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Article

Comparative Study of the Development of EFs in Children: Transition from the First Cycle to the Second Cycle of Early Childhood Education

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Abstract: *Antecedents.* EFs (EFs) are the basis for establishing a goal and working towards that goal by coordinating thoughts and actions. EFs are fundamental to several aspects of daily life, specifically for academic performance. *Aim.* To analyze and compare the development of EFs in the transition period between the first and second cycles of Early Childhood Education. *Methodology.* Non-experimental methodology, ex post facto design, descriptive, cross-sectional evolution study. *Participants.* Preschoolers of different educational levels (first and second cycle of Infant Education). In this study the participants have been evaluated by different informants: 54.42% by parents and 45.58% by teachers. In relation to gender, 52.65% were male and 47.35% were female. In relation to age, 37.54% had a range of 2-3 years and 62.46% had a range of 4-5 years. *Measurement.* Instrument development of EFs were evaluated using BRIEF-P by key informants. *Results*. Preschoolers in the first cycle show significantly higher scores than preschoolers in the second cycle in BRIEP-P. *Conclusions.* The development of EF is key in these first key moments, having a special impact on later development and academic performance. It is necessary to work on EFs from the first cycle of Early Childhood Education, considering the evolutionary development of EFs.

Keywords: BRIEF-P™; development; early childhood education; EFs; parents; teachers

1. Introduction

Garon, Bryson, & Smith (2008) [1] consider that development of the brain involves a process of continuous construction, organisation and re-structuring of the connections of the brain in response to the input of the environment, thus producing in parallel an increase in the complexity of mental structures. These changes can be associated with and linked to the development of EFs (Miyake, Friedman, Emerson, Witzkim Howerter, & Wager, 2000) [2].

1.1. Dimensions and Development of EFs in Early Childhood

EFs (EFs) are the basis of the ability to set a goal and then work towards that goal, while coordinating thoughts and actions [3]. EFs are, therefore, fundamental to various aspects of daily life, such as mental and physical health, academic success and success in daily living, long with social and psychological development [4]. They include diverse dimensions, such as, cognitive flexibility, inhibitory control and working memory [5–7] for the functioning of the human being in society.

EFs include processes that involve intentionality in the control of other processes, such as impulse control, attention, thought and behaviour [2,8].

For Lezak [9], EFs are essential mental capacities for carrying out effective, creative and socially adapted behaviour. Sohlberg & Mateer [10] consider that EFs cover a series of cognitive processes, among which are anticipation, selection of objectives, planning, behaviour selection, self-regulation, self-control and the use of feedback. Tirapu [11], for example, focuses on predicting the consequences that can lead us to anticipated solutions. Funahashi (2001) [12] postulates that they are the result of

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the coordination of the processes which are necessary to meet a particular objective in a flexible way. Zelazo [13] focuses on the self-regulation skills involved in achieving a goal, that are modulated by thinking and emotion, while basically differentiating between executive and motivational executive processes or "hot EFs" and purely cognitive aspects or "cool EFs".

We can say that the "EFs" construct does not really constitute a unitary concept, just like the prefrontal cortex, which area considered as the neuropsychological substrate of EFs.

In relation to the number of dimensions that constitute the EFs throughout the development in these first stages, the results are contradictory and inconclusive. According to Monette, Bigras, & Lafrenière [14], the results being more consistent at 3 years than at 4 - 5 years of age [15,16].

A solution with three factors implies a greater differentiation of dimensions, which would be the most appropriate for older children, between the ages of 8 and 13 years, for example [17] or 15 years of age [18].

Other studies point to the configuration of EFs by two factors for children aged 3 to 5 years [19] or 5 to 13 years [18].

Thus, some studies support a single factor for 5-year-old children [16], in the age ranges of 2.5 to 6 years [20] and 7 to 9 years [21]. Brydges, Fox, Reid, & Anderson [21] reviewed the body of literature and suggest that the solution of a single factor is the most appropriate for children under 9 years of age.

Dimensions that configure the executive function have been studied during the preschool stage using different techniques, mainly factorial analysis, that allows us to know the degree of dependence-independence of the executive function, by studying the construct underlying it [14,22,23].

