table 11: Effect of Function Word Alignment on Self-Focused Closeness (Binned Analysis)

	β	SE	tstat	df	*p*
(Intercept)	1.44	2.39	0.60	6.25	0.57
Basic connectives phase 1	0.74	1.08	0.68	8.59	0.51
Lexical subordinators phase 1	1.81	0.64	2.83	7.19	0.02*
Lexical subordinators phase 2	-4.05	0.99	-4.10	8.46	0.00**
Lexical subordinators phase 3	3.23	1.20	2.69	4.90	0.04*
Addition phase 1	-1.56	1.00	-1.55	7.21	0.16
Addition phase 2	2.68	1.11	2.42	7.60	0.04*
Addition phase 2	2.12	0.98	2.16	7.79	0.06^
Sentence linking phase 1	-3.66	0.89	-4.10	7.65	0.00**
Sentence linking phase 2	1.06	1.17	0.90	7.77	0.39
Sentence linking phase 3	0.99	0.87	1.14	6.50	0.30
Determiners phase 1	1.40	0.98	1.42	5.44	0.21
Determiners phase 2	-1.31	1.02	-1.28	5.85	0.25
Determiners phase 3	-1.37	1.26	-1.08	6.47	0.32
All demonstratives phase 1	0.06	1.11	0.05	6.68	0.96
All demonstratives phase 2	0.86	0.51	1.69	6.18	0.14
All demonstratives phase 3	4.25	1.22	3.48	7.46	0.01*
All additive phase 1	2.45	1.42	1.73	6.97	0.13
All additive phase 2	-2.55	0.96	-2.64	5.73	0.04*
All additive phase 3	-2.50	0.95	-2.63	8.61	0.03*
All positive phase 1	-1.58	1.26	-1.25	8.36	0.25
All positive phase 2	-1.58	1.22	-1.29	7.48	0.24
All positive phase 3	2.76	0.90	3.06	7.30	0.02*
All logical phase 1	-0.13	1.17	-0.11	6.19	0.92
All logical phase 2	1.88	0.67	2.80	8.14	0.02*
All logical phase 3	-8.24	1.34	-6.16	8.25	0.00**
Utterance length (aligner) phase 1	0.03	0.01	4.91	6.97	0.00**
Utterance length (aligner) phase 2	-0.02	0.01	-1.82	7.42	0.11
Utterance length (aligner) phase 3	-0.01	0.01	-1.42	5.64	0.21

Utterance length (target) phase 1	-0.02	0.02	-1.24	8.31	0.25
Utterance length (target) phase 2	0.03	0.02	1.28	7.80	0.24
Utterance length (target) phase 3	0.03	0.02	1.46	4.98	0.20

Note: * indicates statistical significance at p =< .05, ** indicates statistical significance at p =< .01 and ^ indicates approaching statistical significance at p =< .07

Table 12 provides a detailed report of which alignment indices were significant in each phase of the conversation. Just like previous outcomes, phase 3 has the highest number of significant indices, providing tentative evidence for some effect of recency.

Table 12: Pattern of Effects of Function Word Alignment Across Dyadic Coping Conversations

Index	Phase 1	Phase 2	Phase 3
Basic connectives	N.s.	NA	NA
Lexical subordinators	Sig.	Sig.	Sig.
Addition	N.s.	Sig.	Marg. Sig.
Sentence linking	Sig.	N.s.	N.s.
Determiners	N.s.	N.s.	N.s.
All demonstratives	N.s.	N.s.	Sig.
All additive	N.s.	Sig.	Sig.
All positive	N.s.	N.s.	Sig.
All logical	N.s.	Sig.	Sig.
Total sig. + marg. sig. effects	2/9 indices	4/8 indices	6/8 indices

Note: Sig. refers to significant at p =< .05, Marg. Sig. refers to marginally significant at p =< .07, and N.s. refers to not significant at $p > .07$

Self Focused Closeness: Analysis of Serial Position Effects in Alignment Using a Composite Index

None of the phases had alignment scores with statistically significant effects on the outcome of the degree to which they felt close to their partner at the end of the conversation. A detailed report of the results is provided in Appendix A (see Table A.16).

Partner Focused Closeness: Analysis of the Magnitude of Alignment

With regard to the sense of closeness created by the partner, aggregated analyses show no detectable effect. A detailed report of statistical results of the aggregate analysis for partner focused closeness is provided in Appendix A (Table A.17).

Partner Focused Closeness: Analysis of the Rate of Change in Alignment

The results of the slope analysis reiterate the results of the aggregate analysis with none of the function word indices having a significant predictive effect on partner focused closeness. A detailed report of the results of this analysis is provided in Appendix A (Table A.18).

Partner Focused Closeness: Analysis of Serial Position Effects in Alignment

Binned analysis results shed light on the complexity of the relationship between alignment of function word indices and partner focused closeness. For example, for the index of lexical subordinators, both phases 1 and 2 are significant predictors of the outcome, with coefficients that are very similar in magnitude. However, the directions of the effects are opposite in sign, and so the effect is canceled out when the alignment score is aggregated across the conversation. Refer to Table 13 for a detailed report of the statistical results of binned analysis of the effect of function word alignment on partner focused closeness.

Table 13: Effect of Function Word Alignment on Partner Focused Closeness (Binned Analysis)

	β	SE	tstat	df	*p*
(Intercept)	11.01	3.20	3.44	6.25	0.01*
Basic connectives phase 1	-2.74	0.99	-2.76	8.59	0.02*
Lexical subordinators phase 1	-2.18	0.90	-2.42	7.19	0.04*
Lexical subordinators phase 2	2.65	0.97	2.75	8.46	0.02*
Lexical subordinators phase 3	-2.31	1.41	-1.64	4.90	0.16
Addition phase 1	0.28	1.15	0.25	7.21	0.81
Addition phase 2	-2.47	1.20	-2.05	7.60	0.08
Addition phase 3	-1.30	0.98	-1.32	7.79	0.22
Sentence linking phase 1	-0.51	1.05	-0.48	7.65	0.64
Sentence linking phase 2	1.90	1.17	1.63	7.77	0.14
Sentence linking phase 3	-2.19	0.83	-2.64	6.50	0.04*
Determiners phase 1	0.51	1.07	0.48	5.44	0.65
Determiners phase 2	1.74	0.83	2.10	5.85	0.08
Determiners phase 3	1.58	1.61	0.98	6.47	0.36
All demonstratives phase 1	-1.50	0.83	-1.80	6.68	0.12
All demonstratives phase 2	-0.67	0.73	-0.93	6.18	0.39
All demonstratives phase 3	-5.93	1.64	-3.62	7.46	0.01*
All additive phase 1	3.76	1.35	2.78	6.97	0.03*
All additive phase 2	2.61	1.44	1.82	5.73	0.12
All additive phase 3	2.17	0.95	2.30	8.61	0.05*
All positive phase 1	2.72	1.32	2.06	8.36	0.07^
All positive phase 2	0.02	1.12	0.02	7.48	0.99
All positive phase 3	-2.41	1.20	-2.01	7.30	0.08
All logical phase 1	1.60	1.66	0.97	6.19	0.37
All logical phase 2	-2.51	1.03	-2.44	8.14	0.04*
All logical phase 3	10.67	1.14	9.37	8.25	0.00**
Utterance length (aligner) phase 1	-0.02	0.01	-2.70	6.97	0.03*
Utterance length (aligner) phase 2	0.00	0.01	-0.18	7.42	0.86
Utterance length (aligner) phase 3	0.01	0.01	1.57	5.64	0.17

Utterance length (target) phase 1	-0.05	0.02	-2.31	8.31	0.05*
Utterance length (target) phase 2	0.01	0.02	0.51	7.80	0.62
Utterance length (target) phase 3	-0.02	0.02	-0.77	4.98	0.48

Note: * indicates statistical significance at p =< .05, ** indicates statistical significance at p =< .01 and ^ indicates approaching statistical significance at p =< .07

Table 14 provides a detailed report of which alignment indices were significant in each phase of the conversation. Just like previous outcomes, phase 3 has the highest number of significant indices, closely followed by phase 1 providing tentative evidence for some effect of recency and primacy.

