

## Action language deficit: Preclinic sign of Parkinson's? Literature review

### *Déficit en el lenguaje de acción ¿Un signo preclínico de Parkinson? Revisión bibliográfica*

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#### ABSTRACT

Parkinson's disease (PD) is a late-diagnosed neurodegenerative condition, sometimes present almost a decade before its confirmation. It is characterized by involuntary movements such as tremor, slowness, rigidity and loss of postural control related to dopamine depletion in the substantia nigra. In addition to motor symptoms, there are complications with the autonomic system, and neuropsychological symptoms such as depression or cognitive alterations, including deficiency in verbal fluency. Aligned with the embodiment theory and the concept of motor cognition -where cognition is linked to action- some researchers have specifically observed a deficit in action language (ALD) in movement disorders such as PD and suggest that this could be a preclinical sign of PD. This review aimed to present an overview of a set of publications on DLA in Spanish and English between 2013 and 2023, and to analyze whether there is a dominant position on the topic. Through the PRISMA model, 3 databases were explored: Scopus, PubMed and Web of Science. After applying the inclusion criteria, 25 publications were obtained. Most of them supported the DLA, but other experiments -also included- could not replicate the success. The main challenges seem to be the standardization and adaptation of tests to different languages. It was concluded that there is a majority of publications supporting this deficit in PD but it is not yet recommended to consider it as a preclinical sign in the diagnosis.

**Keywords:** Parkinson, action language, review, embodied cognition, embodiment.

#### RESUMEN

La enfermedad de Parkinson es una afección neurodegenerativa de tardío diagnóstico, a veces presente casi una década antes de su confirmación. Se caracteriza por movimientos involuntarios como temblor, lentitud, rigidez y pérdida del control postural relacionada con la depleción de dopamina en la sustancia nigra. A los síntomas motores se suman complicaciones con el sistema autónomo, y síntomas neuropsicológicos como depresión o alteraciones cognitivas, entre ellas la deficiencia en la fluidez verbal. Alineados con la teoría del *embodiment* y el concepto de la cognición motora

—donde la cognición está ligada a la acción— algunos investigadores han observado específicamente un déficit en el lenguaje de acción en desórdenes del movimiento como la EP y plantean que este podría ser un signo preclínico de la EP. Esta revisión se planteó el objetivo de presentar una visión de un conjunto de publicaciones sobre el DLA en español e inglés entre 2013 y 2023, y analizar si hay una postura dominante sobre el tema. A través del modelo PRISMA, se exploraron 3 bases de datos: Scopus, PubMed y Web of Science. Tras aplicar los criterios de inclusión— se obtuvieron 25 publicaciones. La mayoría sustentó el DLA, pero otros experimentos —también incluidos—no pudieron replicar el éxito. Los principales desafíos parecen ser la estandarización y adaptación de tests a distintos idiomas. Se concluyó que existe una mayoría de publicaciones que sustentan este déficit en la EP pero todavía no se recomienda considerarlo un signo preclínico en el diagnóstico.

**Palabras clave:** Parkinson, lenguaje de acción, revisión, cognición corporizada, *embodiment*.

#### INTRODUCTION

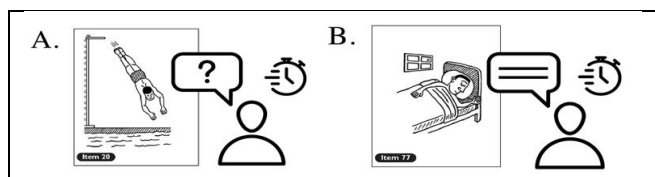
According to the World Health Organization (WHO, 2022), disability and death from Parkinson's disease (PD) are increasing faster than any other neurological disorder. This condition stands out in a worrying and growing way among the most common chronic neurological problems, which has led to talk of the "Parkinson's pandemic" (Dorsey et al., 2018). Its diagnosis is usually late, since when confirmed, it has generally been latent for up to a decade without being detected.

