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Fluency profiles in L2 monologue production: the role of underlying cognitive factors

Highlights

- Identifying cognitive fluency profiles helps to understand mechanisms behind speech production.
- Cluster analysis combining L1 and L2 measures is a valuable tool in the creation of fluency profiles.
- Learners with different profiles could benefit from different types of exercises in the classroom environment.

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Abstract

This article examines the role of cognitive fluency and different fluency profiles that underlie L2 speech fluency, in relation to cognitive efficiency in L1 and L2, in a group (n = 64) of university students of English. The participants conducted, first, a freely produced monologue narration task in L1 and L2. Second, they performed two cognitive tasks in L1 and L2 measuring the efficiency of lexical access: a rapid word naming task and a Stroop task. Thirdly, L2 proficiency level was assessed with a vocabulary test. The correlations between proficiency and cognitive variables were low to moderate. Based on a cluster analysis, the participants were divided into four fluency profile groups differing in speech and disfluency rate, proficiency, and efficiency of processing. The results suggest that an awareness that learners represent various fluency profiles based on cognitive variables can aid formal teaching situations to include more versatile tasks for different kinds of learners.

Keywords: lexical access efficiency, monologue production, profiles, cluster analysis, speech fluency
Asiasanat: sanahaun tehokkuus, monologi, profiilit, klusterianalyysi, puheen sujuvuus

1 Introduction

Second language (L2) speech fluency is a core theme for both language users and those teaching or evaluating L2s for different educational or professional purposes. L2 fluency can be broadly understood as general oral proficiency or more narrowly as the speed and smoothness of production (Lennon 2000: 25). The narrow definition is common in fluency research and also followed here. Effortless and smoothly produced speech refers to speech without extensive pausing, repetitions, or self-repairs, but according to more recent studies, these so-called disfluency features are, nevertheless, an essential part of speech fluency both in first language (L1) and L2 production (see, e.g., Lintunen et al. 2020). This means that, in addition to relatively fast speech rate, even filled pauses and corrections can be features of efficient spoken production and strategically important for the flow of talk.

Language use has been studied in classroom and experimental conditions, and also in freely produced contexts. Study designs imitating authentic spoken production represent ideal contexts for collecting freely produced samples, but they induce other challenges, such as uncontrollable factors and variables. Therefore, a mixed setting including controlled tasks with controlled variables and freely produced speech can reveal new information on speakers' L2 proficiency and fluency profile most ideally, which benefits learners, teachers, and researchers. Earlier research has shown that there is a need for multiple-method studies (see Révész et al. 2022: 2) and especially for those where language users' own linguistic profiles and skills are compared (e.g., Lintunen et al. 2020).

L2 fluency is influenced by language proficiency and many individual factors relating to speech style and the efficiency of cognitive processing (e.g., De Jong 2018; Olkkonen & Mutta 2020; Peltonen 2020). It is important for both language teachers and assessors to understand that fluency features can be related to general language proficiency or may be more individual in nature. Instead of group-level analyses of fluency and proficiency, a more individual analysis can reveal the mechanisms of how speaking styles and differences in general cognitive processing have an effect on L2 fluency within speakers; especially with more proficient language users, these impacts are more highlighted. This can be seen in, for example, the frequency and duration of pauses, which are influenced by L1 speaking style, especially for proficient language users (e.g., Derwing et al. 2009; for fluency features in Finnish, see, e.g., Peltonen & Lintunen 2022; Toivola et al. 2009). In addition, repairs seem to depend on many factors, including resources for monitoring for mistakes and choosing to engage in a repair, as in whether the language user prefers speed or accuracy of the speech (see, e.g., the Complexity-Accuracy-Fluency framework, Kuiken & Vedder 2022).

In L2 research, there are studies on, for example, learner profile, aptitude profile, learning style profile, motivational profile, self-efficacy profile, and anxiety profile (see Li et al. 2022). Profiles can be used to describe the common tendencies and features of individuals or groups of individuals when learning or using a language (see, e.g., the Common European Framework of Reference, CEFR; Council of Europe 2001). Spoken L2 fluency has been studied from different perspectives (see, e.g., Lintunen et al. 2020), but studies focusing on fluency profiles are scarce. Our aim is to shed more light on this matter by examining how certain cognitive background features are related to L2 proficiency and to spoken production and fluency. The first aspect is approached with correlation tests and the second by performing a cluster analysis to examine how differences in lexical access efficiency in both L1 and L2 are related to L2 speech fluency in a group of university students of English. The participants (n = 64) conducted, first, a freely produced monologue task in L2 English. Second, they performed two cognitive lexical access tasks in L1 and L2, testing the automaticity of lexical access and the efficiency in its control. Furthermore, the participants' proficiency level was measured by a vocabulary test. By combining these perspectives, we can add to the understanding of different types of language users and their L2 fluency profiles that, in addition to more direct language proficiency measures, can be based on cognitive background factors behind speech production. The results can offer tools to identify fluency profiles and encourage L2 teachers to use more varied tasks that suit all kinds of learners to enhance their spoken production.

Our research questions are the following:

1) How is cognitive fluency related to L2 proficiency?
2) What kind of L2 fluency profiles can be identified based on cognitive fluency measures?

Before presenting our study, we discuss the dimensions of speech fluency and the different profile perspectives that have been studied in relation to speech fluency.

2 Literature review

2.1 Speech fluency: objective and subjective aspects

For speech fluency, the most oft-cited framework comes from Segalowitz (2010, 2016). In this framework, speech can be studied from three perspectives. Cognitive fluency is described as "the efficiency of operation of the underlying processes" of speaking (Segalowitz 2010: 165), incorporating the processes and abilities that make speech flow fluently on the utterance level and can usually be measured with multiple objective variables. Utterance fluency is the observable fluency of measurable aspects of speech, usually divided into speed, repair, and breakdown fluency (Skehan 2009, 2014; Tavakoli & Skehan 2005). Perceived fluency, the third perspective, is the subjective impression listeners have of the speaker's production (e.g., Lintunen & Peltonen 2020). This study focuses on the link between cognitive and utterance fluency.

