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Impact of cognitive impairment on the processing of discourse particles: an experimental study in patients with sickle cell disease

Impacto del deterioro cognitivo en el procesamiento de partículas discursivas: un estudio experimental en pacientes con enfermedad de células falciformes

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Abstract

This study explored how cognitive impairment associated with sickle cell disease (SCD) affects the processing of utterances with discourse particles, specifically 'therefore' and 'even'. Using an eye-tracking reading test, processing parameters were analyzed in young adults with SCD. The results indicated that discourse particles, which normally facilitate discourse comprehension, do not have the same effect in individuals with SCD. In particular, a significant increase in reading times and greater variability in fixation patterns were observed in this group. These findings suggest that cognitive impairment may alter the effectiveness of these particles in regulating cognitive effort. Despite the differences observed, the principles of discursive marking are not completely invalidated, although their manifestation is less efficient. Thus, this study provides evidence on how SCD, as a neurocognitive condition, affects the processing of discourse markers and pragmatic efficiency.

Key words: discourse particles, cognitive impairment, sickle cell disease (SCD), cognitive processing, eye-tracking.

Resumen

Este estudio exploró cómo el deterioro cognitivo asociado a la enfermedad de células falciformes (ECF) afecta el procesamiento de enunciados con partículas discursivas, específicamente 'por ello' e 'incluso'. Mediante una prueba de lectura con seguimiento ocular (eye-tracking), se analizaron los parámetros de procesamiento en adultos jóvenes con ECF. Los resultados indicaron que las partículas discursivas, que normalmente facilitan la comprensión del discurso, no tienen el mismo efecto en individuos con ECF. En particular, se observó un aumento significativo en los tiempos de lectura y una mayor variabilidad en los patrones de fijación en este grupo. Estos hallazgos sugieren que el deterioro cognitivo puede alterar la efectividad de estas partículas en la regulación del esfuerzo cognitivo. A pesar de las diferencias observadas, los principios de marcación discursiva no se invalidan por completo, aunque su manifestación es menos eficiente. Así, este trabajo aporta evidencia sobre cómo la ECF como condición neurocognitiva afecta el procesamiento de marcadores discursivos y la eficiencia pragmática.

Palabras clave: partículas discursivas, deterioro cognitivo, enfermedad de células falciformes (ECF), procesamiento cognitivo, seguimiento ocular.

INTRODUCTION

The human language is equipped with a series of resources that facilitate the communication process. One such resource is discourse particles, also known as discourse markers (Briz Gómez & Pons Bordería, 2010; Martín Zorraquino & Portolés Lázaro, 1999), whose main function is to guide the inferences made in communication (Loureda *et al*., 2021b). The process derived from this function is known as discourse marking and consists of pointing out the different relationships that exist among the elements of discourse (Borreguero Zuloaga & Loureda, 2013; Briz Gómez & Pons Bordería, 2010). Thus, different particles can be responsible for indicating very different discursive relationships: from connection or modalization to argumentation or focalization (Loureda *et al*., 2021a).

In recent years, experiments have shown that the functions performed by discourse particles have cognitive correlations that greatly impact discourse processing. In this context, understanding how individuals manage inferences has become an increasingly important aspect of linguistic research, particularly in experimental pragmatics (Loureda *et al*., 2021a). This approach has been progressively expanded to include monolingual speakers (Cruz Rubio, 2020; Cuello, 2022; López Serena & Loureda, 2013; Nadal, 2019; Nadal *et al*., 2016; Salameh Jiménez, 2019; Torres Santos, 2020) and bilingual speakers (Ivanova, 2017; Loureda *et al*., 2019, Loureda *et al*., 2022; Narváez García, 2019; Nadal & Narváez, 2021, 2019; Recio Fernández, 2020; Recio Fernández *et al*., 2021). Thus, it has been shown that discourse particles reduce the cognitive effort of the speaker by providing information on how to interpret the introduced element (Loureda *et al*., 2015; Loureda et al., 2021a; Loureda *et al*., 2021b; Loureda *et al*., 2022; Nadal *et al*., 2016; Recio Fernández *et al*., 2021). In this way, utterances marked by discourse particles, as opposed to unmarked utterances, introduce more defined and less ambiguous structures, which enables instructional knowledge (Loureda *et al*., 2015; Nadal *et al*., 2016).

