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Exploring Co-adaptation in an Ecosystem of Dyadic Interaction

Ashley Beccia, Wai Man Adrienne Lew, ZhaoHong Han*

Teachers College, Columbia University, United States

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Abstract

In the field of applied linguistics, Diane Larsen-Freeman is widely recognized, among her numerous contributions, as the originator of Complex Dynamic Systems Theory (CDST). Over the years since her seminal publication (Larsen-Freeman, 1997), CDST has evolved into a meta-theory that guides the field's thinking on a variety of developmental phenomena, not least the study of second language acquisition. As its theoretical potency rises, so does the need to achieve a tangible understanding of CDST's core constructs. In this paper, we empirically examine one such construct, co-adaptation, in the context of asynchronous dyadic interaction. A data corpus of 39 emails sent between two college students in China and the United States over the course of seven weeks is analyzed using NVivo 12. Co-adaptation is observed at the pragmatic, discourse, and linguistic levels. True to the spirit of CDST, we describe, and discuss the nuances of, our findings. Considering the novelty of our approach to data analysis, we end by reflecting on the limitations specific to our study, as well as worthwhile directions for future pursuits.

Keywords: *Co-Adaptation, Dyadic Interaction, Language Change, L2 Development, Complex Dynamic Systems Theory, CDST*

Introduction

To say that Diane Larsen-Freeman is one of a kind in applied linguistics (AL) is surely an understatement. Her scholarly productivity and solid and comprehensive grasp of miscellaneous topics and issues in AL is the envy of those of us who view her as a role model. Her works constitute bedrock contributions to AL development, as, in part, attested to throughout this volume. Known for her erudition and big thinking, Larsen-Freeman is, above all else, a trailblazer who does not settle for the status quo. Her longstanding scholarly pursuits are a paragon of epistemological evolution in both AL and Second Language Acquisition research.

This paper represents a tribute to Larsen-Freeman's ground-breaking work (Larsen-Freeman, 1997, 2017) on Complex Dynamic Systems Theory (CDST), in which we take a close

* Corresponding author.

E-mail address: han@tc.columbia.edu

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look at co-adaptation, one of its core constructs. First, we briefly discuss CDST's view of language as an adaptive system and co-adaptation as its central mechanism. Next, we present our methodology for exploring co-adaptation within a longitudinal, asynchronous dyadic interaction dataset and describe and interpret the results. Following this, we provide a general discussion and close with recommendations of avenues for future research.

Language as an Adaptive System and Co-adaptation

CDST (Larsen-Freeman, 1997, 2017, 2020; see also Ellis & Larsen-Freeman, 2009; Larsen-Freeman & Cameron, 2008), at its core, champions systems thinking that views language as a complex, dynamic, and adaptive system. Language complexity arises from its composition of multiple, interrelated entities; its dynamic nature lies in that language changes over time; and its adaptability is seen in that language is susceptible to environmental influences. Simply put, language is both a means and a product of social-cognitive constructive processes (Han, Kang, & Sok, 2022).

Individuals initiate the socio-cognitive constructive process by engaging in verbal communication in which they attempt to comprehend others' meanings and/or express their own. A language user is therefore integral to the socio-cognitive constructive process by which the environment and the language user form an *ecosystem* (Van Geert, 1991). Ecosystems can take on a variety of forms and scales (see discussion in The Douglas Fir Group, 2016). For one, a dyadic interaction generates an ecosystem in which one interlocutor provides an environment for the other (Han & Liu, 2019).

Change in language use occurs within such an ecosystem, as a result of iteration and co-adaptation (Larsen-Freeman, 2019). Through repeated encounters, the language resources of each interlocutor are dynamically altered, leading, *inter alia*, to co-adaptation and the emergence of stable language-using patterns. In a dyadic interaction, co-adaptation manifests itself as two interlocutors mirroring each other's verbal behavior.

Co-adaptation is natural, ubiquitous, and even inevitable in social interaction. Sociopsychologists Ireland and Pennebaker (2010) have observed that verbal and non-verbal behaviors synchronize almost immediately after social interaction begins. Dyadic interactions involving L2 learners are no exception. In a study on dyadic interaction, Meng (2019) found that the two interlocutors, one an L2-English speaker and the other an L1-English speaker, frequently co-adapted, adopting elements of each other's expressions.

Larsen-Freeman (2020) defines co-adaptation as the reciprocal influence of speakers in a temporal-spatial ecosystem on each other's inclination to adjust their speech in an iterative communicative process (see also Larsen-Freeman, 2019; Larsen-Freeman & Cameron, 2008). As such, co-adaptation is a surface phenomenon but, as psychology research has shown, it is more than a behavioral phenomenon.

Co-adaptation has long been a topic in psychology research. Among the findings, verbal co-adaptation (i.e., synchrony in language use or linguistic coordination) may occur intentionally, due, for instance, to the interlocutors' desire to converge on each other's cognitive perspectives or to build shared knowledge (Clark & Brennan, 1991). It may also occur automatically, as a result of multiple matched cognitive representations, according to Pickering and Garrod (2004). Interestingly, co-adaptation can sometimes arise from cognitive dissonance when interlocutors spontaneously co-adapt their speech in response to

misunderstandings or speech errors (Brennan & Hanna, 2009). In each of these scenarios, linguistic coordination is linked to cognitive coordination (see also Hiver & Al-Hoorie, 2020).

In addition, co-adaptation can perform pragmatic functions. When co-adaptation occurs, it can signal engagement (Niederhoffer & Pennebaker, 2002), solidarity, alignment, and harmony (Han, 2019), moods and emotions (Hatfield, Cacioppo, & Rapson, 1993), and attitudes (Ramanathan & McGill, 2007). Simply put, verbal co-adaptation may encode multiple meanings – linguistic, cognitive, social and psychological. In the case of L2 learners, it may also be a sign of progress in L2 development, denoting that the learner’s language system is permeable and alterable (Adjemian, 1976).

