ISSN online 1688-4221 *Ciencias Psicológicas* January-June 2023; 17(1), e-2873
DOI: 10.22235/cp.v17i1.2873

Working memory and spatial representation in mapuche and non-mapuche schoolchildren from La Araucanía

Memoria de trabajo y representación espacial en escolares mapuches y no mapuche de La Araucanía

Memória de trabalho e representação espacial em estudantes mapuche e não mapuche de La Araucanía

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Abstract

The objective of this study was to determine if there are differences in performance in working memory and spatial representation in rural Mapuche children and non-Mapuche urban children, from the Araucanía region, Chile. 96 students between 8 and 12 years old participated (*M* = 10.33; *SD* = 1.02) who answered tasks of working memory and spatial representation in verbal and non-verbal format. A multivariate analysis of covariance (MANCOVA) was performed, controlling for the effect of age and gender. The results show that Mapuche participants scored lower than their non-Mapuche peers in verbal working memory and marginally significant differences were found in non-verbal working memory. In the verbal spatial representation, no differences will be obtained in the groups and in the non-verbal spatial representation Mapuche children obtained a significantly higher performance than their non-Mapuche peers. Non-Mapuche children perform better on verbal tasks, while Mapuche children perform similarly or higher on non-verbal tasks. The relevance of ecological validity from the situated cognition paradigm is discussed.

Keywords: working memory; spatial representation; mapuche; non mapuche; rural; urban

Resumen

Este estudio tuvo por objetivo determinar si existen diferencias en el desempeño de la memoria de trabajo y representación espacial en niños y niñas mapuches rurales y no mapuche urbanos de la región de La Araucanía (Chile). Participaron 96 estudiantes entre 8 y 12 años (*M* = 10.33; *DE* = 1.02), quienes respondieron tareas de memoria de trabajo y de representación espacial en formato verbal y no verbal. Se utilizó un análisis multivariado de la covarianza (MANCOVA), controlando el efecto de la edad y el sexo. Los resultados evidencian que los participantes mapuche puntuaron más bajo que sus pares no mapuche en memoria de trabajo verbal, y se encontraron diferencias marginalmente significativas en memoria de trabajo no verbal. En la representación espacial verbal no se obtuvieron diferencias entre los grupos y en representación espacial no verbal los niños mapuches obtuvieron un desempeño significativamente más alto que sus pares no mapuche. Los niños no mapuche tienen un mayor desempeño en tareas verbales, mientras que niños mapuche obtienen desempeños similares o más altos en tareas no verbales. Se discute la relevancia de la validez ecológica desde el paradigma de la cognición situada.

Palabras clave: memoria de trabajo; representación espacial; mapuche; no mapuche; rural; urbano

Resumo

O objetivo deste estudo foi determinar se existem diferenças no desempenho da memória de trabalho e da representação espacial em crianças mapuche rurais e não mapuche urbanas, da região de Araucanía, Chile. Participaram 96 alunos entre 8 e 12 anos (M = 10,33; DP = 1,02), que responderam tarefas de memória de trabalho e de representação espacial no formato verbal e não verbal. Foi utilizada uma análise multivariada de covariância (MANCOVA), controlando o efeito de idade e sexo. Os resultados demostram que os participantes mapuche pontuaram mais baixo do que seus pares não mapuche na memória de trabalho verbal e que diferenças marginalmente significativas foram encontradas na memória de trabalho não verbal. Na representação espacial verbal não foram obtidas diferenças entre os grupos e na representação espacial não verbal as crianças mapuche obtiveram um desempenho significativamente superior aos seus pares não mapuche. As crianças não mapuches apresentam melhor desempenho em tarefas verbais, enquanto as crianças mapuche apresentam desempenho similar ou superior em tarefas não verbais. Discute-se a relevância da validade ecológica a partir do paradigma da cognição situada.