Within this context, one of the questions of great scientific interest is to determine to what extent the cognitive behavior triggered by the presence of discourse particles is universal to all speakers. Studies conducted to date have shown that it is universal for speakers of different languages (Cruz Rubio, 2020; Cuello, 2022; Salameh Jiménez, 2019) and with different proficiency levels, being similar in monolinguals and bilinguals (Ivanova & Bello, 2019; Recio Fernández, 2020) However, the study of the behavior of discourse particles in people with cognitive impairment is an area that still requires scientific exploration. Considering that pragmatic competence, crucial for interpreting the meaning introduced by particles, requires high cognitive ability (Ivanova *et al*., 2020), it is worth asking how the course of impairment affects the processing of marked utterances. The complexity of linguistic competence suggests that speakers with cognitive impairment may face specific challenges in managing instructions mediated by discourse particles.

The objective of this article is to describe and discuss the results obtained in the experimental study of the processing of statements marked with the particles “therefore” and “even” in adult speakers with cognitive impairment due to sickle cell disease (SCD). The fundamental purpose of the reported study is to determine whether cognitive impairment alters the processing patterns of marked utterances compared to similar patterns in speakers without cognitive impairment, in order to determine how this affects the fundamental principles of communication. The general premise is that, since it is a fundamental principle of human communication, marking will condition the same processing pattern in conditions of cognitive impairment, although this will affect the timing and homogeneity of processing.

Discursive marking

Within the field of experimental pragmatics, discursive marking refers to the use of certain linguistic resources that perform specific pragmatic functions within the discourse framework. These resources are involved in the organization of information, the structuring of arguments, the cohesion of texts, and the expression of discursive modalities, while also triggering inferences and cognitive operations in interlocutors. In this way, discursive marking strengthens communicative interaction, guides the interpretation of messages, and facilitates

the construction of mental representations that are essential for comprehension (Loureda *et al*., 2021a; Loureda *et al*., 2022).

The linguistic elements linked to this phenomenon mark the limits of cognitive processes, differentiating statements containing particles from those that lack them (Cruz Rubio, 2020; Cuello, 2022; Loureda *et al*., 2021a; Nadal, 2019; Recio Fernández, 2020; Sanders & Evers-Vermeul, 2019; Sanders *et al*., 2009; Torres Santos, 2020). Thus, discourse particles not only contribute to the development of interpretative hypotheses about the content of a statement, but also guide its reformulation, reducing ambiguity and promoting more agile access to the communicated meaning. The experimental evidence obtained using eye-tracking techniques confirms this behavior, showing characteristic fixation patterns in the sections marked by these particles, which points to greater efficiency in the construction of mental representations (Cruz Rubio, 2020; Loureda *et al*., 2015; Loureda *et al*., 2019; Loureda *et al*., 2021a; Loureda *et al*., 2021b; Loureda *et al*., 2022; Nadal, 2019; Nadal *et al*., 2016; Narváez García, 2019; Recio Fernández, 2020; Recio Fernández *et al*., 2021; Torres Santos, 2020).

The interaction amid communication, cognition, and discursive marking is well documented (Loureda, 2021a). This link is supported by four theoretical assumptions that explain how these processes converge in language use. First, communication involves both the decoding of linguistic signs and inferential enrichment, which allows access to the implicit and generates contextual meaning (Sperber & Wilson, 1995). Secondly, the mind dynamically adjusts its inferential hypotheses, so that communicative success depends on the quality and quantity of inferences required for interpretation (Wilson & Sperber, 1993, 2004). Likewise, discourse marking is understood as a mechanism for guiding inferential processing: through discourse particles, it reduces ambiguity and directs interpretation toward more efficient options (Blakemore, 2002; Leonetti & Escandell-Vidal, 2004). Finally, such particles have a key communicative value in regulating context, optimizing access to relevant information and promoting cognitive processing in interaction (Blakemore, 2002; Fraser, 1999; Loureda & Acín, 2010; Martín Zorraquino & Portolés Lázaro, 1999; Portolés Lázaro, 2001). Taken together, these assumptions underline the relevance of discursive marking for the fluency and effectiveness of verbal exchanges, contributing to clearer and more effective interactions.

Principles of discursive marking

Based on the studies available to date, three essential principles have been formulated that explain how discourse particles affect the processing of utterances and the calculation of inferences in communication. These principles (I, II, and III) are oriented toward the cognitive regulation of Interpretative effort and highlight the function of particles in the organization of discourse, as they guide interpretation and optimize interaction among the different discursive components. (Cruz Rubio, 2020; Loureda *et al*., 2015; Loureda et al., 2019; Loureda *et al*., 2021a; Loureda *et al*., 2021b; Loureda *et al*., 2022; Nadal, 2019; Nadal *et al*., 2016; Narváez García, 2019; Recio Fernández, 2020; Recio Fernández *et al*., 2021; Torres Santos, 2020).