Building on these insights, we explored co-adaptation in a longitudinal, asynchronous dyadic interaction between an L2-English speaker and an L1-English speaker. Our study was guided by six questions:

RQ1: Did co-adaptation occur?

RQ2: If so, did it occur immediately?

RQ3: Under what circumstances did it occur?

RQ4: Who led the synchrony?

RQ5: What was the nature of it?

RQ6: What was the extent of it?

The goal of this study was to develop a substantive understanding of co-adaptation, not only as a surface phenomenon but also as a complex, dynamic, and adaptative process influenced by the spatio-temporal context and the dynamics of ongoing discourse.

Method

Our study employed “process tracing,” a within-case technique that uses iterative passes through the data to capture domain-specific and progressively more abstract patterns of cognitive behaviors (Smith & Hoffman, 2017). Process tracing allows for the consideration of multiple dimensions of causal mechanisms (Hiver & Al-Hoorie, 2020). While the present study only scratched the surface of this analytic technique, our ultimate goal—through conducting multiple case studies on different dyadic ecosystems—is to come up with domain-independent descriptions for making inferences about how and why co-adaptation (i.e., the intervening causal chain(s)) leads to L2 development (or lack thereof).

In the present study, for multidimensional, domain-independent descriptions of co-adaptation to emerge through process tracing, we created an analytic template that categorizes linguistic evidence in terms of (a) the overall organization, (b) content of communication, (c) language, and (d) style, to guide our textual analysis. The predictor variables corresponding to the four categories were (a) similarity between the interlocutors’ discourse length and structure, (b) synchrony in textual content, (c) choice of language, and (d) the use of style words, respectively (see Table 1).

Participants

Two university students, pseudo-named Debra and Alicia, participated in an email exchange project for an intercultural communication class taught respectively at a university in China and a community college in the U.S. Debra, a 21-year-old English major from China and a native speaker of Chinese, was randomly partnered with Alicia, a 22-year-old business

marketing major from the U.S. and a native English speaker and heritage Spanish speaker. They did not know each other before the project.

Data Corpus

The data comprised 39 emails exchanged between Debra and Alicia over seven weeks, from March 14 to May 4, 2011. The sender of each email alternated, with Debra initiating the conversation and also sending the final email. For example, Alicia responded to Debra’s first email, Debra replied to Alicia’s response, and so on. For ease of referencing the data, each pair of emails was assigned a number. In every pair, Debra’s email was labeled as “a,” while Alicia’s response was labeled as “b.”

Coding and Analysis

As mentioned, process tracing was the approach we used to trace evidence in four dimensions. Table 1 summarizes the coding categories. In particular, using *NVivo 12* software, the data were systematically coded for instances of linguistic synchrony following the four levels of the analytic template (see Table 1). After coding, *NVivo*’s crosstab query functionality was employed at each level to analyze the type of coded themes and the frequency distribution of codes across the email correspondences (e.g., 1a, 1b, 2a, 2b). By doing so, it was possible to identify patterns and trends within the data. When data coded similarly appeared in adjacent cells of the crosstab query, it was taken as evidence of co-adaptation between the participants. In other words, this suggests that the participants were adjusting their communication with respect to the overall organization, content, language, or style.

Table 1

Analytic Template

Overall organization	The structure and organization of the emails exchanged, such as openings, paragraphing and sign-offs used by participants
Content	The topics, themes, or subjects discussed in the emails
Language	The linguistic choices made by the participants, or in other words, their form-meaning-use mappings
Style	The manner in which the participants communicated, such as the formality and use of non-verbal expressions (e.g., emoticons)

In addition to detecting patterns in the codes, the data were analyzed by computing the word count of each email. This quantitative measure provided additional insights into potential co-adaptation between the participants in terms of overall organization. By comparing word counts across the email exchanges, patterns that might indicate the participants were adjusting their communication to match each other’s preferences in message length and detail were identified.

Results and Context-bound Interpretation

Iterative analyses of the data revealed evidence of co-adaptation at all four analytic levels, though to varying degrees. Ample evidence was found at the levels of content, style, and overall organization, whereas at the level of language, evidence of both co-adaptation and the lack thereof were observed. At the levels of content and style, the majority of evidence was located towards the middle and end of the email exchange project. In contrast, evidence at the level of language was

primarily found toward the beginning of the exchange, while evidence at the level of overall organization was identified throughout. Based on the observed pattern at the level of content, one likely circumstance under which co-adaptation occurred was growing interpersonal familiarity. Overall, the initiation of co-adaptation varied at the four analytic levels. For example, at the level of content, the Chinese participant tended to lead the linguistic synchrony for more serious topics (e.g., political party membership, media censorship). Yet, for more personal topics (e.g., boyfriends, birthdays), the American participant tended to do so. Given these observations, co-adaptation may be characterized as differential, selective and evolving. Below we provide a contextual breakdown of the results by the six research questions.

Did co-adaptation occur between Debra and Alice over seven weeks of asynchronous email exchange?

There was copious evidence of co-adaptation across our analytic dimensions. By way of illustration, the eleventh email that Debra and Alicia each sent was displayed in Figure 1.

Figure 1

Evidence of Co-adaptation in Emails 11a and 11b

Email 11a

Subject: hi!