Utterance fluency in L2 is related to proficiency, but it is also affected by individual differences in speaking styles and cognitive processing skills, that is, cognitive fluency. There is a considerable amount of research on the features of fluent speech that may be the most reliable indicators of language proficiency. Studies have shown that speed (e.g., speech rate) and certain aspects of breakdowns (e.g., location of pauses) are most reliably linked to L2 proficiency (De Jong et al. 2013; Duran-Karaoz & Tavakoli 2020; Kahng 2020). Moreover, L2 speech rate seems to be significantly connected to L1 speech rate (Gagné et al. 2022; Peltonen 2020; Towell & Dewaele 2005), and it is possible that there is a level of proficiency in L2 after which the individual speaking style becomes more apparent (e.g., Derwing et al. 2009). Individual differences in speaking styles seem to affect especially the use of repairs in spoken production. According to research findings, for example, the number of repetitions (Olkkonen 2017; Peltonen 2020) and corrections (Duran-Karaoz & Tavakoli 2020) in L2 speech are not related to proficiency in a reliable manner.

The reasons why the connection between proficiency and speech fluency might be difficult to define stem from multiple sources. Huhta et al. (2020) analysed fluency measures in language assessment and found that even if in most fluency scales certain features appear frequently (e.g., pauses and hesitation), the definition of fluency varies considerably. Individuals seem to pay attention to different subcomponents of fluency, which underlines the subjectivity of fluency perceptions. This kind of *perceived fluency* has been studied by, for example, Lintunen and Peltonen (2020), who examined university-level students' (n = 71) perceptions and concluded that learners had a multifaceted and rich understanding of what fluency means, but they mainly related it to spoken language, L2 proficiency, and a broad sense of fluency (Lennon 2000: 25). Even if fluency can be approached from objective or subjective perspectives, there seems to be a strong association between objective measures and subjective ratings according to Bosker et al. (2013), who reported that about 84% of the variance on ratings on fluency could be explained by objective measures of fluency, such as acoustic fluency features (i.e., speed fluency measured with the mean duration of syllables, breakdown fluency with the number of silent and filled pauses, and repair fluency with the number of repetitions and corrections). The aspects of breakdown and speed fluency seem to be the most strongly related to the subjective perception of fluency.

Besides these perceptions of fluency, differences in cognitive processing can also partly explain a lack of connection found between proficiency and fluency. Segalowitz's (2010) detailed model for *cognitive fluency* includes three aspects which determine fluent speech: the availability of *linguistic resources* (e.g., vocabulary size), *processing speed* (e.g., lexical or grammatical retrieval speed), and the efficiency of *attention control* (e.g., monitoring one's own speech for errors). Beginning language learners' cognitive resources are stretched by engaging in the multiple simultaneous processes of speech production, even with very low-level aspects of language use, which are, in general, automatically produced in L1 (such as correct pronunciation and word recognition, e.g., Levelt 1989; Towell & Dewaele 2005). Resources are freed by training these lower-level processes, but the differences between L1 and L2 performance might be quite notable even on high levels of proficiency, for instance in lexical access (Levelt 1989; Segalowitz 2010). Therefore, efficient lexical access is considered a central aspect of cognitive fluency (Segalowitz 2010: 75–76; Segalowitz & Freed 2004). A more automatic process is usually also more fluent, as it is less prone to interference from outside stimuli. Therefore, in lower proficiency levels, the lack of language skills hinders natural processing fluency. L2 cognitive fluency includes both the general cognitive processing capacity that is subject to individual variation, as well as L2-specific aspects, but their influence on L2 may, in part, be mediated by proficiency. To understand the differences in general and L2-specific processing, automaticity and control of language use differ between individuals can be studied (Segalowitz 2010; Olkkonen & Mutta 2020).

The control aspect, often studied with attention control, is argued to be one of the most important mechanisms differentiating expert language users from beginners (Segalowitz & Frenkiel-Fishman 2005). However, in contrast to automaticity, controlled processes do not seem to be as directly connected to language proficiency. In fact, Segalowitz and Freed (2004) found that efficiency of attention control was negatively related to L2 speech rate, which was explained as the better ability to monitor one's own speech. Furthermore, language users might struggle with multiple languages which they have simultaneously in their mental lexicon. It is more difficult to inhibit the activation of the language one is more proficient in, and more cognitive resources are needed to suppress this kind of ballistic process (Meuter & Allport 1999). Therefore, the combination of automaticity and control as an indication of the efficiency of cognitive operations offers an insight into how closely L1 and L2 processing resemble each other within individuals. The hypothesis is that the more proficient one is in L2, the closer L2 processing aspects are to those of L1 (see, e.g., Marian et al. 2013), and the background speech processes in L2 approach those of L1 processing (Duran-Karaoz & Tavakoli 2020). These relationships have not yet, however, been studied together. By comparing these aspects within individuals, we also aim to obtain information on how individuals differ in their personal preferences and abilities in relation to these aspects.

2.2 Explicit and implicit profiles in spoken language studies

As mentioned above, L2 use contains individual characteristics such as individual speaking style and speech rate. L2 speech fluency is also affected by other user-internal (e.g., personality and affective variables like emotions) and user-external (e.g., formality of the situation, power relations) variables (Lintunen et al. 2020), which all contribute to creating language users' individual profiles. In research, there is a need for profile studies to understand the complex picture of individual L2 learners and users (Li et al. 2022). Next, we will discuss how profiles have been examined in relation to cognitive skills and L2 speech fluency. As the approach is relatively new, all studies below do not present learner or speaker profiles explicitly but describe individual styles or profiles implicitly.