A first aspect (Principle I) points out that these units qualitatively modify processing strategies, both locally and globally, by adjusting the expectations of interlocutors. This perspective is complemented by a second element (Principle II) which establishes how particles also function as mechanisms that limit cognitive effort: they manage available resources and guide interpretation towards more accurate readings, even when the semantic content is complex. In addition, a third component (Principle III) highlights the immediacy with which they intervene in the integration of discursive units, which promotes fluency and reduces the need for reanalysis. These three dimensions complement each other to form a coherent theoretical framework: processing transformation (Principle I), effort management (Principle II), and immediate integration of information (Principle III). This framework is useful for understanding how particles affect cognitive processing and the interpretation of statements (Loureda *et al*., 2021a). To illustrate how it works, it is helpful to examine specific examples from everyday language use. In this context, two specific discourse particles will be analyzed: “por ello” (therefore), which is argumentative in nature, and “incluso” (even), which is focal in nature. Let us consider the following pairs of statements:

- (1a) Ana and Pedro have a lot of savings. They can afford to travel around the world.

- (1b) Ana and Pedro have a lot of savings. Therefore, they can afford to travel around the world.

- (2a) Sara and Luis eat fruits and vegetables. They consume organic foods.

- (2b) Sara and Luis eat fruits and vegetables. They even consume organic foods.

Principle I is evident in the contrast between (1a) and (1b). In (1b), the inclusion of "therefore" explicitly marks a causal relationship between the two propositions, restructuring the cognitive expectations of the receiver and guiding them toward a specific interpretation. In comparison, (1a) requires the receiver to infer this causal relationship on their own, potentially increasing cognitive load and interpretative ambiguity.

Principle II can be observed in the comparison between (2a) and (2b). In (2b), the use of "even" introduces a nuance of additional informational relevance, indicating that consuming organic foods is a step beyond what is expected on the scale of healthy eating habits. This focal particle optimizes the cognitive resources of the receiver by providing an explicit clue about the relative importance of the second statement within the informational structure of the discourse.

Principle III is evident in both examples. In (1b), "therefore" facilitates the immediate integration of the two discursive units by making the causal argumentative relationship explicit. Similarly, in (2b), "even" instantly adjusts the listener's interpretation, adding a nuance of greater informational intensity to the second statement and placing it at a high point on the relevant pragmatic scale.

These examples demonstrate how discourse particles, in this case "therefore" and "even," operate in accordance with the three principles of discourse marking. They qualitatively modify cognitive processing, control interpretative effort, and provide immediate local regulation.

Sickle cell disease (SCD) and its impact on communication skills

As previously stated, this study focuses on analyzing the processing of utterances marked with the particles "therefore" and "even" in adult speakers with cognitive impairment, specifically focusing on individuals affected by (SCD). This pathology offers the opportunity to investigate how cognitive impairment can alter the processing patterns of discourse particles, allowing us to explore whether marking maintains its facilitating function in conditions of cognitive deficit.

The SCD represents a hereditary hemoglobin disorder with significant global prevalence, being considered the most common genetic disease worldwide (Montanaro *et al*., 2013). Its epidemiological impact is considerable: it is estimated that around 300,000 affected children are born each year (Williams & Weatherall, 2012). Furthermore, projections indicate that by 2050, the number will exceed 400,000 new cases (Piel *et al*., 2013). In Panama, the prevalence is particularly high, given that 6% of the population carries the sickle cell trait and about 5% has the disease (Rodríguez & Alvarado, 2020).

The neurological complications associated with SCD are particularly relevant to the analysis of language processing, as they represent one of the most severe clinical manifestations and are often accompanied by cognitive impairment (Montanaro *et al*., 2013). This impairment affects multiple domains, including attention, processing speed, working memory, and executive functions (Sahu *et al*., 2022), all of which are essential for efficient language use. These deficits have been reported in both children (Bangirana *et al*., 2024) and adults (Couette *et al*., 2023), confirming their cross-sectional nature and their impact at different stages of the life cycle.