From: Debra Dong

Date: March 31, 2011, 22:57

To: Alicia Perez

Helloooooo, [GREETING]

Actually, I know what an English name looks like. Haha. We learned it when we first studied English. In the beginning, I got you wrong because I thought Cantu was your first name for I've never come across this name before. But I know it well now. "Debra" is my English name, given by my first foreign English teacher who came from Utah, a very kind lady. I use my English name only when having classes taught by foreign teachers. My Chinese name is "冬峰" (Dong Feng). "冬" (Dong) is my family name while "峰" (Feng) is my given name. You can see our sequence of family and given names is just reversed. [THEME 1]

The Chinese language belongs to the Sino-Tibetan language family. It is totally different in spelling from yours, but a little similar in grammar. Last semester, when I had an English-Chinese translation class, my teacher told us prepositions and nouns make up a very large part of English grammar. Is it exactly so? But it's true that in Chinese adverbs and verbs account for a larger part. [THEME 2]

I have a younger sister. She was born in 1995, 5 years younger than me. We have a very good relationship with each other. I've looked after her almost since she was born because my mother was too busy then. But now she's grown up and can live independently, so I've got "retired". Haha. They all say she's more beautiful and smarter than me, and I think so. It's my honor to have a cute sister. Haha. She'll take her Entrance Exam for Senior High School in about two months. It's a fierce competition and if one can't reach a given grade he has to take the exam again next year. So I really worry about her performance though she's been performing well in study. Is your system of entering a high school similar to ours? Is it also very strict?

Oh, is your brother also a college student? Or he's worked for a long time [THEME 3]

Hope to hear from you soon! 😊

Debra [SIGN-OFF]

Email 11b

Subject: Re: hi!

From: Alicia Perez

Date: April 1, 2011, 07:11

To: Debra Dong

Hi, [GREETING]

Oh ok, wow you have learned so much about English! I am jealous that you know so much about another language. I only know English. So your name is Feng, cool. That is what your friends call you then? [THEME 1]

Yes, nouns and prepositions make up a large part of our grammar. I have never thought about which parts make up the larger portion though, I just always assumed nouns, prepositions, adjectives, verbs, adverbs, and everything else all had significant importance haha I am sure your teacher is correct! [THEME 2]

That is nice that you would take care of your sister! And yes, you have "retired" haha I am sure you are pretty too, you all probably have similar features and you are clearly smart, you know English! Wow, we do not have an entrance exam for high school, you just need to pass 8th grade, which is in middle school. Then you move to 9th grade which is in high school. So if you do not pass this exam you have to wait a whole year to start high school? Do you use numbers when talking about what year you are in school, like we do? For instance, how I am talking about 8th and 9th grade. Your schooling is very different from ours! I am sure you learn more than we do haha

My brother is a college student also. He was born on August 31, 1990. So you are 3 months older than him right? Wait, you are already 21 correct? So you are a year and 3 months older I think. He does not go to the same university as me though. He goes to university in a city that is a 5 hour drive from our home. [THEME 3]

I am also curious as to if you are able to read our conversations and respond quickly or if it takes some time. The way we are conversing is as if I am emailing my friends here! [THEME 4]

Hope you are having a great week!

Alicia [SIGN-OFF]

The two emails displayed in Figure 1 differ in length by 4 words. A close examination of the emails reveals a similar pattern in the overall organization of the emails and their content. Both emails began with a one-word greeting, multiple body paragraphs, and a sign-off. Nearly all of the body paragraphs of both emails corresponded to one of the following topics: (1) names and languages, (2) English versus Chinese grammar, and (3) siblings and education systems. For the first two topics, both participants used one paragraph, yet when writing about the third topic, Alicia used two paragraphs, whereas Debra used one paragraph. Before signing off, Alicia wrote a two-sentence paragraph that compared emailing Debra to emailing her friends. Therefore, though the paragraphing of the two emails was not exactly parallel, Debra and Alicia both organized their emails with paragraphs to mutually attend to topics in a sequential fashion.

Furthermore, the two emails exhibit linguistic synchrony both at the levels of language and style. Debra and Alicia included many of the same content words in their emails, such as *grammar*, *name*, *English*, *younger* and *high school*. The participants mined these words and others from each other's email, meaning that one participant extracted a word from the interlocutor's email(s) for meaning expression (Han, 2020). For example, after Debra's use of the word *grammar* in her email, Alicia used the word *grammar* in her reply email. The word *grammar* was used again in Debra's next email. This demonstrates how linguistic elements were mined and recycled during the dyad's interaction over time. Similarly, at the level of style, both participants demonstrated synchronization in the informal tone they used to communicate, as evidenced by their use of "haha" and exclamation marks, which conveyed a lighthearted, informal tone.

Did Co-adaptation Occur Immediately After the Interaction Began?

Evidence of co-adaptation showed up in the beginning, middle and end of the seven-week, longitudinal dataset. The use of emoticons offered a window into the temporal span of co-adaptation. The three tables in Figure 2 display snippets of the results from crosstab queries performed between each emoticon and email number.

Figure 2*Co-adaptation of Emoticons across the Dataset*

O(∩_∩)O			:)			☺		
	a	b		a	b		a	b
01	1	0	01	0	1	04	4	0
02	1	1	02	0	0	05	0	0
03	1	0	03	0	1	06	0	0
04	0	0	04	1	3	07	1	0
05	0	0	05	2	1	08	0	0
			06	0	1	09	1	1
			07	0	1	10	1	0
			08	1	0	11	1	0
			09	1	0	12	1	1
			10	0	0	13	2	2
			11	0	0	14	2	0
						15	1	0
						16	2	3
						17	1	2
						18	3	0
						19	0	0

Note. "a" is for Debra and "b" is for Alicia.