The most visible motor symptoms include tremor at rest, bradykinesia (slowing of movements), stiffness in the limbs, freezing of gait, problems initiating walking, imbalance and dyskinetic movements (abnormal and involuntary).

In addition to motor symptoms, there are complications with the autonomic system such as intestinal problems and sleep disturbances, and neuropsychological symptoms such as depression, anxiety and cognitive alterations such as loss of verbal fluency also appear (Gianelli et al., 2021). Some researchers postulate that, in PD, verbal fluency is markedly presented through an action language deficit (ALD), a cognitive domain that critically involves motor brain networks (Suárez-García et al., 2021).

The DLA approach is aligned with embodiment theory and its derivative concept of motor cognition (MC), which encompasses the notion that cognition is embedded in action and that the motor system is involved in mental processing (Sommerville and Decety, 2006). Thus, the recruitment of the motor system would be necessary to process linguistic material that expresses motor content, to which is added the hypothesis that the expression and recognition mechanisms would be caused by the same underlying mechanism, and that emotional deficiencies are linked to motor deficiencies (Gallezot et al., 2022). Consequently, an alteration of the motor system— not only in people with PD as is the central theme of this work—should affect the ability to process linguistic elements with motor content (Buccino et al., 2018).

**Figure 1.** Action Language Deficit DLA



*Note.* This figure represents responses to two visual stimuli: A) The person being evaluated is asked to name the activity he or she is observing; if he or she has DLA, he or she responds more slowly when the image represents a higher action activity, such as “jumping” compared to B) when the image shows a lower action activity, such as “sleeping”. This example is not the only way to evaluate a person with DLA. Source of the slides: Object and Action Naming Battery by Judit Druks. Figure created by the authors.

Among the hypotheses to explain the underlying mechanisms of CM is neuronal exploitation and reuse. Gallese and Cuccio (2018) postulate that the evolution of the nervous system could have experienced an efficient reuse of networks when it was differentiating itself from other mammals. If, in an evolutionary leap of homo sapiens, the tail was discarded, for example, the corresponding neuronal network could have been reused to share it with language, redesigning itself to fulfill motor and cognitive functions. Because action and language are linked, these authors explain that the meaning given to a word or phrase depends on the context and the experience of the body. For example, the verb to cut is different depending on the context: to cut bread vs. to cut grass. Thus, the abstraction of mental concepts is influenced by experience with the world. Thus, the Italian expression “to cut the rope” (an action with the hands) depending on the idiomatic context can metaphorically mean to run away (an action with the feet). The metaphor of movement and action permeates everyday life, say Lakoff and Johnson (1980), who defend the embodiment not only of language but also of thought.

Among the theories that oppose embodiment are cognitivism, intellectualism, computational functionalism, realism and Cartesian dualism. In the face of this debate, comes the concept of enaction (Varela et al., 1997) that rejects both realism and idealism: it is not that the world is one for everyone (external approach) nor that everything comes from the mind of the person who perceives it (internal approach): enaction proposes a middle point where the world and the person who perceives it define each other reciprocally, a position that is advocated in this work.

We can see embodiment and CM as philosophical debates that, when transferred to the neuropsychological field, invite us in this work to try to answer the question of whether there is a marked DLA in people with Parkinson's that supports the embodiment theory.

## METHODOLOGY

The methodological format for this research is a bibliographic review whose questions have been guided by the paradigm that in the human nervous system there are neural networks that share motor and linguistic domains, and that when the networks deteriorate, performance in both domains is affected, as explained by some research on DLA in people with PD.

The review questions were:

- Among the selected sample of articles, is there a majority of studies that support the paradigm that DLA is marked within the alterations of verbal fluency in PD?
- Can DLA be considered a preclinical sign in the diagnosis of PD?