Considering that the relationship between language and cognition is intrinsic and bidirectional (Ivanova, 2021), linguistic assessment plays a central role in assessing the extent of neurocognitive disorders linked to this condition. In terms of communication, the literature has shown that people with SCD may present alterations at various linguistic levels, including semantic, syntactic, and phonological levels (Arfé *et al*., 2018; Hogan *et al*., 2005). These difficulties are not limited to lexical-semantic aspects, but also affect more complex linguistic skills (Schatz *et al*., 2001, Schatz *et al*., 2009).

Particularly relevant is the impairment of white matter connectivity, which affects working memory and semantic processing tasks, suggesting additional limitations in the integration of complex information (Clayden *et*

al., 2023; Lambon Ralph *et al*., 2009; Thompson *et al*., 2010). However, one area that has been little studied is inferential communicative competence, particularly in relation to the processing of discourse markers.

Advances in neuropragmatic studies have allowed for a more in-depth examination of the relationship between pragmatic abilities and higher cognitive functions (Cummings, 2009, 2014, 2017; Norbury, 2005; Perkins, 2000; Stemmer, 1999), a key aspect when considering the profile of linguistic deficits described in SCD. In this sense, research on discourse particles in this population is particularly valuable for several reasons.

On the one hand, the processing of such markers depends on the integrity of the frontotemporal networks and white matter, areas that may be compromised in people with SCD (Clayden *et al*., 2023). Furthermore, their interpretation requires complex inferential processing involving both social cognition and executive functions (Schatz *et al*., 2002), domains that are frequently affected in this disease. In real-life communication situations, this phenomenon resembles that observed in other cases of cognitive impairment, such as in patients with right hemisphere lesions or dementia (Stemmer, 2008). Complementarily, discourse markers are essential for the coherence and organization of discourse (Blakemore, 2002). Therefore, its analysis in people with SCD has both clinical implications (related to cognitive functioning) and theoretical implications, linked to inference management and the study of language processing (Sperber & Wilson, 1995), especially in contexts of cognitive impairment.

The specific selection of the particles "therefore" and "even" is based on their role as inferential guides in discursive interpretation (Briz Gómez *et al*., 2008; Loureda & Acín, 2010; Martín Zorraquino & Portolés Lázaro, 1999; Pons Bordería, 2006; Portolés Lázaro, 2001, 2015). Although they differ in their specific functions—causal and focal, respectively (Loureda *et al*., 2021a)—they share fundamental properties of procedural meaning (Escandell-Vidal *et al*., 2011; Portolés *et al*., 2020). Eye-tracking studies have documented significant effects on processing optimization, with a reduction of 22.42% for "therefore" and between 2.45% and 5.48% for "even" (Loureda *et al*., 2021a, p. 82). This ability to highlight relevant information and integrate it into the discursive context is interesting in conditions of cognitive impairment, where the suppression of irrelevant interpretations and contextual integration may be compromised (Tompkins *et al*., 1994, 2001). The selection of these specific particles is also based on the universality of their principles of discursive marking as a fundamental process of linguistic communication (Loureda *et al*., 2021a), which allows for their evaluation in various clinical contexts.

Hypothesis and objective

This research is based on the intersection between the principles of discursive marking and the neurocognitive profile associated with SCD. Based on previous studies on the processing of discourse particles in the normotypical population (Loureda *et al*., 2021a) and on the cognitive characteristics of individuals with SCD, we start from the general hypothesis that cognitive impairment due to SCD will influence the processing patterns of utterances with discourse particles. Specifically, the concrete hypothesis of the study is: in speakers with SCD, the comparison between utterances marked with the discourse particles "therefore" and "even" and unmarked utterances will reflect altered processing patterns, manifesting in a reversal or attenuation of the facilitating effects typically observed in normotypical speakers. However, the principles of discursive marking will remain preserved, although requiring greater cognitive effort for their processing, evidenced by more pronounced quantitative differences in reading times between marked and unmarked utterances, compared to normotypical speakers.

The aim of this study was to determine whether cognitive impairment associated with SCD alters the processing patterns of utterances marked with the discourse particles "therefore" and "even," evaluating whether the principles of discourse marking are maintained in conditions of cognitive deficit. The specific objectives of the study are therefore: (a.) to analyze how speakers with SCD process marked and unmarked utterances; (b.) to evaluate the facilitating effect of the particles "therefore" and "even" in the processing of utterances in speakers with SCD; and (c.) to examine whether the principles of discourse marking proposed by Loureda et al. (2021a) are maintained in speakers with cognitive impairment due to SCD.