As shown in the left table of Figure 2, Debra initially used the emoticon O(∩_∩)O in her first two emails, which prompted Alicia to use it as well in her response to Debra, followed by Debra using it again in her next email. The middle table shows that Alicia used :) in her first email. Then, in her second email, Alicia asked Debra, "...I was wondering what the symbols you keep putting are, the "O(∩_∩)O", there is no button for the other symbol on my keyboard." After Alicia's inquiry, Debra, presumably taking it as feedback on her emoticon use, stopped using the emoticon, marking the exclusion of the linguistic resource from the ecosystem. This was followed by evidence of restructuring and adaptation on Debra's part. Starting with her fourth email, the emoticons :) and ☺ co-appeared, with the former mimicking Alicia's usage – twice in her previous emails. It appears that, after two exposures to the new emoticon, coupled with Alicia's question as feedback, Debra finally caught on. From emails 5 to 8, both Debra and Alicia tended to use :) more than ☺. Apparently, both were now in the shared repertoire of emoticons, as demonstrated in Debra's ninth email where she used both :) and ☺. A transition to ☺ then followed for both Debra and Alicia. From Alicia's fourteenth email onwards, Debra and Alicia almost exclusively used ☺, with only one more instance of :) from each of them. Therefore, timing-wise, the co-adaptation towards the use of ☺ began in the middle of the dataset and continued throughout the remaining email exchanges.

In sum, O(∩_∩)O, the emoticon that Debra brought to the ecosystem, "died out" early on, specifically after Alicia's question about it. Instead, emerging in the process were competing forms :) and ☺. Over time, ☺ became the dominant emoticon used in the ecosystem. This

trajectory demonstrates how co-adaptation began early on in the dataset and continued throughout the emails. By the end of the dataset, the participants had settled on the use of 😊, which was not the initial emoticon choice for Debra or Alicia.

Under What Circumstances Did Co-adaptation Occur?

Our results suggest that co-adaptation can occur under various circumstances. It was found to be more prevalent when participants were familiar with each other and during conflict resolution, but less prevalent when participants were constrained for time.

Interpersonal familiarity

Debra and Alicia co-adapted more when they knew each other better. As the exchange of emails progressed, Debra and Alicia became more comfortable with each other and opened up more to each other. As an example, at the beginning, their exchange was limited to general information about their names, age, linguistic and educational backgrounds, as well as personal interests, topics that Debra initiated in her first email and that Alicia picked up on in her reply email. As the email exchange continued, the participants grew more friendly with each other, as evidenced in the eleventh email sent by Alicia, who wrote, “The way we are conversing is as if I am emailing my friends here!” As the email exchange further advanced, the tone became even more informal and relaxed, as seen in the participants’ liberal use of “haha.”

Figure 3

Co-Adaptation of “haha” with Increasing Interpersonal Familiarity

haha		
	a	b
01	0	0
02	0	1
03	1	1
04	0	2
05	0	2
06	2	1
07	2	2
08	2	0
09	1	3
10	1	1
11	2	2
12	2	1
13	2	4
14	1	2
15	1	3
16	2	3
17	1	4
18	2	3
19	1	2
20	2	-

Note. "a" is for Debra and "b" is for Alicia.

Figure 3 presents results from the cross-tab query conducted between “haha” and email number, showing three chains of co-adaptation in the participants’ use of “haha.” The first chain, observed from Alicia’s second email to her third email, consists of three consecutive emails containing exactly one instance of “haha.” The second chain, beginning at Alicia’s fifth email and ending with Debra’s eighth email, is composed of six consecutive emails each containing at least one instance of “haha.” In fact, five of these six emails contained exactly two instances of “haha.” The last chain, starting from Alicia’s ninth email and continuing through the last email from Debra (i.e., Debra’s twentieth email), spans 23 emails. The number of times Debra and Alicia used “haha” in this email chain was more variable, with Alicia typically using “haha” more frequently in her emails, and Debra never using “haha” more than twice in one email. Clearly, throughout Alicia was leading the way.

While an increase in interpersonal familiarity corresponded to an increase in the length of chains of linguistic synchrony, a different trend emerged when examining the frequency with which the participants used “haha” during the third chain of linguistic synchrony. Unlike the first two chains in which the participants almost always used “haha” the same number of times, they used “haha” with more variable frequencies in the emails comprising the third chain. It thus appears that once the participants gained a certain level of interpersonal familiarity – which happened about midway through the email exchange project, a greater intensity of co-adaptation was observed: the third chain of linguistic synchrony was the longest. At the same time, once the participants reached this threshold of familiarity, they began using “haha” with more divergent frequencies, exhibiting their individuality in self-expression.

Conflict resolution

Conflict resolution was identified as another circumstance under which co-adaptation occurred in the email exchange (see also Brennan & Hanna, 2009). As shown in Figure 4, in Debra’s first email (1a), she expressed her confusion and disappointment over not receiving an email from Alicia, as it was expected that Alicia would initiate the communication. In response, Alicia (1b) promptly addressed the issue, citing the technical difficulties she had experienced with her initial email. She reassured Debra that she had made an effort to communicate earlier and expressed that she was hopeful that there would be no further issues.

Figure 4

Email Initiation Misunderstanding

Excerpt from email 1a (Debra):

Dear Perez Alicia,
I'm Debra from Ocean University of China (OUC). As you know, your teacher and ours arranged us to communicate with each other two weeks ago. Actually, I have been waiting for your email as our teacher told me that you would write to me first. Two weeks have passed, but I still haven't received your email. So I asked my teacher what was wrong. She said you were having spring vacation and she asked me to write to you first, so I'm writing you now. O(∩_∩)O

Excerpt from email 1b (Alicia):

Hello! I am so glad you emailed me. I had sent an email about a week ago and it had problems delivering, but hopefully I won't have anymore problems. My name is Alicia Perez. It is 5:20pm over here.