Table 14: Pattern of Effects of Function Word Alignment Across Dyadic Coping Conversations

Index	Phase 1	Phase 2	Phase 3
Basic connectives	Sig.	NA	NA
Lexical subordinators	Sig.	Sig.	N.s.
Addition	N.s.	N.s.	N.s.
Sentence linking	N.s.	N.s.	Sig.
Determiners	N.s.	N.s.	N.s.
All demonstratives	N.s.	N.s.	Sig.
All additive	Sig.	N.s.	Sig.
All positive	Marg. Sig.	N.s.	N.s.
All logical	N.s.	Sig.	Sig.
Total sig. + marg. Sig. effects	4/9 indices	2/8 indices	4/8 indices

Note: Sig. refers to significant at p =< .05, Marg. Sig. refers to marginally significant at p =< .07, and N.s. refers to not significant at p > .07

Partner Focused Closeness: Analysis of Serial Position Effects in Alignment Using a Composite Index

Similarly to the results of analysis 4 on self-focused closeness, none of the phases of conversation show any clear relationship to the outcome variable of the respondent's sense of closeness created by their partner. A detailed report of the results of this analysis is provided in Appendix A (Table A.19).

DISCUSSION

Lexical alignment has been correlated with communicative success in a variety of domains through both theoretical reasoning (Pickering and Garrod, 2004) and empirical support (Brannigan et al., 2000). Some explanations for why lexical alignment can lead to better communicative outcomes include reduced conceptual ambiguity and greater alignment in mental representations. In this study, I proposed that lexical alignment in conversation would be predictive of the following two cognitive outcomes within the context of dyadic coping:

i) Participants' perceptions of the degree to which they understood what their partner was trying to express
ii) Paeticipants' perceptions of the degree to which their mental representations of the converation and the topic aligned with that of their partners.

Although the above claims are relatively well supported, the analyses in this study failed to uncover any statistically significant effects. This result can be contextualized as a reflection of the fact that the relationship between lexical alignment and the above mentioned constructs is more complex than it originally appears.

Two main points of nuance to the relationship between lexical alignment and cognitive outcomes are the difference between targeted and random alignment in conversation and the trajectory of alignment over the duration of a conversation. As to the former consideration, Fusaroli et al. (2012) notes that, in cognitively focused tasks, indiscriminate matching across the conversation was actually counterproductive to the task, while matching on key words related to the task was beneficial. As to the latter consideration, Doyle and Frank (2016) notes that consistent lexical alignment throughout the course of a conversation can be symbolic of a lack of adequate development of the content of the conversation. That is, as natural conversations progress, the topic of conversation develops and changes over time. This development of the topic necessitates the introduction of new concepts, and thus, new words. If this introduction of new words over time is limited, then while the conversation might be high in lexical alignment, it could also be lacking in the richness of discourse. Indeed, the marginally significant negative relationship between lexical alignment and perceived depth of conversation reflects of Doyle and Frank's assertion.

While the relationship between semantic alignment and cognitive outcomes is not theoretically based, there is some empirical support for the idea that such an effect exists (Angus et al., 2012; Babcock et al., 2014). Specifically, taking inspiration from the observations put forth by Babcock et al. (2014), I proposed that semantic alignment in conversation would be predictive of the following cognitive outcome within the context of dyadic coping:

i) Participants' perceptions of the degree to which their partner was involved in the conversation

However, similarly to the results of the analyses related to lexical alignment, this study found no evidence for such an effect.

Finally, extant literature (e.g., Bowen et al., 2017) shows a clear link between function word alignment and interpersonal rapport and warmth in supportive conversations such as in the case of dyadic coping. Based on the trends shown by studies such as Ireland et al. (2011), Ireland and Pennebaker (2010), Bowen et al., (2017) etc., I proposed that function word alignment in conversation would be predictive of the following two affective outcomes within the context of dyadic coping:

i) Participants' perceptions of their partners' warmth towards them.

ii) Paeticipants' perceptions of the degree of closeness between themselves and their partners.

Unlike the results of content word analyses discussed above, the results of function word analyses did yield some statistically significant results when regressed on affective outcomes. Overall, the effects are mixed, with some indices having negative relationships with affect, some having positive relationships, and some having no effects at all. Furthermore, the effects of many of the indices included in the analyses conducted in this study were not linear and consistent across the duration of the conversations. As such, most of the effects were only detectable in the analyses with the highest granularity: the binned analyses. Analyses where alignment was condensed to one score per index per participant more often failed to demonstrate any clear effects. Although the results of the function word analyses were consistent with the general trends observed in prior literature (e.g., Babcock et al., 2014; Bowen et al., 2017; Gonzales et al., 2010; Ireland et al., 2011), the theoretical reasons behind the specific effects of each individual function word on these outcomes are not within the scope of this research.

Analyses with composite function word indices (analysis 3(b)) as the predictor variables show a very weak trend towards a recency effect. Specifically, it seems that, at least for one outcome, alignment in the final phase of the conversation has a relatively stronger influence than in other phases. This trend is also reflected in the fact that, for all four outcomes, the largest number of alignment indices were significant in the final phase, closely followed for some outcomes by the first phase. As such, there seems to be some evidence for an interaction between function word alignment and phase of the conversation.

Limitations and Future Directions

When considering the results discussed above, it is important to also be cognizant of the potential limitations of this study. One of the major limitations that needs to be discussed is the small sample size. Studies based on small sample sizes tend to be underpowered and may not uncover all the potentially interesting effects that could exist within a topic of examination (Faber & Fonseca, 2014). Sample size limitations may have a particularly severe effect on the binned analyses with function words as predictors, because of the relatively large number of predictors included in the model. As such, all results, but especially those relating to Analysis 3 for Hypothesis 3 should be interpreted with a degree of caution.

Another clear limitation of this study is that the outcome measures in this study were self-report items with a range of 7 points. There is much nuance that could have been missed as a result of this relatively crude measurement choice. An alternative or supplementary method of measurement of cognitive outcomes would have been to instruct participants to recount the contents of their conversation as a short prose and quantify the degree of similarity between the partners' accounts. Similarly, an alternative or supplementary method of measurement of affective outcomes could have been to code their facial expressions based on videos taken during the interactions.

There are a number of ways to make future studies looking at the effects of alignment on dyadic coping outcomes stronger. For example, the results of the analysis could be compared with a control condition, with analyses conducted on scrambled transcripts like Healey et al. (2014). Alternatively, the levels of alignment in the external stress condition can be compared to levels of alignment in a discussion of a neutral or positive topic. Such an analysis would act as an additional control for the phenomenon of homophily pointed out by Danescu-Niculescu-Mizil et al. (2011). Another analytic strategy could have looked at the effects of simialrities in magnitudes of alignment between couples on the congruence in their responses to the outcome variables. Such an analysis would have answered the following, related research question: do similarities in the levels of alignment predict similarities in couples' perceptions of the conversation? Additionally, the interaction between conversation phase and function word alignment could be further probed by creating dummy coded variables for phase and including them in the regression.

Overall, there are many strategies that could be adopted in analyzing the current dataset or collecting new data on the topic that might provide clearer answers to the question of how alignment in conversation affects cognitive and affective outcomes in dyadic coping.

CONCLUSION

The current study explored the various ways in which alignment in language use interacts with communicative and affective outcomes in the context of dyadic coping. The broadest conclusion that can be drawn from this study is that the extent to which alignment interacts with cognitive and affective outcomes within the dyadic coping context is as yet unconfirmed. While there may have been some detectable effects within this study, the reliability and certainty of these results are not unequivocal, given the limitations of this study. However, the outlook is not all grim. Indeed, given the small sample, many of the null results could have been caused by a lack of adequate statistical power rather than the true absence of the hypothesized effects. Therefore, I believe that the mixed results of this study warrant further and more precise examination of the topic.