There is growing evidence that EFs are key to academic success and key as a predictor of the development of academic skills [24–30].

Empirical studies of typical development show that EFs test performance increases at between 3 and 6 years of age [16,31].

The development of EFs is a crucial aspect of cognitive growth in children, especially during the early years of life. These skills, which include working memory, inhibitory control, and cognitive flexibility, play a fundamental role in children's ability to plan, solve problems, and regulate their behavior. In the context of Early Childhood Education, analyzing the development of these functions can provide valuable insights into how children progress through different educational stages.

1.2. Evolution of Cognitive and Social Development Across Early Childhood Education Cycles

In terms of cognitive and psychological development, students in the first cycle (ages 0-3) are primarily engaged in sensory exploration and motor activities. Their learning is driven by direct experiences and free play, with a focus on developing basic skills such as fine and gross motor coordination, imitation, and emerging language abilities. At this stage, children are beginning to develop self-regulation and autonomy but still depend heavily on adults for guidance and decision-making. In contrast, during the second cycle (ages 3-6), students begin to acquire more advanced cognitive skills. They develop working memory, sustained attention, and problem-solving abilities. There is also a notable expansion in language use, allowing them to follow complex instructions and express their thoughts and emotions more clearly. Additionally, their capacity for emotional and social regulation improves, and they start engaging in more complex and cooperative social interactions.

The educational environment also evolves significantly between these two cycles. In the first cycle, the learning environment is highly stimulating and designed for safety, with an emphasis on exploration and free play. Educators act as guides, facilitating learning through interactive play. By the second cycle, the environment becomes more structured, incorporating daily routines and organized activities, including guided play and group tasks. The focus shifts toward preparing children for primary school with an introduction to pre-academic skills such as letter and number recognition and the ability to follow instructions and work in groups.

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When considering development and learning expectations, the goals for the first cycle are centered around sensory-motor development, early socialization, and basic language skills. Evaluation during this period is more observational, focusing on progress in these fundamental areas. In the second cycle, learning goals become more formal, aiming at preparing children for primary education. This includes a focus on initial academic skills, understanding basic concepts, and working on structured tasks. Assessment methods become more formal, although still adapted to the child's age, to evaluate cognitive, linguistic, and social development.

Social interaction and behavior change notably between the two cycles. In the first cycle, social interactions are simpler, typically involving imitation and parallel play, with early development in understanding social norms and cooperative play. By the second cycle, children engage in more cooperative and group activities, showing improved understanding and adherence to social rules, as well as enhanced abilities to share and collaborate with peers.

These differences underscore a significant evolution in children's development as they advance from the first to the second cycle of Early Childhood Education, reflecting their cognitive, social, and emotional growth.

The first and second cycles of Early Childhood Education represent key phases in this developmental process. While the first cycle focuses on initial exploration and the acquisition of basic skills, the second cycle is oriented towards a greater consolidation and refinement of these abilities. The transition between these two cycles can be a critical period for the development of EFs, marking a significant change in how children manage their cognitive and emotional skills.

Given the potential impact that this transition may have on the development of EFs, it is essential to investigate how the level of development of these skills varies between children in the first and second stages of Early Childhood Education. Additionally, identifying the differences in development during the transition period between the two cycles is important for better understanding the needs and appropriate supports for children at this crucial stage of their development.

1.3. Aim

We set ourselves the objective of knowing, analyzing and comparing the level of development of the EFs of the infant of the first cycle of Infant Education versus the second cycle, the age of intercycle transition (first versus second).

The transition from the first stage to the second cycle in Early Childhood Education marks several significant changes in the developmental, educational, and behavioral aspects of students. These differences are crucial for understanding how children evolve as they move through these formative years.

How does the level of executive function development in children in the first stage of Early Childhood Education compare to that of children in the second stage, and what differences are observed in the development of these functions during the transition period between the two stages?

2. Materials and Methods

Non-experimental, ex post facto design, descriptive, cross-sectional development study.