## Search for publications

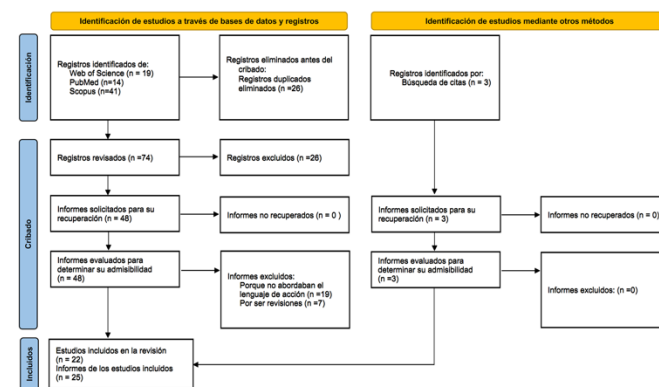
Articles published in English and Spanish between September 2013 and September 2023 were searched in the Scopus, PubMed and Web of Science (WOS) databases that included the search criteria (Table 1).

**Table 1.** Search criteria

Areas “Neuroscience” OR “Experimental Psychology”
[language OR “action-verb*” OR fluency OR semantic]
AND [detect* OR test OR asses OR evalua* OR selective]
AND [parkinson OR neurodegenerative OR “movement disorders”]
AND [embod* OR corpus OR naturalistic]

The search of databases and registries yielded a total of 76 results: 41 articles in Scopus, 14 in PubMed, and 21 in Web of Science (WOS). Twenty-seven duplicates were removed, leaving 49 articles. After reading the abstract of each publication, 19 articles that did not independently assess DLA in PD were excluded, leaving a subtotal of 30. Using direct citation identification, 2 more records were added, reaching a final total of 32 articles. Of these, 7 literature review articles were excluded, resulting in 25 research articles. The flow followed in the final selection process is illustrated in Figure 2.

**Figure 2.** PRISMA flowchart



## Data collection process

The data were collected in a matrix organized by columns of: record identification, DOI, year, author(s), title of the publication, type of publication, country, abstract, evaluation instrument, language of the evaluation, result and conclusion. Each article was subsequently read, analyzed, synthesized and the columns of: Supports the DLA (pro, neutral or con) were added to the matrix.

## RESULTS

This review aimed to identify whether there was a majority of publications supporting DLA and whether this

alteration could become a preclinical marker for the diagnosis of PD. Before answering the research questions, a general summary of the records is presented.

**Table 2.** Publications per year

Year	Quantity	Identificación
2013	2	E01, E02
2016	2	E03, E04
2017	4	E05, E06, E07, E08
2018	3	E09, E10, E11
2019	3	E12, E13, E14
2020	2	E15, E16
2021	3	E17, E18, E19
2022	4	E20, E21, E22, E23
2023	2	E24, E25

Note. This table shows that most of the studies were published in 2017 and 2022, N=4 under the same conditions.

**Table 3.** Publications per country

Country	Quantity	Identificación
USA	7	E01, E02, E07, E10, E13, E18, E24
Colombia	6	E04, E05, E09, E16, E17, E21
Argentina	2	E08, E22
Italy	2	E12, E23
Australia	1	E14
Belgium	1	E15
Brazil	1	E06
Denmark	1	E25
Spain	1	E19
United Kingdom	1	E03
Türkiye	1	E11
Uruguay	1	E20

Note. This table shows that most of the studies were published in the USA N=7, followed by Colombia N=6, and Argentina and Italy in the same conditions N=2. Publications from other countries do not have a relevant weight.

**Table 4.** Publications by assessment language

Language of assessment	Amount	Identificación
Spanish	10	E04, E05, E08, E09, E16, E17, E19, E20, E21, E22
English	9	E01, E02, E03, E07, E10, E12, E13, E14, E24
German	1	E18
Danish	1	E25
Dutch	1	E15
Italian	1	E23
Portuguese	1	E06
Turkish	1	E11

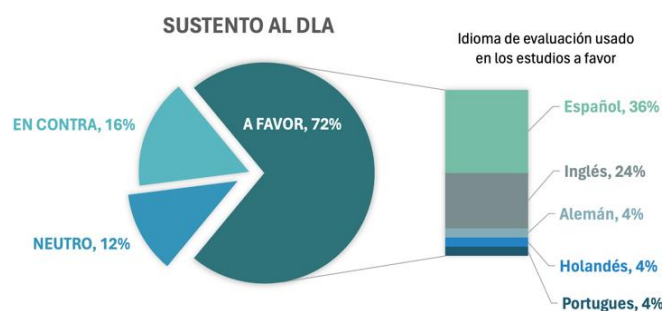
Note. This table shows that most of the studies used Spanish for their evaluations N=12, followed by English N=11 and the mixed ones that, being reviews, could also include studies in Spanish and English.