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APPENDIX A

TABLES WITH NON-SIGNIFICANT RESULTS

Table A.1: Effect of Lexical Alignment on Comprehension of Partner (Aggregate Analysis)

	β	SE	tstat	df	*p*
(Intercept)	9.79	3.68	2.66	17.26	0.02*
Lexical alignment	1.73	2.31	0.75	15.64	0.47
Semantic alignment	0.88	2.06	0.43	15.70	0.67
Utterance length (aligner)	0.00	0.01	-0.28	4.42	0.79
Utterance length (target)	0.01	0.00	1.77	11.49	0.10

Note: * indicates statistical significance at p =< .05, ** indicates statistical significance at $p < .01$ and ^ indicates approaching statistical significance at p =< .07

Table A.2: Effect of Lexical Alignment on Perceived Partner Comprehension (Slope Analysis)

	β	SE	tstat	df	*p*
(Intercept)	5.77	0.22	26.11	20.29	0.00**
Semantic alignment	-10.19	9.80	-1.04	18.24	0.31
Lexical alignment	4.15	7.89	0.53	16.10	0.61
Utterance length (target)	0.01	0.00	2.75	8.28	0.02*
Utterance length (aligner)	0.00	0.01	-0.42	17.65	0.68

Note: * indicates statistical significance at p =< .05, ** indicates statistical significance at $p < .01$ and ^ indicates approaching statistical significance at p =< .07

Table A.3: Effect of Lexical Alignment on Perceived Partner Comprehension (Binned Analysis)

	β	SE	tstat	df	*p*
(Intercept)	10.79	4.04	2.67	16.78	0.02*
Lexical alignment phase 1	0.23	1.34	0.17	18.36	0.86
Lexical alignment phase 2	0.20	1.96	0.10	13.07	0.92
Lexical alignment phase 3	2.60	2.46	1.06	18.66	0.30
Semantic alignment phase 1	1.14	1.04	1.09	15.11	0.29
Semantic alignment phase 2	0.03	1.57	0.02	11.94	0.99
Semantic alignment phase 3	-0.55	1.75	-0.32	8.79	0.76

Utterance length (aligner) phase 1	0.00	0.01	-0.43	12.39	0.68
Utterance length (aligner) phase 2	0.00	0.01	0.03	12.85	0.98
Utterance length (aligner) phase 3	0.00	0.01	-0.31	14.00	0.76
Utterance length (target) phase 1	0.00	0.01	0.35	12.49	0.73
Utterance length (target) phase 2	0.00	0.00	0.21	13.94	0.84
Utterance length (target) phase 3	0.00	0.01	0.44	12.74	0.67

Note: * indicates statistical significance at p =< .05, ** indicates statistical significance at p < .01 and ^ indicates approaching statistical significance at p =< .07

Table A.4: Effect of Lexical Alignment on Perceived Alignment of Mental Representations (Aggregate Analysis)

	β	SE	tstat	df	p
(Intercept)	-1.13	7.93	-0.14	17.26	0.89
Lexical alignment	-1.72	4.21	-0.41	15.64	0.69
Semantic alignment	-1.14	3.95	-0.29	15.70	0.78
Utterance length (aligner)	0.00	0.01	0.08	4.42	0.94
Utterance length (target)	-0.01	0.01	-0.82	11.49	0.43

Note: * indicates statistical significance at p =< .05, ** indicates statistical significance at p < .01 and ^ indicates approaching statistical significance at p =< .07

Table A.5: Effect of Lexical Alignment on Perceived Alignment of Mental Representations (Slope Analysis)

	β	SE	tstat	df	p
(Intercept)	3.38	0.40	8.35	20.29	0.00**
Semantic alignment	10.40	16.38	0.64	18.24	0.53
Lexical alignment	-11.06	14.37	-0.77	16.10	0.45
Utterance length (target)	-0.01	0.01	-1.44	8.28	0.19
Utterance length (aligner)	0.00	0.01	0.33	17.65	0.75

Note: * indicates statistical significance at p =< .05, ** indicates statistical significance at p < .01 and ^ indicates approaching statistical significance at p =< .07

Table A.6: Effect of Lexical Alignment on Perceived Alignment of Mental Representations (Binned Analysis)

	β	SE	tstat	df	*p*
(Intercept)	10.79	4.04	2.67	16.78	0.02*
Lexical alignment phase 1	0.23	1.34	0.17	18.36	0.86
Lexical alignment phase 2	0.20	1.96	0.10	13.07	0.92
Lexical alignment phase 3	2.60	2.46	1.06	18.66	0.30
Semantic alignment phase 1	1.14	1.04	1.09	15.11	0.29
Semantic alignment phase 2	0.03	1.57	0.02	11.94	0.99
Semantic alignment phase 3	-0.55	1.75	-0.32	8.79	0.76
Utterance length (aligner) phase 1	0.00	0.01	-0.43	12.39	0.68
Utterance length (aligner) phase 2	0.00	0.01	0.03	12.85	0.98
Utterance length (aligner) phase 3	0.00	0.01	-0.31	14.00	0.76
Utterance length (target) phase 1	0.00	0.01	0.35	12.49	0.73
Utterance length (target) phase 2	0.00	0.00	0.21	13.94	0.84
Utterance length (target) phase 3	0.00	0.01	0.44	12.74	0.67

Note: * indicates statistical significance at p =< .05, ** indicates statistical significance at $p < .01$ and ^ indicates approaching statistical significance at p =< .07

Table A.7: Effect of Semantic Alignment on Perceived Partner Involvement (Aggregate Analysis)

	β	SE	tstat	df	*p*
(Intercept)	9.95	7.18	1.39	17.26	0.18
Semantic alignment	5.95	4.35	1.37	15.70	0.19
Lexical alignment	-4.87	4.24	-1.15	15.64	0.27
Utterance length (aligner)	0.00	0.01	0.56	4.42	0.60
Utterance length (target)	-0.01	0.01	-1.70	11.49	0.12

Note: * indicates statistical significance at p =< .05, ** indicates statistical significance at $p < .01$ and ^ indicates approaching statistical significance at p =< .07

Table A.8: Effect of Semantic Alignment on Perceived Partner Involvement (Slope Analysis)

	β	SE	tstat	df	p
(Intercept)	2.45	0.47	5.18	20.29	0.00**
Semantic alignment	-8.53	13.45	-0.63	18.24	0.53
Lexical alignment	-0.88	10.94	-0.08	16.10	0.94
Utterance length (target)	-0.01	0.01	-1.26	8.28	0.24
Utterance length (aligner)	0.01	0.01	0.73	17.65	0.47

Note: * indicates statistical significance at *p* =< .05, ** indicates statistical significance at *p* < .01 and ^ indicates approaching statistical significance at *p* =< .07

Table A.9: Effect of Semantic Alignment on Perceived Partner Involvement (Binned Analysis)

	β	SE	tstat	df	p
(Intercept)	7.89	8.05	0.98	16.78	0.34
Lexical alignment phase 1	-3.42	2.51	-1.36	18.36	0.19
Lexical alignment phase 2	-1.44	2.60	-0.55	13.07	0.59
Lexical alignment phase 3	0.87	4.06	0.22	18.66	0.83
Semantic alignment phase 1	0.94	1.31	0.72	15.11	0.48
Semantic alignment phase 2	2.18	2.68	0.81	11.94	0.43
Semantic alignment phase 3	1.49	3.06	0.49	8.79	0.64
Utterance length (aligner) phase 1	0.01	0.01	0.62	12.39	0.55
Utterance length (aligner) phase 2	0.01	0.01	0.56	12.85	0.58
Utterance length (aligner) phase 3	-0.01	0.01	-0.57	14.00	0.58
Utterance length (target) phase 1	0.01	0.01	1.03	12.49	0.32
Utterance length (target) phase 2	0.00	0.01	-0.18	13.94	0.86
Utterance length (target) phase 3	-0.02	0.01	-1.86	12.74	0.09

Note: * indicates statistical significance at *p* =< .05, ** indicates statistical significance at *p* < .01 and ^ indicates approaching statistical significance at *p* =< .07

Table A.10: Effect of Semantic Alignment on Perceived Depth of Interaction (Aggregate Analysis)

	β	SE	tstat	df	*p*
(Intercept)	-9.75	7.61	-1.28	17.26	0.22
Semantic alignment	-2.67	4.21	-0.64	15.70	0.53
Lexical alignment	-6.13	4.47	-1.37	15.64	0.19
Utterance length (aligner)	0.01	0.01	1.14	4.42	0.31
Utterance length (target)	-0.01	0.01	-1.49	11.49	0.16