Palavras-chave: memória de trabalho; representação espacial; mapuche; não mapuche; rural; urbano

Received: 04/05/2022 Accepted: 12/15/2022

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The mechanisms of human cognition are universal although they manifest themselves in a particular way in each culture (Villar, 2016). The situated cognition paradigm, linked to the sociocultural approach of Vygotsky, assumes that knowledge is relational, active, and practical, which is generated in the interaction with the environment, constituting cognitive adaptations according to ecocultural and ecological patterns (Restrepo, 2018; Veloso et al., 2016).

Vygotsky's contributions have given rise to foundational theoretical and empirical developments in the framework of cultural psychology and anthropology of childhood, among which the LOPI model is highlighted (*Learning by Observing and Pitching In to Family and Community Endeavors,* Rogoff & Mejía-Arauz, 2022), as well as to the theoretical and empirical contributions of Gaskins (2020), Lancy (2016), Lave (2019), Lave and Wenger (1991), Rogoff (1998, 2003, 2014), Rogoff and Chavajay (2004), Veresov (2020).

From this perspective, an important criticism has been made regarding the teaching-learning process in school environment. For example, some of the educational materials used are decontextualized, and educational practices are based on a monocultural and hegemonic view of learning and child development (Quilaqueo & Torres, 2013). This has implied, among other things, that the cultural ways of learning and the characteristics of cognitive processes in the indigenous context are considered a deficit or an obstacle to learning (Villar, 2016).

The relevance of studying cognitive processes in context, such as working memory and spatial representation, is related to the importance of these processes in the curricular bases and subjects of the formal educational system. Memory plays an essential role as it is involved in reading, text comprehension, arithmetic, and calculus (Vernucci et al., 2017).

Ardila and Ostrosky (2012) define working memory as the ability to maintain information mentally while working with it or updating it, this ability allows remembering plans and instructions, using alternatives, relating ideas and data from the present with the future and the past. Conversely, spatial memory is defined as the ability to store and manipulate information simultaneously using three subsystems coordinated by a central executive, which functions as an attentional control system. The first subsystem is the visuospatial agenda, the second one is the phonological loop, and the third one is the episodic buffer (Baddeley, 2010).

For the purposes of this article, spatial representation will be understood as the ability to organize and use information to orient oneself in space in a global and organized way; it considers spatial landmarks and place representation (Ávila & García, 2018). This capacity is related to the navigational ability used to orient oneself in a given environment (Newcombe, 2018). Navigation is the most complex domain, since it involves managing information to orient oneself in a given space, e.g., locations, knowledge of landmarks, routes, coordination of perspectives and movement. This area has received less attention due to its methodological complexity and the low availability of instruments for its evaluation (Newcombe, 2019; Nys et al., 2015).

The classic studies by Piaget and Inhelder (1956) demonstrated the importance of studying how children develop spatial knowledge and perception. Furthermore, it has been shown that the interaction and familiarity of the individual with his or her environment, urban or rural origin, age, and gender are relevant aspects for the development of spatial knowledge (Dasen & Mishra, 2010).

In Brazil, a study conducted by Andrade and Amodeo (2007) with 12 indigenous Guarani and 12 non-indigenous people, between 20 and 40 years of age, from São Paulo, indicates that non-indigenous people show a tendency to use verbal memory, while indigenous people are more proficient in visual memory elements and visual-constructive skills. In the same line, a study by Fierro et al. (2018) shows a decrease in verbal aspect scores in indigenous students. In addition, Rogoff et al. (2015) establish that the cognitive development of indigenous populations focuses on the predominance of holistic thinking and learning strategies based on observation, intense attention, and the preponderance of non-verbal linguistic patterns.

De León (1994, 2001) and Brown and Levinson (2000), in research with Tzotzil-speaking children in Mexico, showed that 5-year-old children had a linguistic mastery of the geocentric frame of reference before the egocentric one, in comparison with what is shown in research with Western children who, at the same age, are still unable to recognize the left-right dimension, a situation that, in the case of Mexican children, would be facilitated by the use of a geocentric frame of reference.