During the resolution of this initial conflict, linguistic synchrony is evident both in terms of the overall organization and content. Both participants provided a brief introduction before addressing the issue at hand, exhibiting co-adaptation in the way they organized their emails. Further, both excerpts focused on the same topic, namely, the delay in initiating communication, illustrating synchrony in the content of their emails during conflict resolution.

Time constraint

At different points during the email exchange, Debra and Alicia were preoccupied with various academic and personal obligations. For instance, towards the beginning of the exchange, Alicia was busy with family events, such as her mother's birthday celebration. When faced with time constraints, Debra and Alicia showed a diminished degree of co-adaptation, as illustrated in Figure 5.

As seen in Figure 5, although all emails touched upon the subject of Debra's upcoming BEC test, the depth of detail and elaboration varied substantially between Debra and Alicia. Debra not only introduced the test but also expressed her concerns regarding her preparation and sought advice from Alicia. On the other hand, Alicia's contribution to the topic was restricted to a single question, which indicates a lack of synchronization in content. It thus appears that time constraints impacted the content focus of the participants' emails. When pressed for time, Debra and Alicia were less able to co-adapt. Instead, they selectively engaged with certain topics, eschewing other topics. It may be that due to time constraints, they were limited in their ability to synchronize their communication in terms of depth, detail, and elaboration.

Figure 5

(Lack of) Co-Adaptation under Constrained Time

Email 3a (Debra):

Hello Alicia,

Yes, BEC is short for the Cambridge Business English Certificate, which is provided by Cambridge ESOL. It's divided into five grades: A, B, C, D, and E. I have to get at least C if I want to pass. It's helpful for students who learn English as a second language to go job hunting after graduation. So I'm working hard on it now.

"O(∩_∩)O" stands for "haha", just a symbol of smile! I don't know what inputs you are using now in America. But most Chinese use "souyou" or "weiruan" input (it doesn't matter if you don't know what they are). I use "souyou" input to type "O(∩_∩)O". Are you clear now?

Why do you have "spring break week"? I mean your university give you this break to have a trip or for other purposes? Whatever the reason is, it's really cool to have a break I think.

Our teacher told us that both your summer and winter vacations are very long? Yes? How long are they? And how do you usually spend your vacations? In China, we also have summer and winter vacations. But some universities offer longer vacations than others. Our university allows us to have a 37-day-long summer vacation this year, shorter than last year's. We don't have enough time to do social practices or part-time jobs, which is really annoying. But we can have more time to study. Maybe it's better for us.

Hope to hear from you soon.

Debra

Email 3b (Alicia):

Hello!

Sorry it took so long for me to get back to you. I was at the beach longer than expected and it was also my mother's birthday this weekend so I have been busy with family. Yes, we do get a whole week every spring semester, it is always in mid-March. I guess it is just a break for students half way through the semester. We are lucky to have it! Our winter vacations are about 4 weeks long and our summer vacations are about 3 months long! I am sorry to hear that your breaks are so short compared to ours. I feel a little guilty now, knowing that our breaks are so much longer haha. Most students here are involved in part-time jobs or some school activity. I used to have a part-time job, but I have found that my grades are better now that I don't have one, so it is definitely better to have more time to study. My past couple summer vacations I have spent them taking summer classes so I have not had too many trips. I try to make short trips and go see friends and family in other cities that range from 1-6 hours in driving distance. I also make day trips to the beach that I mentioned, since it is so close to where I live. What do you do during your vacation time? And when is that test for BEC? Oh and our symbol of smile is ":)"

Hope to hear from you soon!

Alicia

Email 4a (Debra):

Hello Alicia,

It doesn't matter! You've told me that you would go to the beach, so I've expected to hear from you later than usual. Happy birthday to your mother! I guess you and your family must have had a good time at the weekend, am I right? :)

You told me in your first letter that you would turn 23 in a month, so it's drawing near! My birthday is June 6 in lunar calendar or July 31 in solar calendar. Most young people in China now celebrate their solar calendar birthday, but I habitually celebrate my lunar calendar birthday every year. When is your birthday? I want to congratulate you with all my best wishes when your thirtieth birthday comes. ☺

I've spent my past couple summer vacations working as a tutor teaching English. Nowadays, more and more Chinese are learning English, especially middle school or high school students, so teachers of English are badly in need. I've almost earned enough to pay for my living costs. I'm not so lucky as you to travel around. I don't have enough money now. Maybe after I've earned enough money, I'll travel wherever I want to go. ☺ ☺

I'll have my test for BEC on May 21, only two months left now. But in recent days I haven't wanted to prepare for it at all. I don't what's wrong with me. I really hope I can get recovered soon or I'll be bound to fail. Can you give me some suggestions? How can I adjust the mood? Thank you ! ☺

Do you have anything interesting to share with me or anything to ask about China or me? I'd like to answer any of your questions!

Hope to hear from you soon! ☺

Debra

Who Led the Synchrony?

Throughout their email exchange, Debra and Alicia took turns leading the synchrony. On some levels, such as language, one participant consistently led the synchrony more than the other, while on other levels, such as content and style, both participants exhibited instances of leading the synchrony.

Casual versus serious content

Throughout the email exchange, Debra and Alicia discussed a variety of topics, ranging from more casual topics (e.g., social media) to more serious ones (e.g., jobs after graduation), as shown in Table 2.