Note: * indicates statistical significance at p =< .05, ** indicates statistical significance at p < .01 and ^ indicates approaching statistical significance at p =< .07

Table A.11*:* Effect of Semantic Alignment on Perceived Depth of Interaction (Slope Analysis)

	β	SE	tstat	df	*p*
(Intercept)	3.86	0.37	10.56	20.29	0.00*
Semantic alignment	-13.37	16.24	-0.82	18.24	0.42
Lexical alignment	20.43	10.65	1.92	16.10	0.07^
Utterance length (target)	-0.03	0.01	-4.43	8.28	0.00*
Utterance length (aligner)	0.00	0.01	-0.61	17.65	0.55

Note: * indicates statistical significance at p =< .05, ** indicates statistical significance at $p < .01$ and ^ indicates approaching statistical significance at p =< .07

Table A.12: Effect of Semantic Alignment on Perceived Depth of Interaction (Binned Analysis)

	β	SE	tstat	df	*p*
(Intercept)	-10.49	8.05	-1.30	16.78	0.21
Lexical alignment phase 1	-1.63	2.78	-0.58	18.36	0.57
Lexical alignment phase 2	-2.55	3.35	-0.76	13.07	0.46
Lexical alignment phase 3	-1.41	3.82	-0.37	18.66	0.72
Semantic alignment phase 1	0.72	1.69	0.43	15.11	0.67
Semantic alignment phase 2	-4.72	3.42	-1.38	11.94	0.19
Semantic alignment phase 3	0.55	2.72	0.20	8.79	0.85

Utterance length (aligner) phase 1	0.00	0.01	-0.37	12.39	0.72
Utterance length (aligner) phase 2	0.02	0.01	1.68	12.85	0.12
Utterance length (aligner) phase 3	-0.01	0.01	-0.57	14.00	0.58
Utterance length (target) phase 1	0.00	0.01	-0.34	12.49	0.74
Utterance length (target) phase 2	0.00	0.01	0.04	13.94	0.97
Utterance length (target) phase 3	-0.01	0.01	-1.57	12.74	0.14

Note: * indicates statistical significance at *p* =< .05, ** indicates statistical significance at *p* < .01 and ^ indicates approaching statistical significance at *p* =< .07

Table A.13: Effect of Function Word Alignment on Communicated Warmth (Slopes Analysis)

	β	SE	tstat	df	*p*
(Intercept)	4.59	0.44	10.38	16.36	0.00**
Basic connectives	-1.03	5.76	-0.18	10.40	0.86
Lexical subordinators	1.37	3.62	0.38	10.13	0.71
Addition	-1.54	1.18	-1.31	3.72	0.27
Sentence linking	1.43	4.81	0.30	9.22	0.77
Determiners	-1.38	4.40	-0.31	9.23	0.76
All demonstratives	2.56	4.30	0.60	15.08	0.56
All additive	-0.14	4.62	-0.03	13.63	0.98
All positive	5.25	6.38	0.82	17.30	0.42
All logical	-3.63	4.61	-0.79	7.47	0.46
Utterance length (aligner)	0.00	0.01	0.59	15.31	0.57
Utterance length (target)	0.02	0.01	2.20	16.14	0.04*

Note: * indicates statistical significance at *p* =< .05, ** indicates statistical significance at *p* =< .01 and ^ indicates approaching statistical significance at *p* =< .07

Table A.14: Analysis of the Temporal Effect of a Composite Index on Warmth Communicated by Partner as Perceived by the Respondent

	β	SE	tstat	df	*p*
(Intercept)	7.70	2.30	3.36	14.56	0.00**
Composite Index phase 1	-0.65	1.77	-0.37	13.17	0.72
Composite Index phase 2	1.34	1.53	0.88	11.96	0.40
Composite Index phase 3	2.40	1.52	1.58	15.14	0.13
Utterance length (aligner) phase 1	0.01	0.01	2.18	8.58	0.06^
Utterance length (aligner) phase 2	-0.04	0.02	-2.15	7.96	0.06^
Utterance length (aligner) phase 3	0.00	0.01	0.60	8.60	0.56
Utterance length (target) phase 1	-0.02	0.02	-1.29	12.25	0.22
Utterance length (target) phase 2	0.02	0.02	1.24	8.28	0.25
Utterance length (target) phase 3	0.01	0.02	0.78	8.71	0.45

Note: * indicates statistical significance at *p* =< .05, ** indicates statistical significance at *p* =< .01 and ^ indicates approaching statistical significance at *p* =< .07

Table A.15: Effect of Function Word Alignment on Self-Focused Closeness (Aggregate Analysis)

	β	SE	tstat	df	*p*
(Intercept)	7.13	1.50	4.75	13.65	0.00**
Basic connectives	-1.08	1.20	-0.90	13.02	0.38
Lexical subordinators	-1.36	0.90	-1.52	16.48	0.15
Addition	0.77	0.84	0.92	20.90	0.37
Sentence linking	0.09	1.09	0.09	17.17	0.93
Determiners	1.02	1.17	0.88	15.44	0.39
All demonstratives	-0.67	1.08	-0.62	16.47	0.54
All positive	3.10	1.61	1.93	21.12	0.07^
Utterance length (aligner)	0.00	0.01	-0.14	7.23	0.89
Utterance length (target)	0.00	0.01	0.60	8.22	0.57

Note: * indicates statistical significance at *p* =< .05, ** indicates statistical significance at *p* =< .01 and ^ indicates approaching statistical significance at *p* =< .07

Table A.16: Analysis of ihe Temporal Effect of LSM As a Composite Index on Self-Focused Closeness

	β	SE	tstat	df	*p*
(Intercept)	7.43	2.52	2.95	14.56	0.01*
Composite Index phase 1	-0.06	1.56	-0.04	13.17	0.97
Composite Index phase 2	1.19	2.12	0.56	11.96	0.59
Composite Index phase 3	0.76	1.60	0.47	15.14	0.64
Utterance length (aligner) phase 1	0.01	0.01	2.11	8.58	0.07^
Utterance length (aligner) phase 2	-0.02	0.02	-1.40	7.96	0.20
Utterance length (aligner) phase 3	-0.01	0.01	-0.84	8.60	0.43
Utterance length (target) phase 1	-0.02	0.02	-1.23	12.25	0.24
Utterance length (target) phase 2	0.00	0.02	0.21	8.28	0.84
Utterance length (target) phase 3	0.01	0.02	0.69	8.71	0.51

Note: * indicates statistical significance at p =< .05, ** indicates statistical significance at p =< .01 and ^ indicates approaching statistical significance at p =< .07

Table A.17: Effect of Function Word Alignment on Partner Focused Closeness (Aggregate Analysis)

	β	SE	tstat	df	*p*
(Intercept)	0.11	1.55	0.07	13.65	0.94
Basic connectives	0.69	1.15	0.60	13.02	0.56
Lexical subordinators	1.33	1.03	1.29	16.48	0.21
Addition	-0.48	0.97	-0.49	20.90	0.63
Sentence linking	-1.97	1.24	-1.59	17.17	0.13
Determiners	-0.48	1.26	-0.38	15.44	0.71
All demonstratives	-1.02	1.11	-0.91	16.47	0.37
All positive	-1.91	1.58	-1.21	21.12	0.24
Utterance length (aligner)	0.00	0.00	-0.97	7.23	0.36
Utterance length (target)	0.00	0.01	0.22	8.22	0.83

Note: * indicates statistical significance at p =< .05, ** indicates statistical significance at p =< .01 and ^ indicates approaching statistical significance at p =< .07

Table A.18: Effect of Function Word Alignment on Partner Focused Closeness (Slope Analysis)