METHODOLOGY

Participants

The experimental group consisted of 40 young adults between 18 and 40 years of age, diagnosed with sickle cell disease. Participants were recruited through the Panamanian Association for the Prevention of Sickle Cell Disease (APAAF, from Spanish initials). All were native Spanish speakers, monolingual, and had at least six years of formal schooling. Sixty-five percent of the total sample were women. To be included in the study, participants could not have uncorrected visual or auditory impairments, nor a history of neurological or psychiatric disorders. A questionnaire collecting sociodemographic and cognitive data was administered to ensure the homogeneity of the sample participants. All participants performed the same self-controlled reading experiment of statements with and without discourse markers while their eye movements were recorded.

Experimental design

In this study, a 2 x 2 x 2 factorial design was applied, following the methodological approach used in previous research on the processing of discourse particles (Cruz Rubio, 2020; Cuello, 2022, Loureda *et al*., 2021a, Loureda *et al*., 2021b; Nadal *et al*., 2016; Nadal, 2019, Recio Fernández, 2020; Salameh Jiménez, 2019; Torres Santos, 2020). Sixty-four experimental statements were generated, distributed evenly among the resulting conditions. The experiment was organized into eight different contexts, each following a specific structure: a background image, followed by two fillers, a critical item, and two more fillers. The ratio between critical stimuli and fillers was kept at 1:2 to prevent participants from detecting systematic patterns (Holmqvist *et al*., 2011). In order to control for order effects, a Latin square design with counterbalanced lists was implemented. Each participant was exposed to all conditions, but with different versions of the statements, ensuring that each statement appeared in each position only once throughout the experiment (Arunachalam, 2013). This design allowed for the evaluation of the main effect of the presence of the discourse particle on statement processing by patients with SCD.

Variables

The study examined three independent variables: (1) the presence or absence of discourse particles (DP), (2) the type of discourse particle (therefore vs. even), and (3) the group of speakers (people with SCD vs. normotypical speakers). This selection was based on the theory of discursive marking (Loureda *et al*., 2021a) and on previous research on the processing of discursive particles (Cruz Rubio, 2020; Cuello, 2022; Nadal, 2019; Recio Fernández, 2020; Salameh Jiménez, 2019; Torres, 2020). The choice of therefore (causal argumentative marker) and even (focal operator) allowed us to explore how different procedural instructions modulated processing in people with cognitive impairments, particularly SCD, compared to normotypical people.

Total reading time (TRT), measured in milliseconds, was selected as the dependent variable due to its ability to reflect overall cognitive effort during sentence processing (Holmqvist., 2011; Rayner, 1998). This configuration of variables sought to establish how SCD affects the differential processing of discursive procedural instructions.

Example of an experimental set:

The following set of examples constitutes a hypothetical experimental set designed to illustrate how the statements are presented: pairs with (P+A) and without (P-A) discourse particles.

Set 1:

a. Maria studies a lot. Therefore, she gets good grades. (P+A)

b. Maria studies a lot. She gets good grades. (P-A)

c. Juan runs 5 km every day, and even trains on Sundays. (SP+A)

d. Juan runs 5 km every day. He trains on Sundays. (SP-A)

e. Carlos reads novels. That's why he has a wide vocabulary. (P+A)

f. Carlos reads novels. He has a wide vocabulary. (P-A)

g. Ana speaks three languages, and she's even studying Hebrew now. (SP+A)

h. Ana speaks three languages. She's studying Hebrew now. (SP-A)

Table 1.
Example of an experimental list

Set 1	Set 2	Set 3	Set 4	Set 5	Set 6	Set 7	Set 8
A	F	C	H	E	B	G	D
B	G	D	A	F	C	H	E
C	H	E	B	G	D	A	F
D	A	F	C	H	E	B	G
E	B	G	D	A	F	C	H
F	C	H	E	B	G	D	A
G	D	A	F	C	H	E	B
H	E	B	G	D	A	F	C

Table 1 presents an experimental list with 8 randomly distributed conditions.

Areas of interest: Areas of interest (AOIs) were established to analyze participants' eye patterns and reading times in relation to discourse particles. These areas were defined based on the experimental conditions, segmenting sentences into regions that allowed us to observe how particles affected comprehension of the utterance.

Equipment and procedure: To record eye movements during reading, an EyeLink 1000 Plus eye tracker from SR Research was used, which captured movements at a frequency of 2000 Hz. This device, with a spatial resolution of 0.01 degrees rms, made it possible to accurately detect micro-saccades as small as 0.05 degrees. The participants performed a self-controlled reading task while their fixation patterns and saccadic movements were recorded. The experiment followed the technical parameters established in previous studies (Cruz Rubio, 2020; Cuello, 2022; Nadal, 2019; Recio Fernández, 2020; Salameh Jiménez, 2019; Torres Santos, 2020). The subjects were positioned approximately 70 centimeters in front of the computer screen to ensure accuracy in the recording of eye movements.

