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Evaluation of Second Language Dialogue Fluency

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Abstract:

This paper provides a comprehensive review of the measures of dialogue fluency, with a focus on within-turn fluency and between-turn fluency. First, within-turn fluency includes three dimensions: speed, breakdown (pauses and prolongations), and repair, while between-turn fluency focuses on turn pause and alignment. By reviewing previous studies, this research summarizes measures for within-turn fluency, particularly the application of composite measures (e.g., frequency of filled pauses, combining pause duration) in fluency studies. The findings reveal that speed, including both pure speed measures like articulation rate and combined measures such as speech rate encompassing both speed and pause, is the most commonly used measure in within-turn fluency studies. Additionally, research on between-turn fluency has been gradually increasing in recent years. Common between-turn fluency measures, as well as other potential measures, are summarized in this paper. Overall, this paper provides a theoretical framework and practical guidance for the selection of measures in future empirical studies and to enhance the systematicity of fluency assessment frameworks in future second language assessments.

Keywords: dialogue fluency; measurement; within-turn fluency; between-turn fluency

1. Introduction

Fluency (narrowly, refers to continuity, smoothness, rate, and effort in speech production, reflecting speaker's ability to express opinions fluently) is one of the core indicators of language proficiency (Segalowitz, 2010). Traditionally, research on fluency has mainly focused on monologue fluency. Monologue involves a predominantly one-way flow of information, with little reliance on feedback or interaction. Thus, monologue fluency primarily focuses on the performance of individuals in continuous speech. However, this one-way assessment of fluency can only reveal the language ability of second language (L2) learners in static environments or single-speech situations (Housen et al., 2012), but cannot adequately reflect learners' speech fluency in more complex interactions necessary in real communicative situations, i.e., dialogues. Dialogue fluency is more dependent on interactional dynamics, including turn-taking andinterlocutors' responses. It is co-constructed between participants, with the timing of the turns and interaction management playing a central role in the speech flow. Although both of them are typically measured by features such as speaking rate, pause frequency, and comma splice (Kormos & Dénes, 2004; Segalowitz, 2010), dialogue fluency provides a better gauge of L2 learners' integrated language abilities in authentic interactive communication (Rossiter, Derwing, & Munro, 2010). The development of L2 learning has also inspired scholars to explore various dimensions of dialogue fluency, such as within-turn fluency, between-turn fluency, and particularly co-construction as part of between-turn fluency.

As linguists examined the complexity of the interactive process more deeply, researchers have increasingly recognized the importance of dialogue fluency (e.g., Kormos & Tavakoli, 2010). Scholars mainly measure dialogue fluency through measures such as turn-taking fluency, speaking speed, pauses, interruption, and speaker repair behavior in the dialogue (Tavakoli & Wright, 2020). However, there are some defects in the early measurement of dialogue fluency. For example, many studies focused on the smoothness of turn-taking in dialogues, while the speaker's performance in each turn (such as pauses, repairs, and repetitions) is less examined (Skehan, 2009). This leads to a narrow scope of research and fails to fully reflect the fluency performance in dialogues. Moreover, dialogue is a joint activity in which co-construction plays a vital role in maintaining fluency (Pickering & Garrod, 2004). In the process of co-construction, speakers take turns to speak and can complete speech together through supplementation or extension of each other's turns. Besides, joint repairs and overlaps also occur. These are all important indicators of co-construction between speakers in a dialogue. However, traditional fluency measurement often regards dialogue as the speech performance of a single individual, thereby underplaying the contribution of this interactive mode to fluency. Many fluency measures only rely on standardized tasks in laboratory settings, lacking the complex interactive features of real dialogues (Saito, 2017), resulting in incomplete evaluations. Additionally, technical tools such as automatic turn-taking detection or real-time speech monitoring, are still underdeveloped in second language research, leaving a gap in the measurement of dialogue fluency (Tavakoli, Nakatsuhara, & Hunter, 2020). Therefore, there is currently a lack of assessment methods in fluency research that can holistically evaluate dialogue fluency.

In light of this, the paper aims to fill this significant research gap, proposing an integrated and systematic framework for evaluating dialogue fluency by reviewing and analyzing existing literature, to provide theoretical support and practical guidance for second language teaching and assessment.

2. Section 1: Within-turn fluency

Within-turn fluency, a key aspect of assessing L2 dialogue fluency, is constituted mainly by three components: speed, breakdown, and repair (Kormos, 2014, Skehan, 2009). These elements have long been central to linguists' measurement of within-turn fluency. The following section delves into their specific roles in measuring within-turn fluency and their contributions to the framework of evaluating L2 fluency by starting with fundamental concepts of these three elements and comparing related research.