2.1. Participants

The typing sample is constituted by 1042 boys and 937 girls who are the participants in the process of adaptation and validation of BRIEF-P (adapted from [32]). The inclusion criteria were to acceptance participation in the study, age range between 2 and 6 years and no signs or indications of any type of neurodevelopmental disorders and/or disability.

In this study the participants have been evaluated by different informants: 54.42% by parents and 45.58% by teachers. In relation to gender, 52.65% were male and 47.35% were female. In relation to age, 37.54% had a range of 2-3 years and 62.46% had a range of 4-5 years.

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Students grouped by education cycle and by age. Table 1 shows the distribution of the participants according to educational cycle.

Table 1. Distribution of participants according to age and educational cycle (own elaboration).

		Parents (n)	Teachers (n)
Educacional cycle	1º Cicle	418	659
	2º Cicle	325	577

Source: BRIEF-P (Spanish adaptation).

2.2. Measurement

Executive function is assessment with BRIEF-P is an instrument that was recently validated in Spain by Bausela and Luque [32] with the aim of evaluating its development through the observation of key informants (teachers or other habitual caregivers of the child) (hetero research, self-investigation).

The BRIEF-P provides scores on various indices (Global Index of Executive Function, Inhibitory Self-Control Index, Flexibility Index, Emergent Metacognition Index) and scales related to EFs (Inhibition, Flexibility, Emotional Control, Working Memory, Planning and Organization).

BRIEF-P was completed by parents, legal guardians and teachers of children with ages from 2 years to 5 years and 11 months who have knowledge of the child for a minimum period of 6 months. The study was carried out using individual and collective applications.

2.3. Analysis of Data

The data were submitted to descriptive and inferential analyses (bivariate and multivariate). It was applied Student's t-test was used to calculate the difference in the scales and clinical indices of BRIEF-P between the two age groups by age and educational cycle.

3. Results

The initial development includes descriptive statistical analyses, followed by inferential analyses.

The difference between 1st cycle versus 2nd cycle students was different depending on the informant: (i) When parents are informants there are no statistically significant differences in Planning and Organization, Inhibitory Self-Control and Emergent Metacognition. In all clinical scales and indices, except in Planning and Organization, scores are higher in 1st cycle participants compared to 2nd cycle participants (see Table 2).

Table 2 and Table 3 shows the distribution of the sample of participants evaluated according to the informants (parents versus teachers) in the two age groups (three years versus four years) and educational cycle (first cycle versus second cycle of Early Childhood Education) that were evaluated.

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Table 2. Distribution of the sample according to the age, educational cycle by informant (parents) (only elaborated).

Clinical Scales / Indices		1º Cicle ECE		2º Cicle ECE	
		M	σ	M	σ
Clinical	Inhibition	23.97	5.589	23.89	5.789
Scales	Flexibility	13.96	3.363	13.17	3.05
	Emotional Control	14.67	3.538	14.36	3.661
	Working Memory	23.75	5.589	23.09	5.479
	Planning and Organisation	14.38	3.002	14.39	3.517
Indices	Inhibitory Autocontrol	38.64	8.417	38.25	8.673
	Flexibility	28.63	5.792	27.53	5.705
	Emergent Metacognition	38.13	8.126	37.48	8.578
	Global Executive Function	90.73	16.58	88.9	17.29

Source: BRIEF-P (Spanish adaptation).

Table 3. Distribution of the sample according to the age group, educational cycle by informant (teachers) (only elaborated).

Clinical Scales / Indices		1º Cicle ECE		2º Cicle ECE	
		M	σ	M	σ
Clinical	Inhibition	22.77	6.255	21.42	6.193
Scales	Flexibility	13.46	3.354	12.26	2.967
	Emotional Control	13.74	3.804	12.8	3.651
	Working Memory	23.64	6.747	21.81	6.015
	Planning and Organisation	13.82	3.919	12.76	3.235
Indices	Inhibitory Autocontrol	36.51	9.183	34.22	9.085
	Flexibility	27.2	6.238	25.06	5.604
	Emergent Metacognition	37.46	10.357	34.57	8.987
	Global Executive Function	87.44	19.278	81.05	17.43

Source: BRIEF-P (Spanish adaptation).