In L2 studies, the examination of individual differences by creating profiles has been rarer than in psychological and educational research (see Sparks et al. 2012; Li et al. 2022). Sparks et al. (2012) performed a cluster analysis to study high school learners' (n=208) cognitive skills and L1 achievement skills with respect to L2 proficiency. They used a large-scale battery of cognitive tests (e.g., aptitude, intelligence) and L1 tests (e.g., the modern language aptitude test, MLAT). These measures were compared to the students' achievement after two years of high school L2 studies. Sparks et al. (2012) wanted to reveal patterns of differences, and based on their analysis, they identified three distinct profiles in the level of cognitive and L2 achievement. Their results indicate, for instance, that learners' L1 skills are strongly related to L2 aptitude and proficiency; however, they did not examine different types of cognitive profiles besides high- or low-achievement.

Cognitive fluency studies are often related to psycho- or neurolinguistically oriented frameworks, and profiles are formed primarily from a disfluency perspective, examining some speech-related disorders such as cluttering (e.g., Oliveira et al. 2010) or cerebral palsy (Hustad et al. 2010), even if an articulation difficulty does not automatically make speech disfluent. The speech profiles are compared to fluent individuals' productions or to the comprehensibility of production, related to perceived fluency, which is not straightforwardly an objective measure because some assessment might reflect the speakers' skills, but some others, the listeners' skills. One cognitive study concerning profiles is Hustad et al. (2010), who studied speech and language problems in children with CP (with dysarthria) and examined speech and language measures (vowel area, speech rate, test of Auditory Comprehension of Language TACL-3) to create communication profiles groups. They combined the objective measures with a subjective one (parents' scaled assessment of the comprehensibility of the children's speech). Following a cluster analysis, the researchers created four profile groups based on children's speech motor involvement and possible language impairment. One of the objective measures, speech rate, was integral to the speech profiles, and this feature has also been widely used as a composite measure in L2 research as well, indicating the speed of talk and general speaking fluency (e.g., De Jong 2016; Skehan 2009, 2014; Tavakoli & Skehan 2005).

In her thesis, Dumont (2018) studied fluency and disfluency features to create non-native (French speakers of L2 English) and native (British English) speaker (dis-) fluency profiles based on utterance fluency. She used objective measures which combined product (i.e., the end product) and process level features, namely speech rate, mean length of run, phonation time ratio, unfilled pauses, filled pauses, restarts, false starts, repetitions, truncated words, foreign words, lengthenings, discourse markers, and conjunctions. Dumont (2018) used a cluster analysis to define the categories for the profile analysis. The analysis showed that temporal (dis)fluency variables had a central role in creating each profile. The most fluent non-native speaker profile had the following characteristics: high temporal fluency (few unfilled pauses, high phonation-time ratio and speech rate), many discourse markers, and few filled pauses, lengthenings and truncations; whereas fluent native speakers had a very high temporal fluency (few and short unfilled pauses, high phonation-time ratio and speech rate) and many lengthenings (Dumont 2018: 418–419). She also discovered that there was no relationship between the learners' fluency profiles and their assessed CEFR levels.

In a recent study, Mutta et al. (2023) made a comprehensive analysis of L2 fluency by examining objective variables of both written and spoken modes in a case study. They combined data from 11 university students who participated in two experiments. Students performed tasks in both L1 (Finnish) and L2 (English). The spoken tasks consisted of monologue picture description tasks, and the written tasks were short essays. The measured variables were chosen to represent central variables in speech (e.g., Peltonen & Lintunen 2022) and written fluency studies (e.g., Mutta 2020; Mutta & Laine 2022) and could be compared with each other illustrating the fluent-disfluent continuum; the used variables included, for example, speech rate, length of production, silent pauses per minute of speaking time, and repairs per minutes of speaking time. These variables were used to create L1 and L2 fluency profiles. The results showed that four speaker profiles could be identified: fast and productive speaker, fast speaker, slow and productive speaker, and slow and reflective speaker. These same profiles were identified in the written production. Furthermore, it was found that six speakers had the same profile in spoken production in L1 and L2; on the other hand, only one participant had the same profile in L1 and L2 speaking and writing. Interestingly, these results were not related to learners' L2 proficiency level.

For their part, Saito et al. (2016) examined different lexical factors' impact on native-speaker raters' assessment of comprehensibility of L2 speech. Comprehensibility was defined as the ease of understanding learners' L2 production including how fluently they spoke without undue pauses and hesitations (i.e., the experienced perceived fluency). They collected 40 short narratives from French L2 English speakers to examine which vocabulary features influenced the evaluators' intuitive assessment of the comprehensibility of speech; they were evaluated by 10 raters. Saito et al. (2016: 686) analysed the narratives for 12 lexical variables (related to appropriateness, fluency, variability, sophistication, abstractness, and sense relations), and based on these variables, they distinguished beginner, intermediate, and advanced levels of L2 comprehensibility. Profiles were linked to these linguistic features, produced by the speakers and not to the speakers themselves in this study. Based on recent studies, De Jong (2016: 205) relates comprehensibility also to objectively measured disfluency features (e.g., filled pauses) when these are used for communicative purposes, for example, to inform the listener that the speaker is searching for an appropriate expression and the listener has to pay more attention to what is coming next. However, there is still a need for a better understanding of how the underlying mechanisms of fluency and disfluency are linked to these surface features.