The first within-turn fluency measure is speed, which has a direct impact on the conversation pace and the naturalness of the interaction. In within-turn fluency research, speed often refers to the speech rate at which speakers articulate within a turn, measured in syllables or words per minute (Ginther, Dimova, & Yang, 2010). Extensive previous research has shown that speech rate is a key indicator of linguistic fluency. In general, a faster speech rate tends to indicate greater fluency (Kormos & Dénes, 2004). Segalowitz (2010), from a psycholinguistic perspective, investigated the role of speech rate in fluency, suggesting that the faster a speaker's rate, the quicker they can process information and organize language cognitively, indicative of higher cognitive fluency. Moreover, De Jong et al. (2019) found that second-language speakers who speak at a faster rate are often perceived by native speakers as more fluent. However, excessively fast speech can also lead to reduced articulatory clarity, accuracy, and comprehensibility, thereby affecting the overall communicative effectiveness. In Zheng and Wagner's (2020) study, they discovered that when the speech rate reaches a certain level, it might lead to more corrections needed by the speaker, thereby reducing fluency. Thus, there is not a simple positive correlation between speech rate and perceived fluency, speech rate is also affected by multiple variables. Table 1 presents the usage role of combined indicators for speed measurement in within-turn fluency. Another speed measure is articulation rate, but this measure focuses more on the time that the speaker spends talking, excluding pauses (Kang & Johnson, 2018).

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Table 1 Measurement of speed and its combination with other measures

Measures	Definitions	References
Articulation Rate	Words or syllables pronounced per minute (excluding pauses)	De Jong (2009), Suzuki & Kormos (2020)
Speech Rate + Pause Duration	The unit of measurement calculated by the number of words produced in a certain time duration (e.g. words per second). Duration of each pause	Towell (2018), Tavakoli & Wright (2020), Kahng (2020), De jong (2016)
Speech Rate + Pause Frequency	Same above Number of pauses in speech	Tavakoli (2021), Kormos (2014), De jong (2016)
Speech Rate + Articulation Rate + Pauses Duration	Same above	Kahng (2020), Kim (2018)
Speech Rate + Pause & Repair Frequency	Same above Number of maintenance actions carried out per unit time.	Kormos (2020), Segalowitz & Freed (2020)
Speech Rate + Articulation Rate + Repair & Pause Frequency	Same above	Skehan (2016), Gilabert (2017)

According to Table 1, speech rate is the core measurement in previous studies. Meanwhile, the first combination is the most common, reflecting the rhythm and smoothness of speech. Moreover, the repair frequency is introduced in multiple combinations, especially in conjunction with speech rate and pause frequency. Overall, the comprehensive use of multiple measures is more frequent, helping to evaluate the within-turn fluency.

The next dimension is breakdown, which is key to understanding within-turn fluency. It comprises three factors: silent pauses, audible (filled) pauses (e.g., “um”, “uh”), and elongations (e.g., stretching of syllables or sounds). Bosker et al. (2012) argued that frequent and protracted pauses are indicative of reduced fluency. He also proposed that different types of pauses have different effects on the listener’s perception of fluency. Listeners perceive a speaker’s fluency to be significantly lower when the speaker frequently inserts silent pauses, especially longer ones. Filled pauses, on the other hand, serve to maintain the flow of speech and prevent listeners’ attention from wandering. A recent study by Pickering and Garrod (2013) on pauses from a psycholinguistic perspective suggested that filled pauses can function as signals for “keeping the floor” or “participation markers” in conversation, as speakers can monitor and adjust their output according to dialogue cues, reflecting the interactive nature of dialogue. Although pauses have been studied extensively (Tavakoli & Wright, 2020), we need to identify which indicators are beneficial for research and which less attended ones should be added for measurement. Table 2 presents pause-related measures and related previous research.