Enesco (1983) conducted a cross-cultural study in an area of Peru in which she investigated the development of spatial concepts in 74 children who were between 6 and 15 years old and belonged to the Shipibo-Conibo ethnolinguistic group. Results showed some differences with respect to the performance observed in Western children. In fact, the hypothesis that topological relations prevailed over Euclidean relations in non-Western societies was refuted. On the other hand, in the coordination of perspectives, a state of spatial egocentrism was not present in this group of children.

Regarding rural and urban schools, studies such as the one conducted by Anckermann (2014), in which there were 40 participants who were between 4 and 5 years old and belonged to an urban private school and a rural public school in Guatemala, reveal that rural schools have low performance in the execution of verbal memory tasks compared to children from urban schools.

In Chile, the results of the study conducted by Denegri (1991), show a difference between Mapuche and non-Mapuche rural children, between 6 and 7 years old, in terms of the representation of spatial notions of conservation and length. Mapuche children perform better than their non-Mapuche peers, which, according to the author, can be explained by the ecocultural context, considering the socialization process and the knowledge acquired from the surrounding environment, since people conceptualize space according to the predominant frame of reference in their own culture and language.

The study by Alonqueo and Silva (2012) regarding spatial notions shows that non-Mapuche rural schoolchildren from Bío Bío and La Araucanía Regions use relative and absolute frames of reference, that is to say, spaces are defined according to the physical position and point of view of the individual and according to his or her own body map; at the same time, they use a large-scale geocentric system, such as the cardinal points. On the other hand, Mapuche children who were between 10 and 12 years old, compared to non-Mapuche children, mostly use the absolute frame of reference. This is consistent with the differences identified in both groups in the study by Muñoz and Alonqueo (2017), since Mapuche schoolchildren, when describing a known path, used more linguistic expressions that encoded an absolute frame of reference.

A recent study conducted in Chile compared the performance between rural and urban schoolchildren, by using the Wechsler Intelligence Scale for Children, fifth edition (WISC V), with a sample of 690 urban students and 47 rural students, demonstrating that the performance of visuospatial reasoning in urban and rural children of medium or low socioeconomic level did not show significant differences, presenting a similar development in both groups (Rodríguez-Cancino et al., 2019).

There is evidence that Western schooling favors the development of the skills required for performance in cognitive tasks that do not take into account the daily context of children. Schoolchildren with low performance in experimental tasks show a good performance in their daily context, unlike what happens in assessment situations (Hein et al., 2015).

The study of spatial representations and working memory has not been studied in rural Mapuche and urban non-Mapuche children, which is why it is a topic of particular relevance. Furthermore, the influence of the types of formats used in the cognitive tasks which assess these abilities has not been considered either. The use of a nonverbal format allows for the possibility that tests can reduce the influence of language, and nonverbal measures have also been shown to produce similar results in people from diverse backgrounds, thereby reducing cultural biases (Veloso et al., 2016).

The results of empirical studies demonstrate the importance of continuing to explore cognitive processes in children, since in Latin America a significant gap in access to educational opportunities among schoolchildren belonging to indigenous peoples has been described in comparison to their non-indigenous peers (Treviño et al., 2017). In the case of Chile, the indigenous child population corresponds to 13 % of the national total (Unicef, 2020), and is mainly distributed in the regions of La Araucanía, Arica and Parinacota, and Aysén (Ministerio de Desarrollo Social, 2017). The aforementioned inequities have also been described for the case of indigenous children living in the national territory, in particular for the Mapuche child population (Treviño et al., 2017).