	β	SE	tstat	df	*p*
(Intercept)	3.05	0.44	6.89	16.36	0.00**
Basic connectives	6.82	4.63	1.47	10.40	0.17
Lexical subordinators	3.42	2.13	1.61	10.13	0.14
Addition	-1.02	1.28	-0.80	3.72	0.47
Sentence linking	-1.37	3.72	-0.37	9.22	0.72
Determiners	-0.57	4.32	-0.13	9.23	0.90
All demonstratives	-0.22	2.94	-0.08	15.08	0.94
All additive	-6.68	5.91	-1.13	13.63	0.28
All positive	-9.76	5.64	-1.73	17.30	0.10
All logical	8.86	4.85	1.82	7.47	0.11
Utterance length (aligner)	-0.01	0.01	-0.69	15.31	0.50
Utterance length (target)	-0.01	0.01	-0.58	16.14	0.57

Note: * indicates statistical significance at *p* =< .05, ** indicates statistical significance at *p* =< .01 and ^ indicates approaching statistical significance at *p* =< .07

Table A.19: Analysis of the Temporal Effect of LSM as a Composite Index On Partner Focused Closeness

	β	SE	tstat	df	*p*
(Intercept)	-0.86	3.92	-0.22	14.56	0.83
Composite Index phase 1	-2.47	2.06	-1.20	13.17	0.25
Composite Index phase 2	-0.21	2.25	-0.09	11.96	0.93
Composite Index phase 3	-1.45	2.22	-0.65	15.14	0.52
Utterance length (aligner) phase 1	-0.02	0.01	-1.49	8.58	0.17
Utterance length (aligner) 2	0.02	0.02	1.49	7.96	0.17
Utterance length (aligner) 3	0.00	0.01	0.15	8.60	0.89
Utterance length (target) 1	0.02	0.02	0.94	12.25	0.37
Utterance length (target) 2	0.01	0.02	0.44	8.28	0.67
Utterance length (target) 3	-0.01	0.02	-0.35	8.71	0.73

Note: * indicates statistical significance at *p* =< .05, ** indicates statistical significance at *p* =< .01 and ^ indicates approaching statistical significance at *p* =< .07

APPENDIX B

DATA PREPARATION AND STATISTICAL ANALYSES CODE

LOAD NECESSARY PACKAGES

```
library(tidyverse)
library(readxl)
library(clubSandwich)
library(lme4)
library(lmerTest)
library(knitr)
```

CODE FOR CONTENT WORD ALIGNMENT

Preliminary Steps

P-Step 1: First step is to import the dataset with all variables:

```
completeData <- read_excel("addRole.xlsx")
```

P-Step 2: In order to be able to treat each type of variable in unique ways (aggregate predictors and remove duplicates for outcomes), I will split the dataset into predictors (predictorsCW) and outcomes (outcomesCW). Because the outcome values were repeated in order to match the number of rows for the predictors, I used the unique function to reduce the outcome dataset to one value per participant.

```
predictorsCW <- completeData %>%
  select(ID,
         Dyad,
         aligner_score,
         Role,
         utterlen_aligner,
         utterlen_target,
         utter_order,
         lexical,
         semantic)

outcomesCW <- completeData %>%
  select(Dyad,
    ID,
    ESAP27,
    ESBCS15,
    ESGII3,
```

ESAP29)

```
outcomesCW <- unique(outcomesCW)
```

P-Step 3: Now, there are some issues with utter_order.

1) First, it starts at 0, while I want it to start at 1. That needs to be fixed. the way to fix that issue is to add 1 to utter_order at each row.

2) Second, utter_order is grouped by Dyad. Meaning each person's utter_order has a step of +2, while I want it to have a step of +1.

3) Third, we need utter_order as a proportion so the range is from 0-1 for all individuals so as to standardize the "time" variable.

```
predictorsCW <- predictorsCW %>%
  mutate(utter_order = utter_order + 1) %>%
  group_by(ID) %>%
  mutate(utter_order = seq_along(utter_order)) %>%
  mutate(ordering_prop = utter_order/max(utter_order)) %>%
  ungroup()
```

All the issues with utter_order have now been fixed

P-Step 4: The next step is to create z-scores for alignment scores so as to standardize them:

```
predictorsCW <- predictorsCW %>%
  mutate(z_lexical = (lexical - mean(lexical)/sd(lexical))) %>%
  mutate(z_semantic = (semantic - mean(semantic)/sd(semantic)))
```

Analysis 1

In this analysis, I will be aggregating the two content word alignment indices of interest by taking their means. By so doing, I can reduce each predictor down to one value per person so as to bring them to the same level as the outcome values.

The way to do this is to use mean() within summarize() and save it to a new dataframe. I have also chosen to group_by both ID and Dyad so as to preserve both of those variables.

```
aggPredictorsCW <- predictorsCW %>%
  group_by(ID, Dyad) %>%
  summarize(aggUtterAligner = mean(utterlen_aligner),
            aggUtterTarg = mean(utterlen_target),
            z_aggLex = mean(z_lexical),
            z_aggSem = mean(z_semantic))
```

Now that predictors and outcomes have the same number of rows and predictors are standardized, I will join both using left_join()

```
meanedForA1 <- aggPredictorsCW %>%
  left_join(outcomesCW, by = NULL)
```

Now we have the dataset that will be used for analyses to be conducted to conduct analysis 1 (*meanedForA1*).

The following are the steps that will be completed:

1) Create a correlation table between the predictors and covariates

2) Run multiple regression with the selected variables and outcomes.

```
A1CormatCW <-
  Hmisc :: rcorr(as.matrix(meanedForA1[, 3:10]))
```

Perform Regressions with Cluster-Robust Standard Errors

```
aggCWm1 <- lm(
  ESAP27 ~
    z_aggSem +
    z_aggLex +
    aggUtterAligner +
    aggUtterTarg,
  data = meanedForA1
  )
```

```
attach(meanedForA1)

kable(coef_test(aggCWm1, vcov ="CR1", cluster=Dyad),
      format = "markdown", digits = 2)

aggCWm2 <- lm(
  ESBCS15 ~
    z_aggSem +
    z_aggLex +
    aggUtterAligner +
    aggUtterTarg,
  data = meanedForA1
  )

attach(meanedForA1)
kable(coef_test(aggCWm2, vcov ="CR1", cluster=Dyad),
      format = "markdown", digits = 2)

aggCWm3 <- lm(
  ESGII3 ~
    z_aggLex +
    z_aggSem +
    aggUtterAligner +
    aggUtterTarg,
  data = meanedForA1
  )

attach(meanedForA1)
kable(coef_test(aggCWm3, vcov ="CR1", cluster=Dyad),
      format = "markdown", digits = 2)

aggCWm4 <- lm(
  ESAP29 ~
    z_aggLex +
    z_aggSem +
    aggUtterAligner +
    aggUtterTarg,
  data = meanedForA1
  )
```

```
attach(meanedForA1)
kable(coef_test(aggCWm4, vcov ="CR1", cluster=Dyad),
      format = "markdown", digits = 2)
```

Analysis 2

My main objectives in this goal are as follows:

1) Compute slopes for lexical and semantic alignment for each individual and save the slopes using the coef() function.

2) Then, use the slopes as the predictor and the outcome as the dependent variable in multiple regressions.