Table 2 Measurement of pauses

Measures	Definitions	References
Pause Frequency	Number of pauses in speech	Suzuki & Kormos (2021), Peltonen & Lintunen (2016), Kang & Johnson (2018), Tavakoli & Wright (2020)
Pause Duration	Duration of each pause	Zhan & Zhou (2019), Liu & Wang (2021)
Pause Position	The placement of pauses in speech	Wang & Liu (2016), Zhang & Li (2020)
Intra-sentence Pause	Pauses occurring within the same discourse	Boersma & Weenink(2018), Bögels & Krahmer (2016)
Pause Frequency & Duration	Assessing speaker fluency and information processing difficulty	Kahng (2014), De jong & Bosker (2016), Foster & Tavakoli (2009)
Pause Frequency & Position	Analyzing the distribution of pauses in different contexts and their impact on fluency	Kahng (2018), O’Connell (2017)

Pause Frequency & Intra-sentence Pause	Analyzing fluency issues in complex syntax	De jong et al. (2015), Doukhan et al. (2012)

Based on Table 2, the frequency, duration, and position of pause, along with their combination, are frequently used for fluency measurement. Besides, the intra-sentence pauses, which is a relatively undervalued measure, hold important measurement values in fluency research. It can reveal the fluency and cognitive load of the speaker in language production, effective in assessing an L2 speaker's fluency (Kahng, 2020).

Additionally, prolongation is also a direction to study speech interruptions. Generally speaking, if a syllable or a word is pronounced exceeds twice the normal duration, it can be considered as prolongation (Esmaili & Vali, 2017). It is worth mentioning that changes in intonation can also be regarded as prolonged (Ladd, 2008). Previous research has suggested that it may subtly index difficulties in language production (Bosker, 2014). For example, Kormos (2014) discussed and highlighted that prolongations are more common in L2 speech, as speakers often need more time to organize their thoughts. Recent research by Miller et al. (2022) conducted acoustic analyses of prolongations and found that frequent prolongations might negatively impact listeners' perception of fluency. To measure prolongations, researchers use software such as Praat to quantify the duration of prolonged sounds. The measurement provides objective data to understand the role of hesitations in speech (De jong, 2021). In addition to the factors mentioned above, paralinguistic noises – such as sighs, laughs, or throat-clearing – also impact within-turn fluency. They often surface during moments of hesitation or difficulty and are used as a strategy to maintain the flow of dialogue, giving speakers more time to plan their next utterance (Kormos & Trebits, 2020). However, paralinguistic noises are sometimes necessary in dialogue as they can help speakers better indicate their attitudes or convey emotions that are challenging to communicate through words alone (Feruzabonu, 2020). It can be quantified in terms of frequency and duration. Although these two factors have been less analyzed in L2 fluency research, they offer additional insight into the challenges that L2 speakers face in real-time language production.

The last within-turn fearure is repair, which consists mainly of three components: repetitions (the speaker repeats previous words, perhaps for emphasis or correction), self-corrections (the speaker immediately corrects the expression after realizing the mistake), and false starts (the speaker pauses at the beginning of an utterance, reorganizes thoughts, or revises expression (Kormos, 2014; Skehan, 2009). Repair plays a role in maintaining coherence and enhancing communicative effectiveness within turns, particularly in L2 learning. Early research on repetitions mainly focuses on their functions as a strategy to manage phonetic production under cognitive load. For instance, Levelt (1983) proposed that repetitions serve not only as a response to errors but also help speakers delay their response when time is limited or their thoughts are interrupted, thus contributing to a balance between fluency and informativity. While repetition contributes to maintaining the flow of dialogue, excessive or unnecessary repetition is generally perceived as a sign of lack of fluency (Kormos, 2014). Recently, repetition has received considerable attention in the measurement and analysis of second language acquisition, particularly fluency. Research shows that less proficient speakers tend to repeat more because they need more time to organize their thoughts and produce a second language (Skehan & Foster, 2019). Self-correction and false starts also play an important role in the study of second language proficiency. Zuniga et al. (2019) studied error correction processes in language production, and they found that self-correction not only benefits fluency but also enhances the effectiveness of intersection. De Jong (2011) found that differences in cultural background affect the frequency and type of self-correction. This indicates that the focus of self-correction research has now expanded to include social contextual factors compared to earlier times. Besides, false starts have also gained some scholarly attention. Early scholars only examined the impact of misstarting on fluency and comprehension, and now they are also looking into its role in dialogue. Norrick (2018) found that false starts can help regulate the pace and fluency of dialogue. Overall, previous studies related to repairs can help researchers more effectively study and assess L2 learners' language production skills through discussions.

3. Section 2: Between-turn fluency

In the assessment of dialogue fluency, between-turn fluency is an indispensable component alongside within-turn fluency. Between-turn fluency refers to the fluency exhibited during the transitions between speakers in dialogues, focusing primarily on turn-taking, responses, and coordination among interlocutors. This section discusses the

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common measures of between-turn fluency in previous research and identifies measures that have been overlooked but should be paid attention to.