The above-mentioned studies show that identifying any kind of profile is a multifaceted phenomenon and contains a lot of intralearner variation. Studies focusing explicitly on L2 fluency profiles are scarce and, therefore, we try to shed light on this issue. Especially lacking is an understanding of the factors that underlie fluent speech, and as its relationship to cognitive fluency does not seem to be direct, it is important to strive for a more in-depth understanding of the different ways this relationship manifests itself. In our experimental study design, we approach the topic with objective measures that allow us to identify L2 fluency profiles with a cluster analysis, focusing on the efficiency of lexical access, speed and accuracy of speech, and L2 proficiency. The efficiency of lexical access was measured both by automaticity and attention control, which are thought to cover the complementary aspects of cognitive fluency (Segalowitz 2010; Olkkonen et al. in review). The aim was to study how L2 proficiency level is related to cognitive fluency and what kind of fluency profiles can be identified based on these measures.

3 Data and methods

3.1 Participants

The participants were native Finnish-speaking university students (n = 64; mean age (M) = 22.7, standard deviation (SD) = 5.5; 61% females) and advanced English users (number of years studying English: M = 10.2, SD = 1.3). LexTale vocabulary test (on the test and its validation, see Lemhöfer & Broersma 2012) was used to assess overall L2 proficiency level, with 70.3% of the participants on the C1/C2 level (LexTale accuracy score M = 84.9, SD = 8.7; C-level cutoff point 80%) in the CEFR scale (Council of Europe 2001). The testing was conducted in university language classes during a course as a voluntary task. The participants were asked about their vision (normal or corrected-to-normal), language-related problems, and colour vision impairments; if answers to any of these were positive, the test results were excluded from further analyses. All the tasks were conducted in the university language and computer laboratories, and the productions were recorded with microphone-headsets. Informed consent to participate in the study was obtained from the participants, and the data were processed according to the university's own ethical as well as GDPR guidelines.

3.2 Fluency tasks

The four objective measures in L1 Finnish and five in L2 English used in the current study are presented in Table 1.

TABLE 1. Profile dimensions and tasks in L1 and L2.

Profile dimensions	**Task & measure**
Language proficiency	LexTale (L2): lexical decision
Speech fluency	Monologue (L1 & L2): Speech rate, syllables / minute
Disfluency	Monologue (L1 & L2): false starts, reformulations, and repetitions / minute
Automaticity	Rapid word reading (L1 & L2): percentage of correct answers
Control of attention	Stroop task (L1 & L2): amount of interference (additional reaction time), number of repairs

The task to measure speech fluency was a freely produced monologue task in L1 Finnish and L2 English, based on two similar cartoon strips with six pictures. The participants had two minutes' time to plan what to say and then another two minutes to tell a short story in their own words based on the cartoons. The cartoon strips and the order of language (L1 and L2) were counterbalanced between the participants (more on the procedure, see Peltonen 2020). The monologues were transcribed and annotated by student assistants using Praat (Boersma & Weenink 2018), and double-checked by the researchers. Based on these transcripts, for the speech fluency variable, speech rate (number of syllables, including filled pauses / total speaking time, multiplied by 60 to standardise per minute; see Kormos 2006) was counted. Speech rate, thus, includes speed and breakdown (pausing) fluency, and provides a composite measure to be used as a general fluency measure that correlates highly with, for instance, perceived fluency (see, e.g., Bosker et al. 2013). Filled pauses were included in the syllable count as they can be considered strategic ways to keep the talk flowing when encountering difficulties with the speech production (following, e.g., Kahng 2020; Peltonen 2020; Dumont 2018). To account for repairs, disfluency rate (total number of false starts, reformulations, and repetitions per minute) was calculated (Kormos 2006).

To measure cognitive fluency, following Segalowitz's (2010) division and previous research (Olkkonen 2017), we opted for one task measuring automaticity (processing of Rapid words) and one task measuring control of attention (Stroop task), as these were considered to cover both aspects of cognitive fluency. The cognitive fluency tasks were conducted in a computer laboratory using jsPsych 6.3 framework (De Leeuw 2015), counterbalancing the order of the tasks and languages between the participants. Automaticity was measured by accuracy in *Rapid words*, where the participants were shown 30 words per language, presented for 50 ms and replaced immediately by a mask. The instructions were to say the words aloud, as fast and accurately as possible, and the participants were encouraged to guess when not sure. The words ranged from 8 to 13 letters, and from 3000 to 9000+ in frequency bands of Finnish (Parole 2007) and English (Nation 2017), getting progressively longer and less frequent. The accuracy of the answers was assessed by two raters (the first author and a research assistant instructed by the first author), listening to the answers independently and scoring based on the degree of accuracy (e.g., target word *reactivate, ympärillään* > 1 point for correct answer, .5 point for a correct base word such as *reactive, ympärillä* and .25 for a correct part such as *react, ympäri*); interrater reliability between two raters with Cohen's Kappa was 0.87.

Control of attention was measured by a Stroop task (Stroop 1935). The participants were shown neutral and colour words, written in different colour inks, and the task was to name the colour of the ink. The task included four colour words (*punainen/red, sininen/blue, keltainen/yellow, vihreä/green*) and three neutral words (*ovi/door, ikkuna/window, tuoli/chair*). The words were written in red, blue, yellow, or green ink on a grey background. There were six conditions (neutral, congruent, and incongruent in L1 and L2): the congruent condition with the word printed in the corresponding colour (*punainen/red* in red); the incongruent condition with a different colour (*punainen/red* in green); and the neutral condition, with a neutral word in any colour (*ovi/door* in red). Moreover, there were cross-language stimuli as the words shown could be either in L1 or L2, but the answering language was always in blocks. Reaction times (RTs) to name the ink were measured from the beginning of the correct answer (wrong answers and late responses of over 2100 ms, which constituted 0.6% of all answers, were excluded) using Praat (Boersma & Weenink 2018). Based on the mean RTs, *interference* effects (mean RTs in incongruent condition minus RTs in neutral condition) were calculated for both languages and cross-language conditions separately. The cross-language interference was used as an index of the strength of the involuntary activation of irrelevant language, and the ease of blocking it. Thus, a larger difference in RTs between the conditions, that is, a higher score, denotes a bigger effect. The number of repairs was also counted to account for the efficiency of the monitoring aspect of attention control. (Overall means and standard deviations in the tasks are reported in Olkkonen et al. in review).