The experimental procedure comprised three fundamental stages. In the first stage, the eye tracker was calibrated, verifying that the maximum deviation did not exceed 0.5° on each axis to ensure the accuracy of the data obtained. In the second stage, participants received detailed instructions and completed an initial practice session with three test items. Finally, in the experimental phase, they performed a self-controlled reading task. This included the presentation of a context consisting of an image accompanied by a text, followed by a central fixation that stabilized the gaze before displaying the critical statement. The subjects progressed through the task at their own pace by pressing a key, which ensured individualized control of reading time. For the analysis, total reading times (TRT) were calculated for both statements with discourse particles and those without them. The data were examined using mixed models, which considered fixed effects (presence or absence of discourse particles, type of particle) and random effects (participants and items).

Similarly, this study relied on the method of measuring eye movements using eye tracking. This technique, in its online form, is a central tool in experimental linguistics, since it enables real-time analysis of cognitive processing during reading. The procedure allows the direction and duration of fixations to be measured, providing accurate information on how readers process the different components of discourse, including discourse particles. By recording fixation times and patterns, eye tracking reveals the comprehension strategies employed by participants and how these strategies change depending on contextual factors, as observed in studies conducted with normotypical readers (Liversedge *et al*., 2011; Loureda *et al*., 2021a).

In this study, the use of eye tracking is particularly useful for identifying the cognitive characteristics involved in speech processing in individuals with SCD. This condition can compromise neurocognitive functions due to complications such as cerebral hypoxia and chronic anemia (King *et al*., 2014; Schatz *et al*., 2001, Schatz *et al*., 2009), making this technique an ideal tool for assessing in real time how they process discourse particles. Detailed recording of fixation patterns and reading times allows not only for the quantification of differences compared to normotypical readers, but also for the identification of possible compensatory mechanisms employed by patients with SCD.

Ethical considerations

The study was approved by the Bioethics Committee of the University of Panama (CBUP). Participants were informed in detail about the objectives and procedures of the research. They then signed an informed consent form before participating in the experiment. The Panamanian Association for the Prevention of Sickle Cell Anemia endorsed the study and facilitated contact with patients. In addition, the complete anonymization of all personal and clinical information was guaranteed during the data collection, analysis, and storage process.

RESULTS AND DISCUSSION

This section focuses on the results and comparative analysis of the discourse particles "por ello" and "incluso" and their impact on total reading time (TRT) and first reading time (FRT) in people with SCD. Tables 2 and 3 summarize the average values of TRT and FRT, respectively, differentiated according to the presence or absence of the discourse particles in the statements.

Table 2.
Total reading time (TRT) for statements with and without the particle

Group	Condition	TRT (ms)	Difference (%)
Normo-typical	With DP	225.96 (40.1)	-11.31%
	Without DP	254.77 (47.3)	
ECF	With DP	702.22 (145.6)	53.76%
	Without DP	456.70 (94.2)	

Table 2 shows the total reading times (TRT) for statements with and without the particle "therefore" in both groups of participants. Normative speakers exhibit an 11.31% reduction in TRT when the particle is present (M = 225.96 ms, SD = 40.1) compared to its absence (M = 254.77 ms, SD = 47.3). This pattern suggests a typical facilitating effect of the causal marker. In contrast, participants with SCD show a significant increase of 53.76% in TRT with the presence of the particle (M = 702.22 ms, SD = 145.6) versus its absence (M = 456.70 ms, SD = 94.2), indicating a significant difference in causal marker processing that could be attributed to the cognitive impairment associated with SCD.

T**able 3.**
Total reading time (TRT) for statements with and without the particle "even"

Group	Condition	TRT (ms)	Difference (%)
Normo-typical	With DP	243.46 (45.2)	3.80%
	Without DP	234.55 (42.8)	
ECF	With DP	476.41 (98.7)	-6.47%
	Without DP	509.37 (105.3)	

Table 3 presents the TRTs for statements with and without the particle "even." Normotypical individuals show a minimal difference, with a slight increase of 3.80% in the presence of the marker (M = 243.46 ms, SD = 45.2) compared to its absence (M = 234.55 ms, SD = 42.8). Speakers with SCD show a moderate reduction of 6.47% with the presence of the marker (M = 476.41 ms, SD = 98.7) versus its absence (M = 509.37 ms, SD = 105.3). These results suggest that the processing of the focal operator "even" shows an opposite trend in patients with SCD, although with lower processing times than in normotypical speakers.