Table 2

Leading Synchrony at the Content Level

Topics		Leading the synchrony
Casual	Information about self – birthday	Alicia
	Social media – Facebook, YouTube, Youku	Debra
	Relationships – boyfriend	Alicia
Serious	University life – professional exams, finals	Debra
	Jobs after graduation	Debra
	Politics – party membership	Debra

Debra typically took the lead in content-level synchrony by introducing more serious topics, whereas Alicia often initiated discussions on lighter, more casual topics. As displayed in Figure 6, in her second email Debra initiated the serious topic of university life, writing about her classes, homework and an upcoming exam. After some initial discussion about this topic toward the beginning of the email exchange project, Debra and Alicia addressed university life in the majority of the emails sent in the second half of the project. In contrast, in her third email, Alicia initiated the casual topic of birthdays, which was maintained by the participants for the following four emails. The topic of birthdays resurfaced later on in the exchange when Debra and Alicia reconciled the differences between solar and lunar calendars (emails 11b-12b).

Figure 6

Leading Synchrony of Casual versus Serious Content

Email 2a (Debra):

Hello Alicia,

Thank you for your reply. I'm very sorry I have your name wrong !

I'm a junior, and I still have many classes this semester. I really feel tired sometimes with so much homework to do, but I have to finish them. I don't know if you feel the same as me. I learn only English now. Actually, I like business very much. I wanted to study some other courses on business at the beginning, but later I found time wasn't enough for me to learn more than one major at the same time, so I gave up. When you told me your major was Business Marketing I really felt excited because maybe we can talk about business later on. O(∩_∩)O

Now I'm preparing for BEC Higher, which will be hold in May 21. I guess you might also know this exam, yes? It's really hard for me because I haven't learnt business before, but I'll try my best.

As to my interest, I like listening to music, especially English and Korean pop songs. And also I like playing badminton very much. I'm 170cm tall, so maybe I have some advantage in playing badminton.

If you want to know more about me, please feel free to ask! can you tell me more about you?

Yours sincerely

Debra

ps: are you a native American or not? O(∩_∩)O

Email 2b (Alicia):

Hello!

Sorry it took so long for me to get back to you. I was at the beach longer than expected and it was also my mother's birthday this weekend so I have been busy with family. Yes, we do get a whole week every spring semester, it is always in mid-March. I guess it is just a break for students half way through the semester. We are lucky to have it! Our winter vacations are about 4 weeks long and our summer vacations are about 3 months long! I am sorry to hear that your breaks are so short compared to ours. I feel a little guilty now, knowing that our breaks are so much longer haha. Most students here are involved in part-time jobs or some school activity. I used to have a part-time job, but I have found that my grades are better now that I don't have one, so it is definitely better to have more time to study. My past couple summer vacations I have spent them taking summer classes so I have not had too many trips. I try to make short trips and go see friends and family in other cities that range from 1-6 hours in driving distance. I also make day trips to the beach that I mentioned, since it is so close to where I live. What do you do during your vacation time? And when is that test for BEC? Oh and our symbol of smile is ":)" Hope to hear from you soon!

Alicia

Email 3a (Debra):

Hello Alicia,

Yes, BEC is short for the Cambridge Business English Certificate, which is provided by Cambridge ESOL. It's divided into five grades: A, B,C,D, and E. I have to get at least C if I want to pass. It's helpful for students who learn English as a second language to go job hunting after graduation. So I'm working hard on it now.

"O(∩_∩)O" stands for "haha", just a symbol of smile! I don't know what inputs you are using now in America. But most Chinese use "sougou" or "weiruan" input (it doesn't matter if you don't know what they are). I use "sougou" input to type "O(∩_∩)O". Are you clear now?

Why do you have "spring break week"? I mean your university give you this break to have a trip or for other purposes? Whatever the reason is, it's really cool to have a break I think.

Our teacher told us that both your summer and winter vacations are very long? Yes? How long are they? And how do you usually spend your vacations? In China, we also have summer and winter vacations. But some universities offer longer vacations than others. Our university allows us to have a 37-day-long summer vacation this year, shorter than last year's. We don't have enough time to do social practices or part-time jobs, which is really annoying. But we can have more time to study. Maybe it's better for us.

Hope to hear from you soon.

Debra

Forms for salutation

Debra and Alicia regularly employed salutations to greet each other at the beginning of their emails. The linguistic forms used for this function varied over time, with some forms appearing only once in the entire dataset and others appearing more extensively. For instance, in the first email, Debra greeted Alicia with the salutation “Dear,” which neither participant used again in the remainder of the email exchanges. In contrast, in her first email, Alicia greeted Debra with “Hello,” a salutation that both participants subsequently adopted a total of 10 times, thereby showing extended synchrony.

The forms for salutation that were picked up and retained in the dyadic ecosystem tended to be introduced by Alicia. As shown in Table 3, Alicia initiated the synchrony in four out of five salutations, while Debra did so only once.

Table 3*Leading Synchrony in Email Salutations*

Salutation	First appearance	Is there synchrony?	Who leads the synchrony?
Dear	1a	No	–
Hello	1b	Yes	Alicia
ø	2b	No	–
Hey	4b	Yes	Alicia
Hi	5b	Yes	Alicia
Hi [Name]	6a	Yes	Debra
Hellooooo	6b	Yes	Alicia
Hi, good afternoon	17b	No	–

Emoticons and laugh tokens

As previously shown in Figure 2, the participants used three unique smiley face emoticons in their email exchanges. Though Debra introduced the first emoticon, O(∩_∩)O, its usage did not last beyond the initial few emails of clarification regarding the meaning of this emoticon. Alicia subsequently introduced the second emoticon, :), which was then used multiple times by both participants. Finally, the third emoticon, ☺, was introduced by Debra and became the most extensively used emoticon by both individuals through the end of the email exchange project. Thus, as far as the use of emoticons is concerned, while both participants took turns leading the synchrony at various points in the email exchanges, Alicia was taken as the one leading the synchrony by introducing the second emoticon, :).