3.3 Method

Sixty-four students' productions were analysed to study their cognitive fluency, L2 proficiency, and fluency profiles. To study the relationship between cognitive fluency and L2 proficiency, Pearson correlations were counted. To identify the profiles, we employed a hierarchical cluster analysis, the Ward method (Ward 1963). Cluster analysis is a method that groups cases together based on their similarity and thus helps to form subgroups of data sets that have high intra-group variation. In the case of language learning, for example, this can be used to form subgroups that "may utilise different pathways to language learning, including different strategies, aptitudes, motivational profiles, or different linguistic features to produce successful spoken or written language" (Staples & Biber 2015: 244; see also Dumont 2018). The hierarchical clustering method combines the closest cases together step by step and is, therefore, well-suited if the number of clusters is not decided beforehand. The distances between the clusters are computed by Euclidean distance and serve as an index of differences. All analyses were conducted on SPSS 27.

4 Results

To answer the first research question about the relationship between L2 proficiency and individual cognitive fluency variables, Pearson correlations were calculated (see Table 2). The connections were mostly low and non-significant. The correlations of accuracy in the L2 Rapid words and L1 Stroop interference to LexTale were moderate (r = .33). Rapid words task measures the depth and breadth of vocabulary skills, and therefore, its connection to LexTale is not surprising. The negative connection between L1 Stroop and LexTale, on the other hand, could be attributed to good skills in control of attention (see, e.g., Ghaffarvand Mokari & Werner 2019). These connections, however, did not reach statistical significance after Bonferroni corrections.

TABLE 2. Pearson correlations between L2 proficiency (LexTale) and cognitive fluency variables.

Cognitive fluency variable	***r***
Rapid words L1	.22
Rapid words L2	.33
Stroop repairs L1	-.03
Stroop repairs L2	-.02
Stroop interference L1	-.33
Stroop interference L2	-.14
Stroop interference L1 > L2	-.16
Stroop interference L2 > L1	-.31

To answer the second research question on the different cognitive profiles in the background of L2 users' speaking profiles, we performed a cluster analysis based on the variables described in Table 1. The cluster analysis is by nature somewhat subjective, as deciding the number of meaningful clusters is often based on an examination of distribution and distances in a dendrogram, and the number of clusters varies accordingly. In the current study, based on the dendrogram (see Appendix 1; for the means and standard deviations, see Appendix 2), we opted for four clusters (henceforth, groups) (also, e.g., Mutta 2020; Mutta et al. 2023). This also aligned with the fluency dimensions used, that is, the groups based on these clusters were compared according to differences in proficiency, fluency and disfluency, automaticity, and control of attention.

Based on the means presented in Appendix 2, we examined the difference between the groups further with one-way between-group ANOVAs (as recommended, e.g., by Staples & Biber 2015) with Bonferroni corrections for multiple testing (significance level at p <.005). In the case of the Disfluency rate, there was no significant difference between the groups (L1: F(3,60) = 1.97, p = .128; and L2 F(3,60) = .05, p = .986), nor for L2 Stroop interference (F(3,60) = 3.56, p = .019). Group differences remained significant after the correction, however, between Speech rates (L1: F(3,60) = 5.42, p = .002; and L2 F(3,60) = 5.22, p = .003), L1 Stroop interference (F(3,60) =

21.38, $p < .001$), L1/L2 Stroop interference ($F(3,60) = 6.87$, $p < .001$), and L2/L1 Stroop interference ($F(3,60) = 9.63$, $p < .001$).

To conceptualise the groups as profiles, the results are presented in a schema table (see Table 3) by groups based on their proficiency, speed, (dis)fluency, automaticity, and interference (i.e., control of attention).

TABLE 3. Schema of fluency groups.

Profile dimension	Group 1	Group 2	Group 3	Group 4
Proficiency (LexTale)			**+**	**-**
Speed (SR)	**+**		**-**	**L1 + / L2 -**
Fluency (DR)	**L1 + / L2 -**		**-**	
Automaticity (RW)		**-**	**+**	**L1 + / L2 -**
Interference (Stroop)	**+**		**-**	**L1 + / L2 -**

Note. + = high score - = low score

Based on this schema, four different fluency profile groups were identified: 1) Fast and fluent, 2) Accuracy-oriented, 3) Proficient but disfluent, and 4) Less proficient but fast. These groups are further described below (see also Figures 1 and 2).

Group 1 "Fast and fluent"

This group included the fastest speakers in both L1 and L2; however, the proficiency scores, albeit high in general, were from the lower end among the participants (mean score in LexTale 80.23). Despite this, the group produced the least repairs in free speech in either language (L1 $M = 2.05$ and L2 $M = 3.27$), although the difference between the number of repairs in L1 and L2 was the highest in this group. They had the most repairs in the L2 Stroop task of the groups ($M = 1.73$), which might be related to the speed of production, as their reaction times did not suffer from this. This may reflect an emphasis on speed over accuracy. This was, moreover, the only group where L2 interfered more with L1 than vice-versa, which may indicate a fast activation of lexical material also in L2.