This idea is reinforced by the low performances obtained in the SIMCE tests and in the Weschler Scales to measure Intellectual Coefficient (IQ), determining the overrepresentation of indigenous children in the School Integration Program (SIP) (Fernández et al., 2017). Mapuche students obtained lower performance compared to non-Mapuche students of the same age and educational level, being below the national and regional average, due to the use of standardized instruments with normative parameters (Agencia de Calidad de la Educación, 2016).

The use of standardized instruments in the indigenous population presents limitations, due to the requirement of a high use of verbal language, influenced by the concepts of time and space (Dingwall et al., 2013). The use of contextually organized materials results in fewer cultural differences in cognitive development (Garcés, 2018); the principle of cultural familiarity operates in the format in which the material is presented, whether it be photographs, drawings or objects to be successfully addressed when they are part of the cultural environment and the structures of the activities are similar to those of everyday life (Villar, 2016).

It is estimated that most of the standardized instruments lack ecological validity, because they do not consider the context in which the assessed behaviors are manifested (Sternberg, 2012). Ecological validity refers to the degree of representativeness of a construct and its relation to the activities the individual performs in his or her natural environment. This type of validity allows the results to be generalized in a context different from their original environment (Tirapu-Ustárroz et al., 2011). In accordance with the aforementioned, the American Psychological Association (APA, 2003) establishes that the instruments must be culturally sensitive, which implies a linguistic adaptation of the instrument that guarantees the equivalence of the measurement in both cultures.

The available theoretical and empirical evidence shows that although cognitive processes such as working memory and spatial representation, in their respective verbal and non-verbal formats, are universal in human experience, the content and form of expression vary according to culture. Therefore, considering the formats is fundamental to overcome the inequities present in standardized assessments and in the content of the school curriculum.

Therefore, it is relevant to explore the following: are there any differences in performance in verbal and nonverbal working memory and spatial representation tasks between Mapuche and non-Mapuche schoolchildren? The general objective of this study was to determine the existence of differences in performance in verbal and nonverbal working memory and spatial representation tasks in Mapuche and non-Mapuche children. The specific objectives were: a) to measure performance in working memory tasks in verbal format in Mapuche and non-Mapuche children, b) to measure the performance in working memory tasks in non-verbal format in Mapuche and non-Mapuche children, c) to measure the performance in spatial representation tasks in verbal format in Mapuche and non-Mapuche children, and d) to measure the performance in spatial representation tasks in non-verbal format in Mapuche and non-Mapuche children.

Method

Participants

A non-probabilistic convenience sample was used. The sample consisted of 96 students (46 girls and 50 boys) from six schools in La Araucanía. Regarding the participants, 44 were rural Mapuche children and 52 were urban non-Mapuche children. Ages ranged from 8 to 12 years old (M = 10.33; SD = 1.02).

The inclusion criteria were: regular student of a primary school, being between 8 and 12 years old, and self-ascription to the Mapuche people. Students with educational lags were excluded from the study.

Instruments

A battery composed of four tasks was applied, two of working memory and two of spatial representation. In addition, a brief sociodemographic questionnaire was administered in which information on age, sex, origin, and cultural group was collected. Reliability estimates by ordinal alpha were calculated with the psych package (Revelle, 2020) in R software version 4.0.3 (R Core Team, 2020).

Subtests of the WISC-V instrument were used to measure verbal and non-verbal working memory, since the instrument was standardized in Chile and it was concluded that it can be used reliably for cognitive assessment processes in clinical and educational contexts (Rosas et al., 2022). The study by Rodríguez-Cancino et al. (2022) reports that, according to the psychometric results obtained, WISC-V could be used to assess cognitive functioning in children of rural origin in Chile without the need to make adjustments in its administration and correction procedures, and that it has adequate levels of internal consistency (above .77) that range from acceptable to good in all subtests. However, the possible ecological validity of this instrument has not been demonstrated.

The tasks of aerial photography and known path take into account the spaces that the children travel daily, the rural or urban locations and the cultural context, so there is greater control over the activity and the resources previously learned by the participants are available. These elements are based on situated cognition and ecological validity, which contributes to greater cultural sensitivity (Restrepo, 2019).