However, when examining the participants’ use of laugh tokens, a different trend emerges. In her second email, Alicia introduced “haha,” which was subsequently employed by both participants in all but three of their emails. In this instance, it was Alicia who assumed the lead in the synchrony of the laugh token “haha.”

Summing up, at the content level, the participants who led the synchrony depended on the seriousness of the topic at hand, with Debra favoring serious topics and Alicia preferring lighter ones. At the level of language, the linguistic synchrony of forms used for salutations was led by Alicia. Lastly, at the level of style, both participants led the synchrony of emoticons at least once, but Alicia also led the synchrony of the laugh token “haha.”

What was the nature of the observed linguistic synchrony?

Our analysis reveals that linguistic synchrony is selective, evolving, and differential across various aspects of communication.

Selective

There was evidence of both synchrony and divergence between the participants at the level of language. As an example, while they sometimes used the same forms to refer to the People’s Republic of China and the United States of America, there was a clear asymmetry in their linguistic choices when referencing these countries. Table 4 gives an overview of the tokens produced respectively by Debra and Alicia.

Table 4
Forms for Referring to China and the United States

	China	U.S.	America	over there	your country
Debra	20	0	9	4	4
Alicia	3	7	2	5	0

As shown in Table 4, both participants used the term “over there” to refer to each other’s countries, showing linguistic synchrony. While Debra also used the expression “your country” to refer to the United States, Alicia never employed this expression to refer to China. When explicitly referencing the names of the countries, both participants used “China,” though Debra used the word on 17 more occasions than Alicia. When referring to the United States, Debra predominantly used “America,” while Alicia opted for “U.S.” (or “US”). One of the two instances in which Alicia co-adapted to Debra’s use of “America” is shown in Figure 7. In Debra’s thirteenth email, she used the non-target-like form “American” instead of “America” on two occasions. In her reply to this email, Alicia used the target-like form “America,” which may have served as an exemplar for Debra to adapt to. Indeed, in Debra’s next email, she employed the form “America” on two different occasions. This instance shows how Alicia selectively co-adapted Debra’s linguistic choices, as well as how co-adaptation led to progress in Debra’s English language development if we go by the emergence criterion of Processability Theory (Pienemann, 1998).

Figure 7

Selective Co-adaptation of the Form “America”

Excerpt from email 13a (Debra):

Aren't you busy with your internship? Do you enjoy your work there? We students here don't have such a chance to make contribution to our community. All they do before they graduate is to writing their graduation thesis or go job hunting.

Oh, I heard that you have to take GRE and then apply for your ideal university after high school education, yes? Many of my classmates who want to go to American for further study have already taken GRE. They say this is the same exam as the one you take in American. Of course, it's much harder for them.

Hope you're having a good day!

Debra

Excerpt from email 13b (Alicia):

Yes! Students that want to continue their education by going to graduate school and obtaining a masters degree take the GRE. Not all programs require THAT test though. To go to graduate school for business you need to take an exam called the GMAT. For law school the exam is the LSAT. For medical school there is the MCAT. I think those are the only exams. But you are correct the GRE is the most common exam when applying to masters programs. Are you considering coming to America?

---Alicia ☺

Excerpt from email 14a (Debra):

Hey, ☺

I really appreciate you having letting me know all kinds of exams in America. I've only heard the GRE and GMAT before. Some of my classmates are also preparing for the GMAT and they, like you, told me that to go to graduate school for business one need to take the GMAT. They thought it is easier than the GRE. But I don't know. One of my friends took the first part of the GRE—composition on March 15, about 20 days ago. And she told me she would take the latter part in June. Is it so in America? A senior year student got 1700 points last year. Is it a high score compared to that of the students over there?

Evolving

Over the course of the email exchange, the linguistic synchrony between Debra and Alicia evolved. As illustrated in Figure 3, the chains of synchrony of the laugh token “haha” increased in length over time, with the longest chain spanning the final 23 emails. However, the frequency of each participant's use of “haha” became increasingly divergent over time, as Alicia tended to employ the laugh token more frequently in her emails, particularly towards the end of the email exchange project. Therefore, synchrony in the participants' laughter tokens underwent continuous, concurrent changes throughout the interaction.

The evolving nature of co-adaptation is also attested to in the data displayed in Figure 2. The synchrony of emoticons shifted gradually over time. At first, the synchrony involved Debra discontinuing her use of O(∩_∩)O and mining :) from Alicia's emails. Once Debra adopted Alicia's use of :), the shared use of this emoticon lasted a while, before transitioning to another shared (i.e., the third) emoticon, ☺. Thereafter, though the preponderance of emoticons were ☺, there were two more instances of :). This indicates that a stable pattern is not permanently stable; instead, it phases into another stable pattern.

Differential

In examining the synchrony between Debra and Alicia, it became evident that the nature of their synchrony was different. Varying degrees and types of co-adaptation were observed across different dimensions of their communication.

In the aspect of overall organization, Debra and Alicia's synchrony differed from what was observed in language or content. For instance, synchrony in the overall organization was sometimes evident in the structuring of their emails, that is, providing a brief introduction before addressing the main issue. In contrast, synchrony in content often manifested itself in the alignment of topics discussed, with Debra leading more serious topics and Alicia leading more casual ones.

In the aspect of language, typically Alicia led the synchrony, as in the use of forms of salutations, and Debra followed the lead. But at the level of style, both participants took turns leading the synchrony, as in the use of emoticons at various points in the email exchange.

The distinct patterns of synchrony highlight the complex multifacetedness of co-adaptation, a dynamic interplay between interlocutors, and the need to consider the ecosystem as a basic unit of analysis when researching co-adaptation in its multiple, likely interrelated, manifestations.