Table 4 examines the first reading time (FPRT) for the member marked with "therefore." Normotypical speakers show an 11.78% reduction in FPRT with the presence of the marker (M = 209.51 ms, SD = 38.5) compared to its absence (M = 237.48 ms, SD = 43.6). Notably, individuals with SCD exhibit a more pronounced reduction of 48.55% in FPRT when the marker is present (M = 233.32 ms, SD = 48.3) versus its absence (M = 453.46 ms, SD = 93.8). This finding suggests that, during initial processing, the causal marker maintains its facilitating function in patients with SCD, even more pronouncedly than in normotypical individuals.

Table 4.
First reading time (FPRT) for the member marked with "therefore"

Group	Condition	FPRT (ms)	Difference (%)
Normotypical	With DP	209.51 (38.5)	-11.78%
	Without DP	237.48 (43.6)	
SCD	With DP	233.32 (48.3)	-48.55%
	Without DP	453.46 (93.8)	

Table 5.
First reading time (FPRT) for the member marked/ focused with "even"

Group	Condition	FPRT (ms)	Difference (%)
Normo-typical	With DP	182.23 (33.5)	-5.48%
	Without DP	192.79 (35.4)	
SCD	With DP	436.46 (90.2)	-24.27%
	Without DP	576.36 (119.1)	

The results presented show greater variability in reading times (TRT and FPRT) in the group of people with SCD compared to the normotypical group, as indicated by higher SDs in all conditions for participants with SCD. For example, in Table 2, speakers with SCD show a standard deviation of 145.6 ms in the presence of the particle "por ello" (compared to 40.1 ms in normotypical speakers) and 94.2 ms in its absence (compared to 47.3 ms in normotypical individuals). This pattern suggests that the processing of utterances with and without discourse markers is less consistent among individuals with SCD.

This higher variability in reading times could be associated with the cognitive impairment characteristic of SCD, which affects linguistic processing ability and therefore results in greater fluctuation in processing costs. This finding is consistent with the difference observed among the groups: while the normotypical group shows a more homogeneous and consistent pattern in reading times, the SCD group shows longer and more heterogeneous processing times.

Taken together, these results reveal a complex pattern in the processing of discourse markers in patients with FSC. While initial processing (FPRT) shows preservation and even intensification of the facilitating effects for both "therefore" and "even", global processing (TRT) shows divergent patterns: a reversal of the facilitating effect for "therefore" and relative preservation for "even." These differences suggest that cognitive impairment associated with SCD differentially affects the processing of different types of discourse markers, possibly due to the different cognitive demands that each type of marker places on the linguistic processing system.

The results of this study reveal complex patterns in the processing of discourse particles (DP) in speakers with SCD compared to normotypical speakers. These findings allow us to examine how the cognitive impairment associated with SCD may affect the fundamental principles of discourse marking and, by extension, key aspects of communicative competence.

Impact on Principle I: Qualitative modification of processing

The results of the study indicate that Principle I of discourse marking manifests itself in an altered form in the SCD group. While in the normotypical group discourse particles generally facilitate processing (evidenced by reduced reading times), in the SCD group we observe mixed and, in some cases, opposite patterns.

For "therefore," the significant increase in reading time in the SCD group (53.76%) contrasts sharply with the reduction observed in the normotypical group (-11.31%). This pattern suggests that, far from facilitating processing, the presence of this argumentative particle could be imposing an additional cognitive load on speakers with SCD. One possible explanation is that the cognitive impairment associated with SCD could be affecting these speakers' ability to quickly integrate the causal information signaled by "therefore."

In the case of "even," although the differences were less pronounced, we also observed a divergent pattern between the groups. The slight reduction in reading time in the SCD group (-6.47%) compared to the increase in normotypical speakers (3.80%) could indicate different processing strategies. It is possible that speakers with SCD are processing "even" in a more superficial way, without fully grasping its scalar function, resulting in shorter reading times but potentially less profound comprehension.

Alterations in Principle II: Control of the cognitive effort

The results related to Principle II suggest that the ability of discourse particles to limit cognitive effort is compromised in the SCD group. This is particularly evident in the case of "por ello" (therefore), where the presence of the particle significantly increased processing time in the SCD group, contrary to what was observed in the normotypical group.