Group 2 "Accuracy-oriented"

The group was in the mid-range in both speech rate (L1 $M = 232.97$ and L2 $M = 153.59$) and disfluency rate (L1 $M = 2.67$ and L2 $M = 3.52$). They had the lowest accuracy in L2 rapid words ($M = 74.35$) and second lowest in the L1 version ($M = 45.49$), which indicates lower overall processing speed. In the Stroop task, this group had very few repairs (L1 M = 1.19 and L2 M = 0.63); interestingly, they did experience interference in the task, which is seen in the longer reaction times (L1 M = 115.56 and L2 M = 106.76) compared to the Groups 1 (L1 M = 106.40 and L2 M = 36.50) and 3 (L1 M = 57.44 and L2 M = 59.31), but this did not translate into more repairs. These findings can point to either slightly lower automaticity (and therefore less need to correct) or to more emphasis on accuracy than speed, and therefore, not trying to guess the rapid words if not completely sure of the correct answer.

Group 3 "Proficient but disfluent"
This group had the highest scores in both proficiency (LexTale M = 90.09) and in the L2 rapid words' accuracy (M = 62.03), indicating that their L2 skills and automaticity were very high. Despite this, their speech rate was the lowest of all groups (M = 141.90). They also had the most disfluencies in L1 monologue (M = 3.91), and of all the groups, they were the only ones with more disfluencies in L1 than in L2 (M = 3.43). Furthermore, this group had very few repairs in the Stroop task in both L1 (M = 1.06) and L2 (M = 0.88), which may relate to slower speed in production. This slowness, however, seemed not to affect reception, as the rapid word scores were high (L1 M = 83.91 and L2 M = 62.03). Therefore, this group's performance in L1 and L2 resembled each other the closest of all groups, also regarding the disfluency behaviour.

Group 4 "Less proficient but fast"
This group was on the lowest level in the proficiency test along with Group 1 (M = 80.83), but compared to Group 1, Group 4 had the highest disfluency rate in L2; furthermore, the difference between their L1 (M = 232.87) and L2 speech rates (M = 136.94) was the largest. They had the highest accuracy scores in the L1 rapid words (M = 89.03), and even though they scored the second highest in L2 (M = 55.28), the discrepancy between the languages was, nevertheless, the largest in this measure as well. The difference between the strength of the Stroop effect between the languages (L1 M = 320.60 and L2 M = 123.10) was also highest in this group, all pointing to a less-developed and less-automatic L2 skill. However, it is important to notice that this did not translate into a slow speech rate, although with a lot of repairs. Furthermore, the relatively high score in L2 automaticity in rapid words may point to good overall automaticity which mediated even the lower language skill in the task.

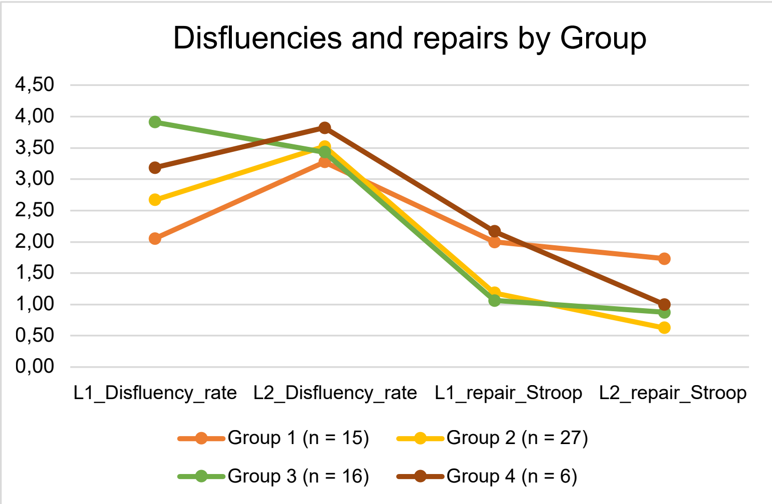

FIGURE 1. Means of disfluencies and repairs by profile groups.

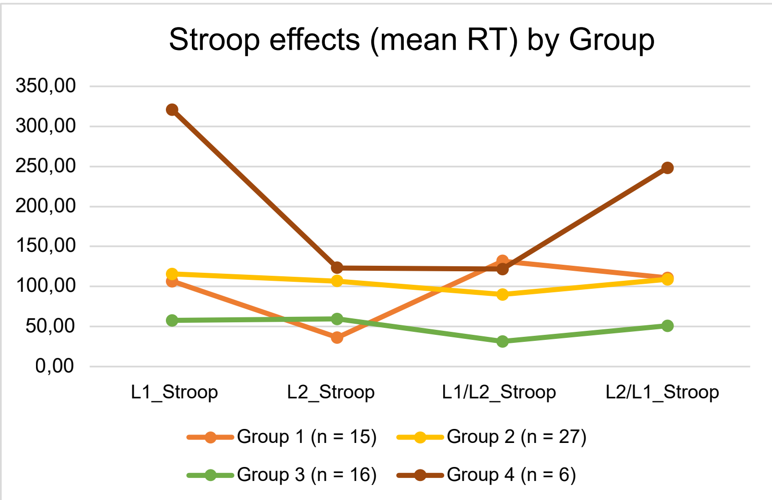

FIGURE 2. Means of different Stroop effects by profile groups.

5 Discussion and conclusion

In this article, we studied L2 learners' fluency profiles, based on cognitive fluency, L2 proficiency, and L2 speech production fluency. There is a need for multiple-method studies where language users' individual profiles and skills are studied in their different languages to form a more comprehensive picture of L2 learners' competences. Our experimental multiple-method study design combined freely produced monologue tasks and cognitive lexical access tasks to allow us to create fluency profiles in L1 and L2 production based on utterance and cognitive fluency variables. Until today, there have been only a few studies concentrating directly on speech fluency profiles, especially from a cognitive processing viewpoint, and our study tries to fill this gap and complement other L2 fluency studies in the field.