In the study of between-turn fluency, turn pause occupies a central position as it directly reflects the fluency of turn transition and cognitive load during interaction, making it one of the important dimensions for evaluating dialogue fluency (Levinson & Torreira, 2015). Table 3 illustrates the commonly used measurements and methods.

Table 3 Measurement of turn pauses

Measures	Calculation	Relevant Research
Pause Frequency	$\frac{Total\ number\ of\ Pauses}{Total\ Speaking\ Time} \times Unit\ Conversation\ Factor$	Stivers et al. (2009), De Jong & Bosker (2013)
Pause Location	Pause Position Ratio $= \frac{Number\ of\ Pauses\ at\ Position\ X}{Total\ Number\ of\ Pauses} \times 100\%$	Levinson & Torreira (2015), Heldner & Edlund (2010)
Turn Pause Length	T2 – T1	Levinson & Torreira (2015), Choi (2016)
Transfer Time	T2 – T1	Stivers et al. (2009), Levinson &Torreira (2015)
Response Latency	Tb – Ta	De Jong & Bosker (2013), Saito et al. (2019)

Notes:

(1) T2 refers to the time when the second speaker starts speaking, and T1 refers to the time when the first speaker finishes speaking.

(2) Tb refers to the time when the second speaker begins to respond, and Ta refers to the time when the first speaker finishes speaking.

According to previous studies on between-turn fluency, alignment mechanism, and response appropriateness are other common measures. First, alignment mechanisms mainly involve verbal and non-verbal alignment in dialogues. Table 4 provides detailed information on the specific measures and calculation methods for these two types of alignment.

Table 4 Summary of the alignment mechanism

Classification	Common Measures	Measures	Methodology	Relevant Research
Verbal Alignment	Phonetic Alignment	Pitch, Speech Rate	$r = \frac{\sum(Ai-\bar{A})(Bi-\bar{B})}{\sqrt{\sum(Ai-\bar{A})^2+\sum(Bi-\bar{B})^2}}$ Rate alignment $= \frac{\lvert SPM1-SPM2\rvert}{SPMmax}$	Saito (2019), Kim (2015), Schmidt (2012)
	Lexical Alignment	Lexical Repetition Rate	$\frac{Number\ of\ repeated\ words}{Total\ number\ of\ words} \times 100\%$	Saito (2021)
	Syntactic Alignment	Syntactic Structure Repetition Rate	$\frac{Number\ of\ aligned\ syntactic\ structures}{Total\ number\ of\ syntactic\ structures}$	Saito (2019)
	Semantic Alignment	Lexical Overlap, Synonym Usage	Lexical Overlap $= \frac{Numebr\ pf\ overlapping\ words}{Total\ words\ spoken}$ Semantic Alignment $= \frac{Number\ of\ synonyms\ used}{Total\ unique\ words\ used}$	Pickering & Garrod (2021)

	Pragmatic Alignment	Speech Acts, Consistency of Dialogue Strategies	Pragmatic Alignment $= \frac{Number\ of\ matched\ speech\ acts}{Total\ number\ of\ speech\ acts}$ Strategy Alignment $= \frac{Number\ of\ aligned\ strategies}{Total\ number\ of\ strategies\ used}$	Healey et al. (2014)
Non-verbal Alignment		Posture, Eye Contact, Facial Expression	Posture Alignment $= \frac{Number\ of\ aligned\ postures}{Total\ number\ of\ postures\ observed}$ Eye Contact Alignment $= \frac{Duration\ of\ aligned\ eye\ contact}{Total\ conversation\ time}$ Facial Expression Alignment $= \frac{Number\ of\ aligned\ facial\ expressions}{Total\ facial\ expressions\ observed}$	Louwerse et al. (2012)

Notes:
(1) r = pitch correlation coefficient, Ai & Bi represent the pitch of two speakers at moment "I".
(2) SPM1 & SPM2 are the speaking rates of both parties in specific dialogue turns, and SPMmax is the maximum speech rate in dialogue.

In addition, appropriate responses determine whether the speaker's responses in a dialogue are timely and appropriate, and are an important indicator of dialogue participants' ability to understand and interact (Rapanta & Felton, 2022). It is commonly measured for response latency, content adequacy, and pragmatic adequacy (Taguchi & Roever, 2017). For example, Saito (2019) developed a scoring system (including relevance to the dialogue topic, completeness and accuracy of information, clarity of speech, logicality, and ease of understanding for listeners) and scores participants' speech content based on these criteria to measure content adequacy and practical adequacy. This evaluation is typically conducted by multiple experienced raters. Moreover, the calculation is determined by dividing the total score given by raters by the number of raters to obtain the result.