Step 1: Calculate slopes

```
CW_coefficients <- predictorsCW %>%
   group_by(ID) %>%
   summarise(
     across(
       starts_with("z_"),
              list(slope = ~lm(. ~ utter_order)$coef[2])
       )
     )

utterLenMeans <- meanedForA1 %>%
  select(ID, aggUtterAligner, aggUtterTarg)
```

Step 2: merge the outcome variable dataframe with the predictor slope dataframe

```
fullDat <- full_join(CW_coefficients, outcomesCW, by = "ID")

fullDat <- full_join(fullDat, utterLenMeans, by = "ID")

fullDat <- fullDat %>%
  select(ID, Dyad,
         aggUtterAligner, aggUtterTarg,
         z_lexical_slope, z_semantic_slope,
         ESAP27, ESBCS15, ESGII3, ESAP29)
```

Step 3: Create new correlation tables with slopes instead of means

```
A2CormatCW <-
  Hmisc :: rcorr(as.matrix(fullDat[, 3:10]))
```

Perform Regressions with Cluster-Robust Standard Errors

```
SlopeCWm1 <- lm(
  ESAP27 ~
    z_semantic_slope +
    z_lexical_slope +
    aggUtterTarg +
    aggUtterAligner,
  data = fullDat
  )

attach(fullDat)
kable(coef_test(SlopeCWm1, vcov ="CR1", cluster=Dyad),
      format = "markdown", digits = 2)

SlopeCWm2 <- lm(
  ESBCS15 ~
    z_semantic_slope +
    z_lexical_slope +
    aggUtterTarg +
    aggUtterAligner,
  data = fullDat
  )

attach(fullDat)
kable(coef_test(SlopeCWm2, vcov ="CR1", cluster=Dyad),
      format = "markdown", digits = 2)

SlopeCWm3 <- lm(
  ESGII3 ~
    z_semantic_slope +
    z_lexical_slope +
    aggUtterTarg +
    aggUtterAligner,
  data = fullDat
  )
```

```
attach(fullDat)
kable(coef_test(SlopeCWm3, vcov ="CR1", cluster=Dyad),
      format = "markdown", digits = 2)

SlopeCWm4 <- lm(
  ESAP29 ~
    z_semantic_slope +
    z_lexical_slope +
    aggUtterTarg +
    aggUtterAligner,
  data = fullDat
  )

attach(fullDat)
kable(coef_test(SlopeCWm4, vcov ="CR1", cluster=Dyad),
      format = "markdown", digits = 2)
```

Analysis 3

My goal in this section is to bin the predictors into thirds and see if alignment in any specific phases of the conversation makes a bigger difference than others.

Step 1: create 3 bins per predictor

```
binned_avgsCW <- predictorsCW %>%
  group_by(ID) %>%
  mutate(bin = case_when(ordering_prop <= 0.33 ~ "1",
                          ordering_prop > 0.66 ~ "3",
                         ordering_prop > 0.33 ~ "2")) %>%
  pivot_wider(names_from = bin, values_from = c(utterlen_aligner, utterlen_target,
z_lexical, z_semantic, )) %>%
  group_by(ID, Dyad) %>%
  summarise(mean_lexical_1 = mean(z_lexical_1, na.rm = TRUE),
          mean_lexical_2 = mean(z_lexical_2, na.rm = TRUE),
          mean_lexical_3 = mean(z_lexical_3, na.rm = TRUE),
          mean_semantic_1 = mean(z_semantic_1, na.rm = TRUE),
          mean_semantic_2 = mean(z_semantic_2, na.rm = TRUE),
          mean_semantic_3 = mean(z_semantic_3, na.rm = TRUE),
          meanUtterAligner1 = mean(utterlen_aligner_1, na.rm = TRUE),
          meanUtterAligner2 = mean(utterlen_aligner_2, na.rm = TRUE),
          meanUtterAligner3 = mean(utterlen_aligner_3, na.rm = TRUE),
          meanUtterTarg1 = mean(utterlen_target_1, na.rm = TRUE),
```

```
        meanUtterTarg2 = mean(utterlen_target_2, na.rm = TRUE),
        meanUtterTarg3 = mean(utterlen_target_3, na.rm = TRUE))

binned_utterlens <- binned_avgsCW %>%
  select(Dyad, ID,
       meanUtterAligner1, meanUtterAligner2, meanUtterAligner3,
       meanUtterTarg1, meanUtterTarg2, meanUtterTarg3)
```

Step 2: combine the set of predictors with outcomes

```
binned_DFCW <- binned_avgsCW %>%
  left_join(outcomesCW, by = NULL)
```

Step 3: create correlation tables using new DF

```
A3CormatCW <-
  Hmisc :: rcorr(as.matrix(binned_DFCW[, 3:18]))
```

None of the variables have correlation values above 0.65, so none of them will be omitted.

Perform Regressions with Cluster-Robust Standard Errors

```
binnedCWm1 <- lm(
  ESAP27 ~ .
  - ID
  -Dyad
  -ESBCS15
  -ESGII3
  -ESAP29,
  data = binned_DFCW
  )

attach(binned_DFCW)
kable(coef_test(binnedCWm1, vcov ="CR1", cluster=Dyad),
     format = "markdown", digits = 2)

binnedCWm2 <- lm(
  ESBCS15 ~ .
  - ID
  -Dyad
```

```
  -ESAP27
  -ESGII3
  -ESAP29,
  data = binned_DFCW
  )

attach(binned_DFCW)
kable(coef_test(binnedCWm2, vcov ="CR1", cluster=Dyad),
      format = "markdown", digits = 2)

binnedCWm3 <- lm(
  ESGII3 ~ .
  - ID
  -Dyad
  -ESAP27
  -ESBCS15
  -ESAP29,
  data = binned_DFCW
  )

attach(binned_DFCW)
kable(coef_test(binnedCWm3, vcov ="CR1", cluster=Dyad),
      format = "markdown", digits = 2)

binnedCWm4 <- lm(
  ESAP29 ~ .
  - ID
  -Dyad
  -ESAP27
  -ESBCS15
  -ESGII3,
  data = binned_DFCW
  )

attach(binned_DFCW)
kable(coef_test(binnedCWm3, vcov ="CR1", cluster=Dyad),
      format = "markdown", digits = 2)
```

CODE FOR FUNCTION WORD ALIGNMENT

Preliminary Steps

P-Step 1: First step is to import predictor and outcome datasets

```
predictorsFW <- read_excel("All_rLSM.xlsx")

outcomesFW <- readxl::read_excel("postRatingsPAes.xlsx") %>%
  select("Dyad", "ID", "ESBCS2", "ESGII1", "ESAP35", "ESAP36")
```

P-Step 2: Now, there are some issues with utter_order that need to be fixed:

1) First, utter_order is grouped by Dyad. Meaning each person's utter_order has a step of +2, while I want it to have a step of +1.

2) Second, we need utter_order as a proportion so the range is from 0-1 for all individuals so as to standardize the "time" variable.

```
predictorsFW <- predictorsFW %>%
  group_by(ID) %>%
  mutate(turn = seq_along(turn)) %>%
  mutate(turn_prop = turn/max(turn)) %>%
  ungroup()
```

All the issues with utter_order have now been fixed

P-Step 3: Create z-scores for alignment scores so as to standardize them:

```
predictorsFW <- predictorsFW %>%

   mutate(z_basic_connectives_rLSM =
         (basic_connectives_rLSM -
           mean(basic_connectives_rLSM,
               na.rm = TRUE)/
           sd(basic_connectives_rLSM,
             na.rm = TRUE))) %>%

  mutate(z_lexical_subordinators_rLSM =
         (lexical_subordinators_rLSM -
           mean(lexical_subordinators_rLSM,
```

```
                na.rm = TRUE)/
            sd(lexical_subordinators_rLSM,
              na.rm = TRUE))) %>%

mutate(z_addition_rLSM =
          (addition_rLSM -
            mean(addition_rLSM,
                na.rm = TRUE)/
            sd(addition_rLSM,
              na.rm = TRUE))) %>%

mutate(z_sentence_linking_rLSM =
          (sentence_linking_rLSM -
            mean(sentence_linking_rLSM,
                na.rm = TRUE)/
            sd(sentence_linking_rLSM,
              na.rm = TRUE))) %>%

mutate(z_determiners_rLSM =
          (determiners_rLSM -
            mean(determiners_rLSM,
                na.rm = TRUE)/
            sd(determiners_rLSM,
              na.rm = TRUE))) %>%

mutate(z_all_demonstratives_rLSM =
          (all_demonstratives_rLSM -
            mean(all_demonstratives_rLSM,
                na.rm = TRUE)/
            sd(all_demonstratives_rLSM,
              na.rm = TRUE))) %>%

mutate(z_all_additive_rLSM =
          (all_additive_rLSM -
            mean(all_additive_rLSM,
                na.rm = TRUE)/
            sd(all_additive_rLSM,
              na.rm = TRUE))) %>%

mutate(z_all_positive_rLSM =
```

```
        (all_positive_rLSM -
          mean(all_positive_rLSM,
               na.rm = TRUE)/
          sd(all_positive_rLSM,
             na.rm = TRUE))) %>%

  mutate(z_all_logical_rLSM =
        (all_logical_rLSM -
          mean(all_logical_rLSM,
               na.rm = TRUE)/
          sd(all_logical_rLSM,
             na.rm = TRUE))) %>%

  mutate(z_all_connective_rLSM =
        (all_connective_rLSM -
          mean(all_connective_rLSM,
               na.rm = TRUE)/
          sd(all_connective_rLSM,
             na.rm = TRUE)))
```

Analysis 1

In this analysis, I will be aggregating the alignment scores for each function word index of interest by taking their means. By so doing, I can reduce each predictor down to one value per person so as to bring them to the same level as the outcome values.