Digit Retention Task of the Wechsler Intelligence Scale for Children (WISC-V). This task was used to measure verbal working memory, and assesses the ability to record, maintain, and operate with information presented in verbal form (Rosas et al., 2017). The reliability of this scale in Chile was a Cronbach's alpha of .97 (Rosas et al., 2017). In this study the ordinal alpha was .93, a value that is consistent with previous studies.

Drawing Span Task of the Wechsler Intelligence Scale for Children (WISC-V). This test was used to measure nonverbal working memory and assesses the ability to operate effectively with visual information (Rosas et al., 2017). The ordinal alpha in this study was .91.

Known Path Task. In order to measure verbal spatial representation, an adapted version of the task utilized by Muñoz and Alonqueo (2017) was used. This consists of verbally identifying how to transit between two known points according to the geographical context. Although this task has been previously used in other studies in Chile (Silva, 2019; Muñoz & Alonqueo, 2017), reliability had not been analyzed. In this study the ordinal alpha was .66, a coefficient considered acceptable given the sample size and the number of items.

Aerial Photograph task. In order to measure nonverbal spatial representation, the Aerial Photograph task was adapted (Plester et al., 2002). For this purpose, an image of the area where each school was located was captured using the Google Maps Satellite tool. The task was developed internationally (Plester et al., 2002), but reliability was not reported. The ordinal alpha in this sample was .54, a coefficient considered acceptable given the sample size and the number of items.

Procedure

The tasks were applied individually in one of the school's classrooms. The assessor explained to the students the characteristics of the tasks, the absence of grading, and the possibility of asking questions if they needed it. The assessment lasted approximately 20 minutes.

First, a familiarization phase of the nonverbal spatial representation task was established, in which the students were asked to visualize for 5 seconds an aerial photograph corresponding to the place where their school was located. Then, they were instructed on how to use the computer and the Microsoft Paint program by tracing a maze. The assessor assisted the student if he or she presented difficulties in handling these tools. The order of application of the tasks was counterbalanced.

In the application of the digit retention task, the participant is read a sequence of numbers that he or she must then repeat in the same order (digits in direct order), in reverse order (digits in reverse order) and in ascending order (sequential digits). While in the drawing span task, the participant observes a stimulus page with one or more illustrations for a specific time and then is asked to select the illustrations he or she remembers, in sequential order or not, identifying himself or herself within the options shown on a response page (Rosas et al., 2017).

In the familiar pathway task, the researcher verbally stated the instruction: “I was told there is a place near here called C. de R., could you tell me how to walk from here, the M. School? Remember I don't know the way, so you will have to give me as many details and directions as possible so that I don't get lost. I need you to tell me where to go and how to get from here, the M. School, to the C. of R.” (example of rural school instruction).

For the aerial photography task, the students were shown the image and asked to write the names of the places they recognized in the Microsoft Paint program and to trace a path from one point to another (previously established) using the Microsoft Paint program. The instruction was as follows: “1. The first thing we are going to do, I am going to show you a picture, what do you see here? Do you recognize any place? Now, could you write the names of the places you recognize on the picture? 2. Could you show me, by tracing the image with the pencil, how to walk from the A.H. school to the promenade” (example of urban school instruction).

Ethical Considerations

The principals of each school were asked for authorization to administer the battery of tasks to the students. Subsequently, an informed consent form was given to the parents, who were asked to sign the document for their children to participate in the study, and the children were given an informed assent form, explaining in simple language what the study consisted of, and they were asked to write their names. In the documents, voluntariness, confidentiality, absence of risks, and the possibility of abandoning the study were expressed. Each student was given a graphite pencil as a reward. The researcher in charge gave a return of the results to each establishment.