There are statistically significant differences in three clinical scales: Flexibility (t [1075] = 3.94, p = 0.000, d = 0.014), Emotional Control (*t* [1075] = 1.373, *p* = 0.17, *d* = 0.002) and Working Memory (*t* [1075] = 1.915, *p* = 0.056, *d* = 0.003); and in two clinical indexes: Flexibility (*t* [1075] = 3.049, *p* = 0.002, *d* = 0.009) and Global Executive Performance (*t* [1075] = 1.714, *p* = 0.087, *d* = 0.003) (see Table 4). (ii) When teachers are informants, there are statistically significant differences. These differences were found in all clinical scales and indices. In all clinical scales and indices, the scores are higher in participants in the first cycle compared to those in the second cycle (see Table 3). Statistically significant differences are obtained in: (a) Three clinical scales: Inhibition (*t* [900] = 3.127, *p* = 0.000, *d* = 0.000) (*t* [900] = 4.179, *p* = 0.000, *d* = 0.000), Emotional Control (*t* [900] = 3.668, *p* = 0.000, *d* = 0.000) and Planning and Organisation (*t* [900] = 4.381, *p* = 0.000, *d* = 0.000). (b) All clinical indices: Inhibitory Self-Control (*t* [900] = 3.622, *p* = 0.000, *d* = 0.000); Flexibility (t [900] = 5.249, *p* = 0.000, *d* = 0.000); Emergent Metacognition (*t* [900] = 4.377, *p* = 0.000, *d* = 0.000) and Global Executive Function (*t* [900] = 5.08, *p* = 0.000, *d* = 0.000).

Table 4 shows the results of the Levene test of equality of variances prior to the Student's t-test for the equality of means (or medians) of independent samples of the two informants (parents - teachers).

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Table 4. Independent sample test in relation to age (first cycle versus second educational cycle of Early Childhood Education) (version for parents and teachers) (own elaboration).

Executive Function		Parents [a]							Teachers [b]						
		Levene test of equality variances		Student's t-test for the equality of means					Levene test of equality variances		Student's t-test for the equality of means				
		F	Sig. (bilateral)	t	gl	Sig. (bilateral)	Difference in means	d	F	Sig. (bilateral)	t	gl	Sig. (bilateral)	Difference in means	d
Clinical Scales	Inhibition	1.258	.262 n.s.	0.215	1075	.83 n.s.	0.077	0.000	0.115	.734 n.s.	3.127	900	.002**	1.348	0.002
	Flexibility	4.49	.034 *	3.941	1075	.000***	0.782	0.014	12.309	.000 ***	5.565	900	.000***	1.201	0.000
	Emotional Control	0.614	.433 n.s.	1.373	1075	.17**	0.31	0.002	2.626	.105*	3.668	900	.000***	0.943	0.000
	Working Memory	0.005	.941 n.s.	1.915	1075	.056*	0.661	0.003	5.759	.017**	4.179	900	.000***	1.822	0.000
	Planning and Organisation	10.234	.001 ***	-0.047	1075	.962 n.s.	-0.01	0.000	11.969	.001***	4.381	900	.000***	1.062	0.000
Indices	Inhibitory Autocontrol	0.826	.364 n.s	0.726	1075	.468 n.s.	0.389	0.000	0.393	.531n.s.	3.622	900	.000***	2.291	0.000
	Flexibility	0.047	.828 n.s.	3.049	1075	.002**	1.094	0.009	8.272	.004***	5.294	900	.000***	2.144	0.000
	Emergent Metacognition	2.79	.095***	1.239	1075	.216 n.s.	0.651	0.001	6.856	.009***	4.377	900	.000***	2.885	0.000
	Global Executive Function	1.268	.26 n.s.	1.714	1075	.087*	1.824	0.003	3.502	.062*	5.08	900	.000***	6.383	0.000

Source: BRIEF-P (Spanish adaptation). *** ϱ<0.01, ** ϱ<0.05, * ϱ<0.1, N.S. not significant. Parents: 1º cicle= 418 / 2º cicle= 659 Teachers: 1º cicle= 325 / 2º cicle= 577.