**Table 5.** Publications according to the dominant position regarding the DLA

Position	Quantity	Identificación
In favor	18	E01, E03, E04, E05, E06, E07, E08, E09, E10, E12, E15, E17, E18, E19, E20, E21, E22, E24
Against	4	E02, E11, E23, E25
Neutral	3	E13, E14, E16

Note. This table shows a larger number of studies N=18 with a dominant position in favor of DLA. }

**Figure 3.** Publications supporting the DLA



Note. This figure shows a 72% majority of articles that support the DLA; 16% do not report support for the DLA; and 12% remain neutral. To the right of the graph, the breakdown of languages used in the evaluations that came out in favor can be seen, with Spanish and English obtaining majorities of 36% and 24% respectively.

Among all the reviewed articles, it was found that a majority, 72%, reported results in favor of the DLA. It is interesting to note that half of these articles (36% of 72%) used Spanish for the assessments, as illustrated in Figure 3. On the other hand, the studies opposing the DLA administered the tests in several languages, including English (E02), Turkish (E11), Danish (E25) and Italian (E23).

## DISCUSSION

The methodologies used in these studies to assess the semantics of actions are varied, and include: the picture matching task [Semantic Association Task, SAT] (Aiello et al., 2022); the phonemic version of the standard German verbal fluency task, Regensburger Wortflüssigkeitstest (Klostermann et al., 2022; Wolff et al., 2021); the picture-word association task (PWA) with action-verb and object-substance conditions (Suárez-García et al., 2021); storytelling tasks and automatic recognition of language components (Eyigöz et al., 2020); the metaphor comprehension task, with button-grab responses (Humphries et al., 2019); the Pyramids and Palms Test (PPT) and the Kissing and Dancing Test (KDT); Verbal fluency for verbs (action fluency), verb naming task, subtest of the Cambridge Semantic Memory Battery; (Salmazo-Silva et al., 2017) ; fMRI scans of PD versus controls (Abrevaya et al., 2017); Experimental protocol with a baseline session and a reading session (Nisticò et al., 2019); Computer naming task: reading + picture with timing and voice recording (Muñoz-Salgado and Del Río, 2021). Two investigations use the phonemic version of the standard German verbal fluency task, Regensburger

Wortflüssigkeitstest, and others refer to the Object and Action Naming Battery used by Bocanegra (2017) .

The structure of the questions in the evaluative tasks is varied. For example, Wolff et al. (2021) categorized the questions according to (i) general movement, (ii) movement of one's own body, (iii) movement of objects, and (iv) movement of other beings. Thus, in response to questions about the ecological validity of the tasks, there are narrative modalities such as that of the team of Eyigoz et al. (2020).

A limitation observed in this sample of studies was the impossibility of applying unified tests. The contradictory findings in this work could be explained by the concentration of research carried out by the same authors in a Spanish-speaking population (Colombia and Argentina), which could unbalance the objectivity of the postulate, suggesting that the tests that work are only suitable for the semantics of Spanish. However, a more feasible explanation would be that the morphological pattern (including linguistic and tonal differences) may be distinctively affected in PD depending on the patient's mother tongue, as well as under ecological testing conditions (E16). Therefore, this preclinical marker could be useful only in the populations studied. Cultural relativity does not rule out embodiment theory, but rather reinforces enaction, where the world and the person who perceives it define each other reciprocally (Varela et al., 1997).