The two research questions related to how L2 proficiency and cognitive fluency are linked together and what kind of L2 proficiency profiles can be identified based on these measures. Regarding the first research question, the correlations between the cognitive fluency variables and L2 proficiency were mostly low to moderate, suggesting that the cognitive fluency variables used here reflect more individual differences. For example, in the case of the number of repairs in the Stroop task, this is not very surprising, as the correlation between the number of repairs between languages (L1 and L2) has been shown to be high and significant (see Olkkonen et al. in review). Together these results confirm further that repair behaviour is strongly influenced by individual cognitive or speaking style differences (see, e.g., Duran-Karaoz & Tavakoli 2020; Olkkonen 2017; Peltonen 2020). Noticeably, our target group was advanced language users, and therefore, in line with previous studies (e.g., Derwing et al. 2009), it seems that the high proficiency level enables the application of personal speaking style.

To answer the second research question, we measured proficiency, speed of production, disfluency rate, automaticity, and interference in L1 and L2 to create four fluency profile groups by means of a cluster analysis. The main differences between the groups fell into two main strands: the relationship between proficiency and fluency, and the relationship between speed and accuracy.

On the connection between proficiency and fluency, earlier studies have shown that L2 speech fluency is related to proficiency level but different aspects have different impact on L2 speech production such as speech rate in L1 (Gagné et al. 2022; Peltonen 2020; Towell & Dewaele 2005) or L2 (De Jong et al. 2013; Duran-Karaoz & Tavakoli 2020; Kahng 2020), individual speaking style (Derwing et al. 2009), or use of repairs (Olkkonen 2017; Duran-Karaoz & Tavakoli 2020; Peltonen 2020). In the current study, the most proficient L2 profile (Group 3) was shown not to be the most fluent one when using L2 in freely produced speech. However, based on their L1 monologue results, we can see that their general speaking style in L1 was very similar, that is, they were quite slow and disfluent in producing a monologue in their L1 as well. Together with the observation that the difference in the speech rate between L1 and L2 for this group was the lowest, this finding supports the interpretation that the more proficient language users are, the closer their L2 speech comes to their personal speaking style in general. Group 4, with the lowest proficiency, also had the biggest difference between the speech rates; however, it is notable that their speech rate was still slightly higher than that of Group 3. These two groups serve to illustrate the dissociation of proficiency and fluency, especially in the higher levels of proficiency, as Group 3 was characterised as proficient but disfluent, whereas Group 4 was less proficient but fast.

When speaking freely, as in the monologue task, there is the option of concentrating more on speed and unpaused speech, or ensuring as accurate production as possible. This may be, in part, related to personal differences and choices, and in the current study, we have focussed on how automaticity and interference as background factors can reveal this. In the current results, Group 1 showed fast performance in freely produced speech, and although they had a high number of repairs in the L2 Stroop task, this was not associated with slower naming of the colour. As the reaction times were measured from the beginning of the correct answer, this seems an indication of very fast performance. This was in contrast to Group 2, for whom most of the other measures were very close to Group 1, but for the low number of repairs and markedly slower reaction times in the L2 Stroop task. Fast reaction to the prompts produced more inaccurate answers, whereas taking more time assured more accurate answers in the case of interference. This is in line with some previous findings indicating that individual preferences can affect reaction times in the Stroop task (Shao et al. 2015).

It is noteworthy that, using the bilingual, mixed version of the Stroop task, we were able to find robust differences between the groups' processing abilities. The most significant group differences were found for the different Stroop interference variables. As these variables are based on reaction times in milliseconds, they are able to reveal minute differences in the processing of linguistic material. The high proficiency of Group 3 was shown in the high interference they experienced from the activating L2 words, as compared to the fluent Group 1, for whom interference was mainly from the L1 words.

There are also limitations regarding this study. Especially in cognitive fluency studies, the chosen cognitive measures have differed quite widely, and this has an impact on the results. Therefore, emphasising other cognitive processes and their relationship to the spoken outcome, the L2 fluency profiles in speech production could have also emerged quite differently. This should be considered whenever language learner/user profiles are created in later studies in order to allow comparison with other studies. The current choice of tests derived from processing-based interpretation of cognitive fluency, whereas, for example, Kahng (2020) based her cognitive fluency measures (e.g., picture naming and syntactic encoding) on Levelt's (1989) model, leading to more detailed results on different stages of speech production. As the proficiency differences between the participants were very small, future studies are required to see how the framework applies to lower levels of proficiency. In addition, although the proficiency test used here has been validated in relation to an array of external tests, more fine-tuned and varied proficiency level assessments would provide the results with more robustness. These variables, combined with the chosen method of cluster analysis, highlight the exploratory nature of the current study. Regarding further studies, as the languages in question (English and Finnish) are not related or typologically close, an interesting follow-up would be to compare how closer languages might either help or interfere with the processing in the lexical access tests.

The importance of the identified L2 fluency profiles to language teaching and assessment is based on the fact that individual characteristics influence speech production and might intervene in assessing the production. As Huhta et al. (2020) stated, the definition of fluency in L2 assessment often varies considerably and those who assess oral production might pay attention more or less subjectively to different subcomponents of fluency. Although the correlations between individual cognitive variables and proficiency were moderate, cluster analysis revealed their important role in distinguishing fluency profiles. Cognitive background features can, therefore, provide valuable insights into how a person communicates in any language, and thus help to understand how these features interact with L2 oral production. In contrast to, for example, Sparks et al. (2012), who found three groups with quite distinct levels of proficiency, our results were more mixed. For instance, speech rate seems to be related to a learner's language proficiency, as the speaker might retrieve words more easily from their mental lexicon, but only to a degree, as it might also reflect individual characteristics in speaking style that are not related to language proficiency (see Group 1 vs. Group 4).