Meanwhile, syntactic adaptation(speaker's ability to adjust the syntactic structure according to the other party's language structure during communication) and dialogue synchronization (coordination process whereby dialogue participants maintain consistency in language rhythm, intonation, and language structure) (Pickering & Garrod, 2004), two closely related concepts, are two other measures, but they have not attracted as much scholarly attention as the measures above. Saito and Kachlicka (2021) mainly used measures of syntactic adaption as shown in Table 5.

Table 5 Measurement of syntactic adaption

Measures	Methodology
Grammatical Structure Matching	$\frac{Number\ of\ Matched\ Structures}{Total\ number\ of\ Structures} \times 100\%$
Phrase Repetition	$\frac{Number\ of\ Repeated\ Phrases}{Total\ Number\ of\ Phrases} \times 100\%$
Reverse Conversation	$\frac{Number\ of\ Reverse\ Structures}{Total\ Number\ of\ Speaker\ Turns} \times 100\%$

Besides, there is some research on the different types of synchronization that occur in dialogues, such as dialogue synchronization. Table 6 represents their measurements and methods.

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Table 6 Summary of synchronization

Classification	Measures	Calculation	Relevant Research
Dialogue Synchronization	Turn-Taking dynamics, Pauses, and Overlaps	Turn Duration = End Time – Start Time Pause Frequency $= \frac{Number\ of\ Pauses}{Total\ Turns}$	Gregory & Webster (2021)
Voice Synchronization	Pitch Matching, Prosodic Features	Pitch Similarity $=1-(\frac{Average\ Pitch\ Difference}{Max\ Pitch\ Range})$ Prosodic Similarity $= \frac{Matched\ Features}{Total\ Features}$	Louwerse et al. (2012)
Gesture Synchronization	Gesture Timing, Gesture Types	Gesture Overlap $= \frac{Time\ Overlap\ with\ Speech}{Total\ Gesture\ Duration}$ Gesture Frequency $= \frac{Number\ of\ Specific\ Gesture\ Type}{Total\ Gestures}$	As above
Speech Synchronization	Volume Similarity, Rhythmic Similarity	$1-(\frac{Average\ Volume\ Difference}{Max\ Volume\ Range})$ $\frac{Matched\ Rhythmic\ Patterns}{Total\ Patterns}$	As above

However, there are still some potential measures available for measurement, such as listening fluency, which is usually measured by reaction speed and depth of understanding, a listener's ability to understand language input quickly and accurately (Field, 2008). It is crucial for response and information processing in turn-taking, significantly influencing the fluency of dialogue (Brouwer & Krahmer, 2018). Although there is relatively little literature on the measurement of listening fluency in between-turn fluency studies, it can be measured by these measures in Table 7.

Table 7 Measurement of listening fluency

Measures	Calculation	Relevant Research
Response Time	T2 – T1 (Refer to table 3)	Wang & Xu (2020)
Comprehensive Accuracy	$\frac{Number\ of\ correct\ responses}{Total\ number\ of\ questions} \times 100\%$	Field (2018)
Processing Speed	$\frac{Total\ information\ processed}{Total\ processing\ time}$	Saito & Lyster (2018)

Therefore, if this measure can be widely used to measure between-turn fluency, future research can further develop these measurements to provide a more systematic evaluation framework for dialogue fluency.

4. Conclusion and Discussion

This review highlights measures of both within-turn fluency and between-turn fluency in the assessment of dialogue fluency. In assessing within-turn fluency, speed, pause (frequency, duration, location), and self-repair are the most common sub-dimensions. Moreover, the review emphasizes the use of composite measures of dialogue fluency from multiple perspectives. Meanwhile, measures of between-turn fluency, such as turn pause length, can reflect the cooperation and smoothness of interaction between speakers. In addition, this paper summarizes co-construction measures that are worth considering or potentially applicable in between-turn fluency measures, such as alignment, synchronization, and listening fluency, which broaden the research horizon. This paper also outlines methods for calculating certain measures to help refine the theoretical framework for fluency evaluation. However, existing research has shown a greater focus on within-turn fluency, resulting in relatively fewer measures for between-turn fluency. Future studies can further explore the synchronization behaviors in dialogue and listening fluency as measures to better assess the fluency performance of speakers between turns. In conclusion, future research should continue to explore further and uncover potential measures to achieve a more comprehensive analysis and evaluation of dialogue fluency, especially in L2 learning.

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