What Was the Extent of Co-adaptation?

The extent of co-adaptation between Debra and Alicia in their email exchange was explored by examining the breadth and depth of synchrony across various levels of communication and considering within-level nuances.

Here breadth refers to the range of levels and aspects of communication in which synchrony is observed, whereas depth refers to the degree or intensity of synchrony within a specific level. For example, at the content level, the breadth of synchrony was evident in the range of topics addressed by both participants, including casual conversations about birthdays and more serious discussions about post-graduation plans. The depth of synchrony, on the other hand, was observed in their alignment—or the lack thereof—when elaborating on specific topics, such as university life. Debra initiated this serious topic and tended to elaborate more on it.

Within-level nuances are observed in multiple aspects of the dyadic interaction. For instance, at the level of style, Debra's and Alicia's use of the laugh token "haha" exhibited distinct patterns of co-adaptation throughout their email exchange. As shown in Figure 3, the crosstab query results reveal three separate chains of co-adaptation in the usage of "haha." The first chain, spanning from Alicia's second to her third email, consists of three consecutive emails, each containing exactly one instance of "haha." The second chain, which begins with Alicia's fifth email and concludes with her eighth email, comprises six consecutive emails, all featuring at least one "haha." The final chain, commencing with Alicia's ninth email and persisting until the end of the dataset (i.e., Alicia's twentieth email), encompasses 23 emails. The frequency of "haha" usage in this chain varies, with Alicia typically employing the laugh token more often in her emails, while Debra never used "haha" more than twice in a single email.

Overall, the depth and breadth of synchrony between Debra and Alicia varied across different aspects of communication. In addition, the process of co-adaptation was not uniform, but consisted rather of intricate adjustments in response to the ongoing, dynamic discourse.

Discussion

This study aimed to make headway in understanding co-adaptation, a mechanism for language change posited by CDST (Larsen-Freeman, 2022; Larsen-Freeman & Cameron, 2008). A process-tracing methodology, utilizing a multi-leveled analytic template, was employed to explore evidence of co-adaptation in a longitudinal dataset comprising dyadic email exchanges. The results suggested that both participants adjusted their language use throughout their interactions to mirror each other, though the synchrony was far from uniform.

Such variation in co-adaptation can be attributed to the dynamic interplay within the ecosystem, in this case, between Debra and Alicia. The ecosystem, including the participants' backgrounds, may have shaped the nature and extent of co-adaptation. For instance, macro ideological structures, such as political and cultural value systems, may have influenced the delineation between "neutral" and "non-neutral" territory for Debra and Alicia's synchronization. Greater co-adaptation was observed in more neutral areas, such as email salutations, allowing the interlocutors to preserve their identities while signaling alignment. Conversely, lesser co-adaptation occurred in more controversial or culturally specific areas, such as referencing countries, likely due to the participants' distinct worldviews and sociocultural differences. Individual differences also seemed to influence the types of topics initiated throughout the exchange, with Debra leading the synchrony in serious topics, such as jobs after graduation, and Alicia leading casual topics, such as relationships.

These findings point to co-adaptation as a function of interaction between language users, their environment, and time. Shedding light on the ways in which these interconnected systems influence the language that emerges as dyadic interaction unfolds, our study contributes to the CDST literature by evidencing language change arising from the interaction between learners and their environment, a characteristic central to CDST that remains relatively uncharted (Han et al., 2022).

Another important characteristic of complex dynamic systems that was observed in this study is the shift of states, including attractor states (Han & Liu, 2019; Han et al., 2022). Attractor states refer to relatively stable patterns of behavior that emerge over time within a dynamic system (Hiver, 2014). In our study, linguistic synchrony displayed moments of chaotic variation, such as fluctuations in alignment in emoticon use between Debra and Alicia, followed by periods of stabilization where their linguistic behaviors consistently aligned, reflecting the dynamic and adaptive nature of the dyadic interaction or the ecosystem.

Conclusion

This study contributes to an enhanced understanding of co-adaptation, a mechanism that drives iterations of language change, from a CDST perspective. By process-tracing co-adaptation in an ecosystem of longitudinal, asynchronous dyadic interaction, we probed the dynamic interplay of the language users, their environment, and time in shaping linguistic synchrony (or not). We found evidence of linguistic synchrony at various analytic levels and to varying degrees, and identified a complex of factors that influenced such synchrony. These findings suggest that co-adaptation is a non-linear, non-monolithic phenomenon that warrants further investigation in its own right.

The study has its limitations. Due to the breadth and depth of our questions, we were only able to present evidence selectively for each question. Consequently, the treatment of the

questions was not adequate, which, in turn, limited the insights and inferences we could draw. There is also the obvious limitation of the amount of data we used. Because we examined only one dyadic ecosystem, our results cannot be generalized. Nevertheless, it is our hope that this study will initiate a synchrony of scholars interested in studying L2 development as a complex, dynamic, and adaptive system underpinned by a socio-cognitive constructive process.

Future research on co-adaptation should, among other things, aim at conducting multiple case studies, guided by questions similar to those that guided the present study. Research along those lines is likely to reveal robust patterns of co-adaptation in interactions involving L2 users. Other worthwhile avenues of research may target higher-order questions such as: Do iterative changes in language use necessarily imply L2 development, as Larsen-Freeman (2019) has argued? How does co-adaptation unfold in other ecosystems characterized by different modalities of human-human interaction as well as human-machine interaction (e.g., with ChatGPT)?

ORCID

 <https://orcid.org/0009-0007-7337-116X>

 <https://orcid.org/0000-0002-2513-1475>

 <https://orcid.org/0000-0001-9139-441X>

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