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4. Discussion

The objective of the present study was to analyse and compare the development of EFs among schoolchildren who are in the transition period between the first and second cycles of Early Childhood Education, in order to identify the executive dimensions that are developed in this educational period, which will mark the subsequent development and academic performance.

The choice of two groups of schoolchildren with very different ages, we have allowed us to know whether, in these first periods of development, EFs form a segment or set, or whether, on the contrary, the dimensions that make up this construct are already differentiated according to different rhythms in their trajectory.

When the comparison is made using educational cycles, the differences increase in the number of indexes and clinical scales within which there are statistically significant differences, particularly, in the case of parents, having significant differences in: Inhibition, Flexibility (Index and Scale) Emotional Control, Working Memory and Global Executive Composite. In the case of teachers, there are still statistically significant differences between schoolchildren of both cycles at all scales and clinical indexes. It can be affirmed that when the comparison is made by educational level, a greater number of dimensions are obtained in which there are statistically significant differences among school children in order to design intervention programs aimed at the development of EFs in Early Childhood Education.

The results obtained are in line with the results obtained by [15] who allude to the fact that at 3 years of age, more complex executive skills are developed (conflict resolution or active manipulation of information in working memory). At this same age, some 3-year-olds are flexible with respect to their attention in response to the demands of the situation and change, for example, their responses following clear verbal instructions. The foundations of planning and organisational skills have been evidenced in children aged 3 and 4 years [33].

In relation to inhibitory control, the results obtained take on the same direction as those obtained by Pérez, Carboni, & Capila [11] who conclude that in tasks requiring set change (e.g., Wisconsin Card Sorting Test) 3-year-olds are unable to inhibit the mental set in which they are currently engaged and redirect their attentional focus to the new set.

We can consider that the stage between 3 years and 5 years of age is the period in which there is improvement of the processes of memory and inhibitory control that have arisen in early childhood (0-2 years of age). These basic skills will be fully developed in the school year.

Regarding cognitive flexibility, the results also confirm what Diamond [4] pointed out earlier, which began to develop later in the period of 2 years 10 weeks to 3 years of age, showing a significant increase during the school years.

Concerning self-regulation abilities, the data obtained are consistent with what indicates that from 3 years 6 months of age, a new stage is reached in terms of the inhibitory properties of adult speech, which is intended to be the child's own voice as the factor that achieves some voluntary control. This is achieved in children between the ages of 3 and 4 years as during this period the impulsive function of children's speech continues to predominate, although it slowly gives way to a semantic control that in later stages will really be determinant.

Functions of the central executive (inhibitory control, working memory and cognitive flexibility) are especially important in this stage of Early Childhood Education. Conditioning subsequent development and access at the Primary Education stage. At the end of the first cycle of Early Childhood Education, it is expected that the child will be able to initiate skills in logical/mathematical intelligence and in reading/writing, among others.

In relation to the informant, we can state in general terms that parents and teachers are reliable sources for assessing development of EFs in Early Childhood Education. However, there are differences and similarities in their perception of the development of EFs, being in agreement with other authors [34,35]. These results may indicate that, when the teachers are the informants they are more sensitive to development compared to the parents. On the other hand, in children of 3 years of age and of the first cycles present more difficulties in EFs, but these difficulties are reduced in the

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following year as a result of their own neurological maturation and their own educational intervention, that is developed in Infantile Education.

The obtained data indicate that when the informants are the teachers, statistically significant differences are obtained in all scales and clinical indexes of BRIEF-P, both when the comparison is made by educational cycles as well as by chronological age.

When the informants are the parents, statistically significant differences are obtained in a smaller number of scales and clinical indexes of BRIEF-P. Specifically, when the comparison is made by age and the informants are the parents, we obtain differences in scale and clinical index flexibility. When the comparison is made equally by age by teachers, statistically significant differences are obtained in all scales and clinical indexes.