Step 1: aggregate the predictors

```
aggPredictorsFW <- predictorsFW %>%
  group_by(ID, Dyad) %>%
  summarize(z_basic_connectives_rLSM_agg =
          mean(z_basic_connectives_rLSM,
               na.rm = TRUE),
         z_lexical_subordinators_rLSM_agg =
          mean(z_lexical_subordinators_rLSM,
               na.rm = TRUE),
         z_addition_rLSM_agg =
          mean(z_addition_rLSM,
               na.rm = TRUE),
         z_sentence_linking_rLSM_agg =
```

```
      mean(z_sentence_linking_rLSM,
         na.rm = TRUE),
    z_determiners_rLSM_agg =
      mean(z_determiners_rLSM,
         na.rm = TRUE),
    z_all_demonstratives_rLSM_agg =
      mean(z_all_demonstratives_rLSM,
         na.rm = TRUE),
    z_all_additive_rLSM_agg =
      mean(z_all_additive_rLSM,
         na.rm = TRUE),
    z_all_positive_rLSM_agg =
      mean(z_all_positive_rLSM,
         na.rm = TRUE),
    z_all_logical_rLSM_agg =
      mean(z_all_logical_rLSM,
         na.rm = TRUE),
    z_all_connective_rLSM_agg =
      mean(z_all_connective_rLSM,
         na.rm = TRUE))
```

Step 2: Now that predictors and outcomes have the same number of rows and predictors are standardized, I will join the two dataframes

```
meanedForA1FW <- aggPredictorsFW %>%
  left_join(outcomesFW,
    by = NULL)%>%
  left_join(utterLenMeans,
    by = NULL)
```

Now we have the dataset that will be used for analyses to be conducted to conduct analysis 1.

The following are the steps that will be completed:

1) Create a correlation table between the predictors and covariates

2) Run multiple regression with the selected variables and outcomes.

Step 3: Create correlation matrix to check for and eliminate multicollinearity

```
A1CormatFW <-
  Hmisc :: rcorr(as.matrix(meanedForA1FW[, 3:18]))
```

Based on the values of correlation coefficients, I have decided to drop all_additive, and

all_connective

```
meanedForA1FW <- meanedForA1FW %>%
  select(-z_all_additive_rLSM_agg,
         -z_all_connective_rLSM_agg)
```

Perform Regressions with Cluster-Robust Standard Errors

```
aggFWm1 <- lm(
  ESBCS2 ~
    z_basic_connectives_rLSM_agg+
    z_all_logical_rLSM_agg +
    z_lexical_subordinators_rLSM_agg+
    z_addition_rLSM_agg+
    z_sentence_linking_rLSM_agg+
    z_determiners_rLSM_agg+
    z_all_demonstratives_rLSM_agg+
    z_all_positive_rLSM_agg+
    aggUtterAligner +
    aggUtterTarg,
  data = meanedForA1FW
  )

attach(meanedForA1FW)

kable(coef_test(aggFWm1, vcov ="CR1", cluster=Dyad),
      format = "markdown", digits = 2)

aggFWm2 <- lm(
  ESGII1 ~
    z_basic_connectives_rLSM_agg+
    z_lexical_subordinators_rLSM_agg+
    z_addition_rLSM_agg+
    z_sentence_linking_rLSM_agg+
    z_determiners_rLSM_agg+
    z_all_demonstratives_rLSM_agg+
```

```
    z_all_positive_rLSM_agg+
    aggUtterAligner +
    aggUtterTarg,
  data = meanedForA1FW
  )

attach(meanedForA1FW)

kable(coef_test(aggFWm2, vcov ="CR1", cluster=Dyad),
      format = "markdown", digits = 2)

aggFWm3 <- lm(
  ESAP36 ~
    z_basic_connectives_rLSM_agg+
    z_lexical_subordinators_rLSM_agg+
    z_addition_rLSM_agg+
    z_sentence_linking_rLSM_agg+
    z_determiners_rLSM_agg+
    z_all_demonstratives_rLSM_agg+
    z_all_positive_rLSM_agg+
    aggUtterAligner +
    aggUtterTarg,
  data = meanedForA1FW
  )

attach(meanedForA1FW)
kable(coef_test(aggFWm3, vcov ="CR1", cluster=Dyad),
      format = "markdown", digits = 2)

aggFWm4 <- lm(
  ESAP35 ~
    z_basic_connectives_rLSM_agg+
    z_all_logical_rLSM_agg +
    z_lexical_subordinators_rLSM_agg+
    z_addition_rLSM_agg+
    z_sentence_linking_rLSM_agg+
    z_determiners_rLSM_agg+
    z_all_demonstratives_rLSM_agg+
    z_all_positive_rLSM_agg+
    aggUtterAligner +
```

```
    aggUtterTarg,
  data = meanedForA1FW
  )

attach(meanedForA1FW)
kable(coef_test(aggFWm4, vcov ="CR1", cluster=Dyad),
      format = "markdown", digits = 2)
```

Analysis 2

My main objectives in this analysis are as follows:

1) Compute slopes for lexical and semantic alignment for each individual and save the slopes using the coef() function.
2) Then, use the slopes as the predictor in multiple regressions.

Step 1: Calculate slopes for each predictor per individual and save the slopes to a variable using coef function

```
coefficientsFW <- predictorsFW %>%
   group_by(ID) %>%
   summarise(
     across(
       starts_with("z_"),
              list(slope = ~lm(. ~ turn)$coef[2])
       )
     )
```

Step 2: merge the outcome variable dataframe with the predictor slope dataframe

```
FWslopeDF <- coefficientsFW %>%
  left_join(outcomesFW, by = NULL) %>%
  full_join(utterLenMeans)
```

Step 3: Run correlations to make sure there’s no multicollinearity

```
A2CormatFW <-
  Hmisc :: rcorr(as.matrix(FWslopeDF[, 2:18]))
```

Based on the correlation matrix, I have decided to remove z_all_connective_rLSM_slope from the set of predictors

```
FWslopeDF <- FWslopeDF %>%
  select(-z_all_connective_rLSM_slope)
```

Perform Regressions with Cluster-Robust Standard Errors

```
slopeFWm1 <- lm(
  ESBCS2 ~
    z_basic_connectives_rLSM_slope +
    z_lexical_subordinators_rLSM_slope +
    z_addition_rLSM_slope +
    z_sentence_linking_rLSM_slope +
    z_determiners_rLSM_slope +
    z_all_demonstratives_rLSM_slope +
    z_all_additive_rLSM_slope +
    z_all_positive_rLSM_slope +
    z_all_logical_rLSM_slope +
    aggUtterAligner +
    aggUtterTarg,
  data = FWslopeDF
  )

attach(FWslopeDF)
kable(coef_test(slopeFWm1, vcov ="CR1", cluster=Dyad),
      format = "markdown", digits = 2)

slopeFWm2 <- lm(
  ESGII1 ~
    z_basic_connectives_rLSM_slope +
    z_lexical_subordinators_rLSM_slope +
    z_addition_rLSM_slope +
    z_sentence_linking_rLSM_slope +
    z_determiners_rLSM_slope +
    z_all_demonstratives_rLSM_slope +
    z_all_additive_rLSM_slope +
    z_all_positive_rLSM_slope +
    z_all_logical_rLSM_slope +
```

```
    aggUtterAligner +
    aggUtterTarg,
  data = FWslopeDF
  )

attach(FWslopeDF)
kable(coef_test(slopeFWm2, vcov ="CR1", cluster=Dyad),
      format = "markdown", digits = 2)

slopeFWm3 <- lm(
  ESAP36 ~
    z_basic_connectives_rLSM_slope +
    z_lexical_subordinators_rLSM_slope +
    z_addition_rLSM_slope +
    z_sentence_linking_rLSM_slope +
    z_determiners_rLSM_slope +
    z_all_demonstratives_rLSM_slope +
    z_all_additive_rLSM_slope +
    z_all_positive_rLSM_slope +
    z_all_logical_rLSM_slope +
    aggUtterAligner +
    aggUtterTarg,
  data = FWslopeDF
  )

attach(FWslopeDF)
kable(coef_test(slopeFWm3, vcov ="CR1", cluster=Dyad),
      format = "markdown", digits = 2)

slopeFWm4 <- lm(
  ESAP35 ~
    z_basic_connectives_rLSM_slope +
    z_lexical_subordinators_rLSM_slope +
    z_addition_rLSM_slope +
    z_sentence_linking_rLSM_slope +
    z_determiners_rLSM_slope +
    z_all_demonstratives_rLSM_slope +
    z_all_additive_rLSM_slope +
    z_all_positive_rLSM_slope +
    z_all_logical_rLSM_slope +
```

```
    aggUtterAligner +
    aggUtterTarg,
  data = FWslopeDF
  )

attach(FWslopeDF)
kable(coef_test(slopeFWm4, vcov ="CR1", cluster=Dyad),
      format = "markdown", digits = 2)
```