In educational contexts, information on different kinds of profiles might help learners and teachers to better understand the role of underlying cognitive factors in L2 fluency. Learners with different kind of speaking profiles benefit from divergent tasks to improve their speech fluency: for instance, an accuracy-oriented speaker could practise short improvised dialogues; a proficient but disfluent speaker might benefit from drill-type exercises; a less proficient but fast speaker could find support from supporting vocabulary list during exercises; and a fast and fluent speaker, being ready for the next level tasks, could benefit from more demanding exercises and language use contexts. The knowledge of various fluency profiles can further encourage teachers to create and use multiple types of exercises to motivate learners' practising their spoken language skills in a beneficial and supportive way.

Acknowledgments

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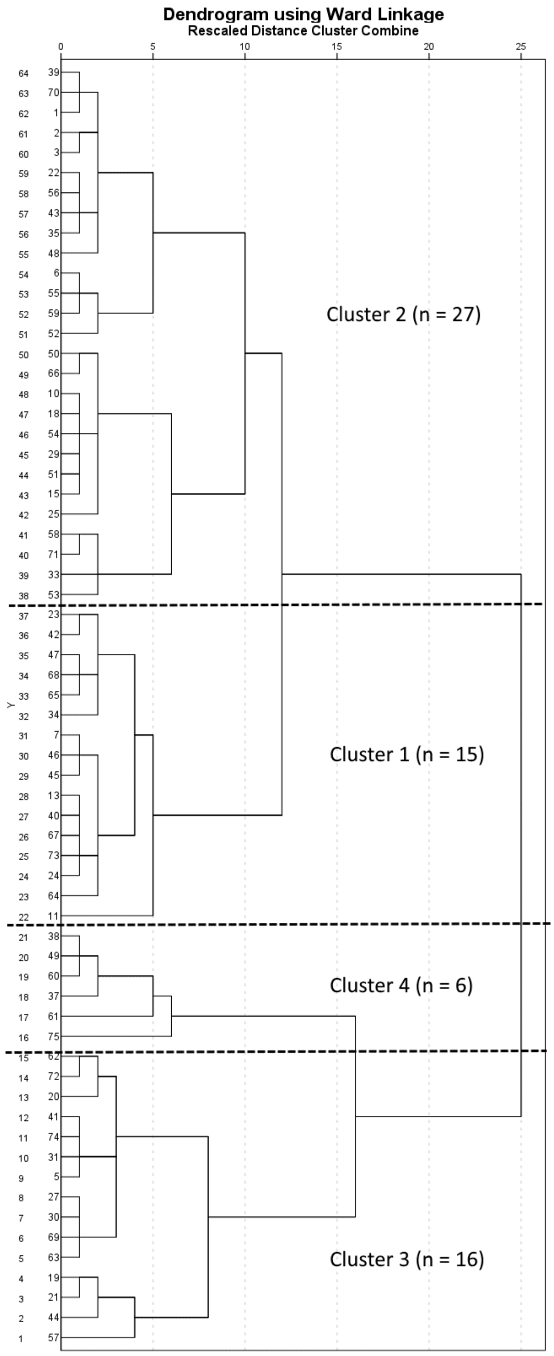
APPENDIX 1.

Dendrogram obtained from Hierarchical Cluster Analysis: Speaker cluster groups across fluency and cognitive measures (Ward's method, Squared Euclidean Distance)



APPENDIX 2.

The means and standard deviations of the four cluster groups based on L2 proficiency, speech fluency, and cognitive fluency measures.

Measure	Group 1 (n = 15)	Group 2 (n = 27)	Group 3 (n = 16)	Group 4 (n = 6)
	M (SD)	M (SD)	M (SD)	M (SD)
Proficiency (LexTale accuracy %)	80.83 (6.84)	84.91 (8.38)	90.09 (6.97)	80.83 (12.29)
Speech rate L1 (syllables/min)	251.14 (33.31)	232.97 (33.65)	197.62 (44.75)	232.87 (49.04)
Speech rate L2 (syllables/min)	174.26 (25.67)	153.59 (21.60)	141.90 (27.65)	136.94 (35.91)
Disfluency rate L1 (number/min)	2.05 (3.03)	2.67 (1.83)	3.91 (2.01)	3.19 (1.95)
Disfluency rate L2 (number/min)	3.27 (2.80)	3.52 (3.22)	3.43 (3.49)	3.82 (2.19)
Rapid words L1 (accuracy %)	70.94 (18.58)	74.35 (18.47)	83.91 (14.30)	89.03 (8.34)
Rapid words L2 (accuracy %)	46.61 (17.13)	45.49 (22.27)	62.03 (17.55)	55.28 (12.52)
Stroop repairs L1 (mean number)	2.00 (2.33)	1.19 (1.69)	1.06 (1.00)	2.17 (1.94)
Stroop repairs L2 (mean number)	1.73 (2.09)	0.63 (0.88)	0.88 (1.02)	1.00 (1.10)
Stroop interference L1 (milliseconds)	106.40 (83.91)	115.56 (57.81)	57.44 (52.98)	320.60 (109.31)
Stroop interference L2 (ms)	36.50 (74.88)	106.76 (81.66)	59.31 (59.08)	123.10 (93.03)
Stroop interference L1>L2 (ms)	131.85 (68.01)	89.88 (72.94)	31.19 (45.40)	121.77 (63.85)
Stroop interference L2>L1 (ms)	110.65 (73.74)	108.87 (78.61)	50.78 (52.00)	248.03 (123.24)