The opposition to embodiment, such as Cartesian dualism, has ignored and underestimated the involvement of the body in mental processes, arguing that mental phenomena are not physical and therefore not influenced by the body. However, research continues, such as that of Cervetto et al. (2022), who reported improvements in DLA after an intervention with physical exercise and video games. Although this intervention was not carried out on people with PD, it offers an interesting example of alternative therapies that could be applied to this population.

## CONCLUSIONS

The selected sample shows that most studies support the paradigm that DLA is prominent among verbal fluency disorders in PD. However, the heterogeneity in the types of tests used and the results obtained make it difficult to identify consistent relationships.

Motor cognition and the alteration of the semantics of actions in PD constitute a theoretical model that is still controversial. It would be necessary to standardize the tasks, adjust the ecological validity and successfully replicate new studies to incorporate the alteration of DLA in the diagnosis of parkinsonian syndromes, so that the use of DLA as a preclinical sign in the diagnosis of PD is accurate.

## REFERENCES

- Abrevaya, S., Sedeño, L., Fitipaldi, S., Pineda, D., Lopera, F., Buritica, O., Villegas, A., Bustamante, C., Gomez, D., Trujillo, N., Pautassi, R., Ibáñez, A., & García, A. M. (2017). The Road Less Traveled: Alternative Pathways for Action-Verb Processing in Parkinson's Disease. *Journal of Alzheimer's Disease*, 55(4), 1429–1435. <https://doi.org/10.3233/JAD-160737>
- Aiello, E., Grosso, M., Di Liberto, A., Andriulo, A., Buscone, S., Caracciolo, C., Ottobrini, M., & Luzzatti, C. (2022). Disembodying language: Actionality does not account for

verb processing deficits in Parkinson's disease. *Journal of Neurolinguistics*, 61.

<https://doi.org/10.1016/j.jneuroling.2021.101040>

- Bocanegra, Y., García, A., Lopera, F., Pineda, D., Baena, A., Ospina, P., Alzate, D., Buritica, O., Moreno, L., Ibáñez, A., & Cuetos, F. (2017). Unspeakable motion: Selective action-verb impairments in Parkinson's disease patients without mild cognitive impairment. *Brain and Language*, 168, 37–46. <https://doi.org/10.1016/j.bandl.2017.01.005>
- Buccino, G., Dalla Volta, R., Arabia, G., Morelli, M., Chiriaco, C., Lupo, A., Silipo, F., & Quattrone, A. (2018). Processing graspable object images and their nouns is impaired in Parkinson's disease patients. *Cortex*, 100, 32–39. <https://doi.org/10.1016/j.cortex.2017.03.009>
- Cervetto, S., Birba, A., Pérez, G., Amoroso, L., & García, A. M. (2022). Body into Narrative: Behavioral and Neurophysiological Signatures of Action Text Processing After Ecological Motor Training. *Neuroscience*, 507, 52–63. <https://doi.org/10.1016/J.NEUROSCIENCE.2022.10.024>
- Dorsey, E., Sherer, T., Okun, M., & Bloem, B. (2018). The Emerging Evidence of the Parkinson Pandemic. *Journal of Parkinson's Disease*, 8(Suppl 1), S3. <https://doi.org/10.3233/JPD-181474>
- Eyigoz, E., Courson, M., Sedeño, L., Rogg, K., Orozco-Arroyave, J. R., Nöth, E., Skodda, S., Trujillo, N., Rodríguez, M., Rusz, J., Muñoz, E., Cardona, J. F., Herrera, E., Hesse, E., Ibáñez, A., Cecchi, G., & García, A. M. (2020). From discourse to pathology: Automatic identification of Parkinson's disease patients via morphological measures across three languages. *Cortex*, 132, 191–205. <https://doi.org/10.1016/j.cortex.2020.08.020>
- Gallese, V. y Cuccio, V. (2018). The neural exploitation hypothesis and its implications for an embodied approach to language and cognition: Insights from the study of action verbs processing and motor disorders in Parkinson's disease. *Cortex*, 100, 215–225. <https://doi.org/10.1016/j.cortex.2018.01.010>
- Gallezot, C., Riad, R., Titeux, H., Lemoine, L., Montillot, J., Sliwinski, A., Hamet Bagnou, J., Cao, X., Youssouf, K., Dupoux, E., & Levi, A. (2022). *Emotion expression through spoken language in Huntington disease*. <https://doi.org/10.1016/j.cortex.2022.05.024>
- Gianelli, C., Maiocchi, C., & Canessa, N. (2021). Action Fluency in Parkinson's Disease: A Mini-Review and Viewpoint. *Frontiers in Aging Neuroscience*, 13, 806. <https://doi.org/10.3389/FNAGI.2021.778429/BIBTEX>
- Humphries, S., Klooster, N., Cardillo, E., Weintraub, D., Rick, J., & Chatterjee, A. (2019). From action to abstraction: The sensorimotor grounding of metaphor in Parkinson's disease. *Cortex*, 121, 362–384. <https://doi.org/10.1016/j.cortex.2019.09.005>
- Klostermann, F., Wyrobnik, M., Boll, M., Ehlen, F., & Tiedt, H. (2022). Tracing embodied word production in persons with Parkinson's disease in distinct motor conditions. *Scientific Reports*, 12(1), 16669. <https://doi.org/10.1038/s41598-022-21106-6>
- Lakoff, George., & Johnson, M. (1980). *Metaphors we live by*. University of Chicago Press.
- Muñoz-Salgado, M., & Del Río, D. (2021). Denominación de objetos y acciones en un contexto oracional en personas con enfermedad de Parkinson sin demencia. *Revista de Neurología*, 72(7), 223–230. <https://doi.org/10.33588/rn.7207.2020561>
- Nisticò, R., Cerasa, A., Olivadese, G., Dalla Volta, R., Crasà, M., Vasta, R., Gramigna, V., Vescio, B., Barbagallo, G., Chiriaco, C., Quattrone, A., Salsone, M., Novellino, F., Arabia, G., Nicoletti, G., Morelli, M., & Quattrone, A. (2019). The embodiment of language in tremor-dominant