Analysis 3

My goal in this section is to bin the predictors into thirds and see if alignment in any specific phases of the conversation makes a bigger difference than others.

Step 1: create 3 bins per predictor

```
binned_avgsFW <- predictorsFW %>%
  group_by(ID) %>%
  mutate(bin = case_when(turn_prop <= 0.33 ~ "1",
                         turn_prop > 0.66 ~ "3",
                        turn_prop > 0.33 ~ "2")) %>%
  pivot_wider(
    names_from =
            bin,
    values_from =
            c(z_basic_connectives_rLSM,
              z_lexical_subordinators_rLSM,
              z_addition_rLSM,
              z_sentence_linking_rLSM,
              z_determiners_rLSM,
              z_all_demonstratives_rLSM,
              z_all_additive_rLSM,
              z_all_positive_rLSM,
              z_all_logical_rLSM,
              z_all_connective_rLSM)) %>%
  group_by(ID, Dyad) %>%
  summarise(across(
          z_basic_connectives_rLSM_1: z_all_connective_rLSM_3,
          mean,
          na.rm = TRUE))
```

Step 2: combine the set of predictors with outcomes

```
binned_DFFW <- binned_avgsFW %>%
  left_join(outcomesFW, by = NULL) %>%
  left_join(binned_utterlens, by = NULL)
```

Step 3: create correlation tables using new DF

```
AG1bCormatFW <-
  Hmisc :: rcorr(as.matrix(binned_DFFW[, 3:32]))
```

I have decided to take out alignment scores for all three phases of all_connective_rLSM, and phases two and 3 of basic_connectives_rLSM based on the correlation matrix. I have decided not to remove the scores for phase 1 of basic_connectives_rLSM because it is does not have a correlation coefficient > .65 with any other variable

```
binned_DFFW <- binned_DFFW %>%
  select(-z_basic_connectives_rLSM_2,
         -z_basic_connectives_rLSM_3,
         -z_all_connective_rLSM_1,
         -z_all_connective_rLSM_2,
         -z_all_connective_rLSM_3)
```

Perform Regressions with Cluster-Robust Standard Errors

```
binsFWm1 <- lm(
  ESBCS2 ~ . -ID -Dyad -ESGII1 -ESAP35 -ESAP36,
  data = binned_DFFW
  )

attach(binned_DFFW)
kable(coef_test(binsFWm1, vcov ="CR1", cluster=Dyad),
      format = "markdown", digits = 2)

binsFWm2 <- lm(ESGII1 ~ .
  -ID -Dyad -ESBCS2 -ESAP35 -ESAP36,
  data = binned_DFFW)

attach(binned_DFFW)
kable(coef_test(binsFWm2, vcov ="CR1", cluster=Dyad),
      format = "markdown", digits = 2)
```

```
binsFWm3 <- lm(
  ESAP36 ~ .
  -ID -Dyad -ESGII1 -ESBCS2 -ESAP35,
  data = binned_DFFW
  )

attach(binned_DFFW)
kable(coef_test(binsFWm3, vcov ="CR1", cluster=Dyad),
      format = "markdown", digits = 2)

binsFWm4 <- lm(
  ESAP35 ~ .
  -ID -Dyad -ESGII1 -ESBCS2 -ESAP36,
  data = binned_DFFW
  )

attach(binned_DFFW)
kable(coef_test(binsFWm4, vcov ="CR1", cluster=Dyad),
      format = "markdown", digits = 2)
```

Analysis 3(b)

Now, I am interested in seeing the effects of the binned analyses using composite function word indices

Step 1: Check Cronbach's alpha values for the set of function words at each phase

```
summary(psych:: alpha(
  binned_DFFW[, 7:15],
  na.rm = TRUE
))

##
## Reliability analysis
##  raw_alpha std.alpha G6(smc) average_r S/N   ase  mean   sd median_r
##       0.82      0.81    0.85      0.33 4.4 0.031 -0.64 0.18     0.33

summary(psych:: alpha(
  binned_DFFW[, 16:23],
  na.rm = TRUE
))
```

```
##
## Reliability analysis
##  raw_alpha std.alpha G6(smc) average_r S/N   ase  mean   sd median_r
##       0.75      0.75    0.77      0.27   3 0.044 -0.61 0.15     0.26
```

```
summary(psych:: alpha(
  binned_DFFW[, 24:31],
  na.rm = TRUE
))
```

```
##
## Reliability analysis
##  raw_alpha std.alpha G6(smc) average_r S/N   ase  mean   sd median_r
##       0.78      0.78    0.81       0.3 3.5 0.038 -0.64 0.16     0.33
```

Cronbach's alpha values for function word indices are at or above .75 for all three phases.

As such, I will collapse the indices into composite measures.

```
binned_DFFW$combined_bins_1 <- rowMeans(
  binned_DFFW[, 7:15]
)

binned_DFFW$combined_bins_2 <- rowMeans(
  binned_DFFW[, 16:23]
)

binned_DFFW$combined_bins_3 <- rowMeans(
  binned_DFFW[, 24:31]
)

collapsedBinsDF <- binned_DFFW %>%
  select(ID, Dyad,
        ESGII1, ESBCS2, ESAP35, ESAP36,
        combined_bins_1, combined_bins_2, combined_bins_3,
        meanUtterAligner1, meanUtterAligner2, meanUtterAligner3,
        meanUtterTarg1, meanUtterTarg2, meanUtterTarg3)
```

Perform Regressions with Cluster-Robust Standard Errors

```
binsComb1 <- lm(
  ESBCS2 ~ . -ID -Dyad -ESGII1 -ESAP35 -ESAP36,
  data = collapsedBinsDF
)

attach(collapsedBinsDF)
```

```
kable(coef_test(binsComb1, vcov ="CR1", cluster=Dyad),
      format = "markdown", digits = 2)
binsComb2 <- lm(
  ESGII1 ~ . -ID -Dyad -ESBCS2 -ESAP35 -ESAP36,
   data = collapsedBinsDF
  )

attach(collapsedBinsDF)
kable(coef_test(binsComb2, vcov ="CR1", cluster=Dyad),
      format = "markdown", digits = 2)
binsComb3 <- lm(
  ESAP36 ~ . -ID -Dyad -ESGII1 -ESBCS2 -ESAP35,
   data = collapsedBinsDF
  )

attach(collapsedBinsDF)
kable(coef_test(binsComb3, vcov ="CR1", cluster=Dyad),
      format = "markdown", digits = 2)
binsComb4 <- lm(
  ESAP35 ~ . -ID -Dyad -ESGII1 -ESBCS2 -ESAP36,
   data = collapsedBinsDF
  )

attach(collapsedBinsDF)
kable(coef_test(binsComb4, vcov ="CR1", cluster=Dyad),
      format = "markdown", digits = 2)
```