This reversal of the expected effect could indicate that speakers with SCD, although they recognize "por ello" as a marking mechanism, find its processing more costly. This could be due to difficulties in integrating causal information or maintaining discursive coherence, cognitive functions that could be affected by SCD.

For "even," although we observed a slight reduction in processing time in the SCD group, the magnitude of this reduction was smaller than that observed for "therefore" in normotypical individuals. This suggests that, while "even" does not appear to impose an additional cognitive burden on speakers with SCD, it also does not appear to provide the same level of facilitation observed in normotypical speakers with other particles.

Partial preservation of Principle III: Immediacy of local regulation

The results related to Principle III suggest that this aspect of discourse marking could be relatively preserved in the SCD group. Both groups compared showed a reduction in the first reading time of the marked member, indicating that the immediate local regulatory function of discourse particles is maintained.

However, it is crucial to note that the magnitude of this effect was considerably greater in the SCD group, especially for this reason (-48.55% vs. -11.78% in the normotypical group). This marked difference could indicate less deep, or more superficial, processing in the SCD group. It is possible that these speakers are using particles as cues to move quickly through the text, without fully processing their semantic content or discursive function.

Furthermore, the greater variability observed in reading times in the SCD group suggests inconsistency in processing that could reflect difficulties in maintaining stable reading strategies, possibly due to fluctuations in attention or working memory associated with SCD.

CONCLUSIONS

The present study has allowed an approach to understanding how cognitive impairment associated with SCD affects the processing of discourse particles, revealing complex patterns that partially confirm our initial hypothesis and provide data on the interaction between cognitive deficit and the principles of discourse marking.

In the first place, the results partially confirm our hypothesis about the alteration of processing patterns in speakers with SCD. However, this alteration did not manifest itself uniformly for both particles studied. While for "therefore" a significant reversal of the facilitating effect was observed (53.76% increase in TRT), for "even" a pattern closer to the norm was maintained (6.47% reduction in TRT). This divergence suggests that the impact of cognitive impairment on discourse processing is selective and depends on the specific nature of each particle.

The first reading time (FPRT) data reveal a particularly interesting finding that was not anticipated in the initial hypothesis: the preservation and even intensification of the facilitating effect in early processing for both particles in the SCD group (-48.55% for "therefore" and -24.27% for "even"). This phenomenon suggests that the initial processing mechanisms of discourse particles remain relatively intact, despite overall cognitive decline.

The higher variability in reading times observed in the SCD group (reflected in consistently higher standard deviations) indicates heterogeneity in processing that could be attributed to fluctuations in the cognitive abilities characteristic of SCD. This finding could have important implications for understanding how cognitive impairment affects the stability of linguistic processing.

In relation to the principles of discursive marking, we can conclude that:

1) Principle I (qualitative modification of processing) remains unchanged, although in an altered form, manifesting itself differently depending on the type of particle.

2) Principle II (control of cognitive effort) shows considerable impairment, especially in the global processing of "therefore," suggesting that SCD impacts the ability of particles to optimize the cognitive effort.

3) Principle III (immediacy of local regulation) shows remarkable preservation, especially in the early stages of processing, although possibly at the expense of more superficial processing.

Finally, it is important to note that, while this study provides interesting evidence on the differential processing of discourse particles in speakers with ECF, its findings should be considered a first approximation of a complex phenomenon that requires further exploration.

Contribution to knowledge

These findings contribute to understanding the differential behavior of argumentative and focal markers in populations with cognitive impairment. Complementarily, they expand knowledge about their procedural function in contexts of neurological vulnerability. In disciplinary terms, it enriches the field of clinical linguistics by demonstrating how procedural instructions for different types of markers are compromised by cognitive impairment. These contributions may guide future research in experimental linguistics, clinical linguistics, and neuropragmatics.

Limitations

The absence of a control group is acknowledged, requiring the results to be compared with previously published data from normotypical speakers. Furthermore, the experimental design focused exclusively on self-controlled reading, excluding other modes of discourse processing, suggesting the need to expand future research to more diverse communicative contexts.

Author's contribution

Linier E. Escobar Samaniego: Conceptualization, Formal analysis, Research, Methodology, Supervision, Validation, Writing – Original draft, Writing – Review and editing.

Conflicts of interest

There are no conflicts of interest that have influenced the design, development, analysis, or publication of this study. Nor was any external sponsorship or financial support received that could have influenced the results or their interpretation.

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