Thus, we researched how to analyse the degree of "sensitivity" that parents and teachers have toward this development, and also to know the variable that has the greater predictive power of the performance of the EFs. The absence of statistically significant differences in the development of EFs in the two age groups (first cycle *versus* second cycle of Early Childhood Education) was hypothesised in this study, since the study dimensions that configure the construct of EFs are interrelated with the first periods of development. Further, it is not easy for observers (parents and teachers) to discriminate whether there is a year of difference between the two groups of participants, when comparing two groups of subjects with very similar ages.

The development of EFs is analysed differently by informants (parents versus teachers), with significant differences between respondents. Thus, when the informants are teachers, statistically significant differences are obtained between the two age groups that are being analysed, whereas when the informants are the parents, there are no statistically significant differences in different clinical scales (Inhibition, and Planning and Organisation) and in clinical indexes (Inhibitory Self-Control, and Emerging Metacognition). The differences found among the observers are in line with the results obtained by other researchers [34–37].

The obtained results allow us to acknowledge the existence of statistically significant differences according to the two age groups that were analysed, when evaluated by both parents and teachers. These data confirm that the different executive dimensions are supported by general neural circuits that mature, and change throughout the life cycle, making it possible to analyse and make comparisons from the first periods of the life cycle. Our data, as well as those provided by other studies [1,38,39] suggest that as the development of typical children progresses, the children are maturing with respect to their executive competencies. This mean that those children are abler to inhibit automatic responses that positively affect their attentional capacity, they are more flexible, they have greater emotional control, are they are more capable of storing and managing information [40], in the field of mathematics [41] and in other fields of study. This typical developmental milestone will allow us to understand the difficulties that some children have in these competences; for example, children with attention deficit hyperactivity disorder ([42,43], children with low birth weight (Anderson, McNamara, Andridge, & Keim, 2015) [44] , children with language disorders [45], learning disabilities [46] or children with autism spectrum disorder [47,48].

We can conclude by affirming that BRIEF-P is an instrument that is sensitive to the development of EFs and it is the informant that interacts with the child, guaranteeing a plural and diverse view depending on the development contexts (home *versus* school) and guarantees ecological validity of the scores. These results are in line with results obtained by other researchers [49] and justify the creation of different scales according to age groups and educational cycle. It is observed that the different dimensions evaluated (Emergent Metacognition, Inhibitory Self-Control, and Flexibility) follow different trajectories, being in line with the approach proposed by several researchers in relation to the EFs topic [4,24,50–52].

These results lead to a need to proffer intervention proposals that are sensitive to these differences in development during the first stage of the life cycle, avoiding consideration of the EFs as a segment or set, since for this first stage evidences of differences in their development have been verified among children of age groups first cycle versus second cycle of Early Childhood Education [3,53]. These results are consistent with neuroimaging studies, which confirm that the maturation of

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neural connections occurs by following a process, from the interconnected local regions to the regions of distributed connectivity, which work as the basis of the same function and this is reflected in the maturation of cognitive abilities [54].

In the case of cognitive flexibility, the data are in line with those data provided by [3], who indicate that flexibility emerges towards the end of the third year of life, being therefore at the border between the two age groups at were analysed.

Also, these results force us to include teachers and parents as evaluation agents and not to ignore their contributions. In accordance with this, also the need to train and instruct parents and teachers in this construct is estimated (for example, EFs and their relationship with basic instrumental skills, such as mathematical competence). The deep knowledge of the qualitative changes (and not limited to the quantitative aspects) of these cognitive processes of higher order are necessary in order to be able to have a referent norm and to be able to understand all the differences and / or deviations that occur in a typical development or disorders from the early stages of the life cycle (primary intervention) [55].

One of the strengths that we estimate from the present study is the sample that has been extracted from all of the national territory, which guarantees the representativeness and generalisation of the obtained results.

5. Conclusions

In the present study, a crosscutting design has been proposed, which makes it impossible to analyse intraindividual differences in the development of EFs, and it is therefore necessary to choose longitudinal designs [56], in order to analyse and to make comparisons of the intraindividual changes in the development of EFs.

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Institutional Review Board Statement: The study has been favorably evaluated by the Bioethics Committee of UNED during the session held on January 25, 2011.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

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Conflicts of Interest: The author is a co-author of the BRIEF-P adaptation in Spanish, receiving royalties in return.

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