- Parkinson's disease patients. *Brain and Cognition*, 135.  
<https://doi.org/10.1016/j.bandc.2019.103586>
- Salmazo, H., Parente, M., Rocha, M., Baradel, R., Cravo, A., Sato, J., Godinho, F., & Carthery-Goulart, M. (2017). Lexical-retrieval and semantic memory in Parkinson's disease: The question of noun and verb dissociation. *Brain and Language*, 165, 10–20.  
<https://doi.org/10.1016/j.bandl.2016.10.006>
- Sommerville, J., & Decety, J. (2006). Weaving the fabric of social interaction: Articulating developmental psychology and cognitive neuroscience in the domain of motor cognition. *Psychonomic Bulletin & Review* 2006 13:2, 13(2), 179–200. <https://doi.org/10.3758/BF03193831>
- Suárez, D., Birba, A., Zimerman, M., Diazgranados, J., Da Cunha, P., Ibáñez, A., Grisales, J., Cardona, J., & García, A. (2021). Rekindling action language: A neuromodulatory study on parkinson's disease patients. *Brain Sciences*, 11(7).  
<https://doi.org/10.3390/brainsci11070887>
- Varela, F., Thompson, E., & Rosch, E. (1997). De cuerpo presente: Las ciencias cognitivas y la experiencia humana. In *Euridicente*. Gedisa.
- WHO. (2022, June 13). *Parkinson disease*. Newsroom .  
<https://www.who.int/news-room/fact-sheets/detail/parkinson-disease>
- Wolff, L., Benge, J. F., Ortiz-Hernandez, S., Beevers, S., Armitage, A., Park, J., & Drane, D. L. (2021). Apathy and actions-another consideration when theorizing about embodied nature of language in Parkinson's disease. *Journal of Communication Disorders*, 93.  
<https://doi.org/10.1016/j.jcomdis.2021.106144>