The informed consent and assent documents were approved by the Master's program in Psychology, following the requirements of the Scientific Ethical Committee of the Universidad de La Frontera and the principles on research ethics of the Ethics Code of the Chilean Association of Psychologists.

Coding and Analysis of Information

In the verbal working memory task, raw scores were used, correct answers received a score of 1 and incorrect answers received a score of 0. The suspension criterion was applied after giving 2 incorrect answers in both attempts of an item.

In the nonverbal working memory task, raw scores were used in the same way. Correct answers, both in content and in the order of the stimuli, had a maximum score of 2, 1 point was assigned if the answer was correct only in content and 0 points if it was incorrect. The criterion for test suspension was obtaining 3 consecutive scores equal to 0.

The verbal spatial representation task score was obtained from the application of an ad-hoc rubric. These scores were subjected to inter-rater agreement by each educational establishment by intra-class correlation (ICC). The results of the inter-rater agreement were satisfactory. The known path task obtained an ICC of .953 with a 95 % confidence interval from .929 to .969, $F(87) = 21.17$, $p < .001$ for Mapuche children, and an ICC of .970 with a 95 % confidence interval from .956 a .980, $F(103) = 33.99$, $p < .001$ for non-Mapuche children.

The first item received 3 points if the child managed to give the correct directions, 2 points if he or she indicated a path with errors, but managed to notice and give the correct directions, and 0 points if he or she mentioned a wrong path or did not respond. The second item received 1 point for each recognized landmark. The score ranged from 0 to 7 points for both Mapuche and non-Mapuche children, where 0 implies poor performance and 7 implies optimal performance.

The scores for the nonverbal spatial representation task were obtained from the application of an ad-hoc rubric. These scores were subjected to inter-rater agreement by each educational institution by intra-class correlation (ICC). The aerial photography task obtained an ICC value of .895 with a 95 % confidence interval from .855 to .923, $F(219) = 10.20$, $p < .001$. For urban non-Mapuche children, an ICC of .958 was obtained with a 95 % confidence interval from .946 to .967, $F(259) = 23.58$, $p < .001$.

This task is composed of three items: the first item, corresponding to the path tracing, was assigned 2 points when the path was successfully traced, 1 point if the path had one or more self-corrections, but the reference points were correct, and 0 points if the path did not correspond or did not perform the tracing. Another item is that the route represents a possible path; 1 point was assigned if the route was made through streets or free transit (in rural areas), and 0 points if it passes over buildings, houses or places without access. The third item corresponds to the number of natural and urban elements recognized, because the number of possible elements in the urban and rural context differ, the scores for Mapuche children ranged from 0 to 9 points and for urban children between 0 and 12 points, where the minimum score implies a deficient performance and the maximum score an optimal performance.

Analysis Plan

In order to determine the differences between Mapuche and non-Mapuche groups, a multivariate analysis of covariance was used (MANCOVA), in which the dependent variables of verbal and nonverbal working memory and verbal and nonverbal spatial representation were inserted. Age and sex of the participant were considered as covariates. A nominal p-value of .05 was considered. The data were analyzed using SPSS statistical software, version 25.

Results

The results obtained by the participants in both groups for each of the dependent variables are presented in Table 1, displaying the means and standard deviations.

In order to test whether the differences in the scores of the two groups are statistically significant, a MANCOVA was performed controlling the effect of age and sex. The result of the analysis showed a main effect of the cultural group in the model ($\Lambda = .820$, $F(4,89) = 4.89$, $p = .001$).

Table 1

Means and standard deviations of performance on working memory and spatial representation tasks by cultural group

		Working memory		Spatial Representation	
	N	Verbal	Nonverbal	Verbal	Nonverbal
Mapuche	44	18.98 (3.66)	17.41 (6.59)	2.82 (1.99)	62.88 (20.18)
Non-mapuche	52	22.17 (4.18)	20.54 (6.09)	2.85 (2.19)	53.85 (19.34)

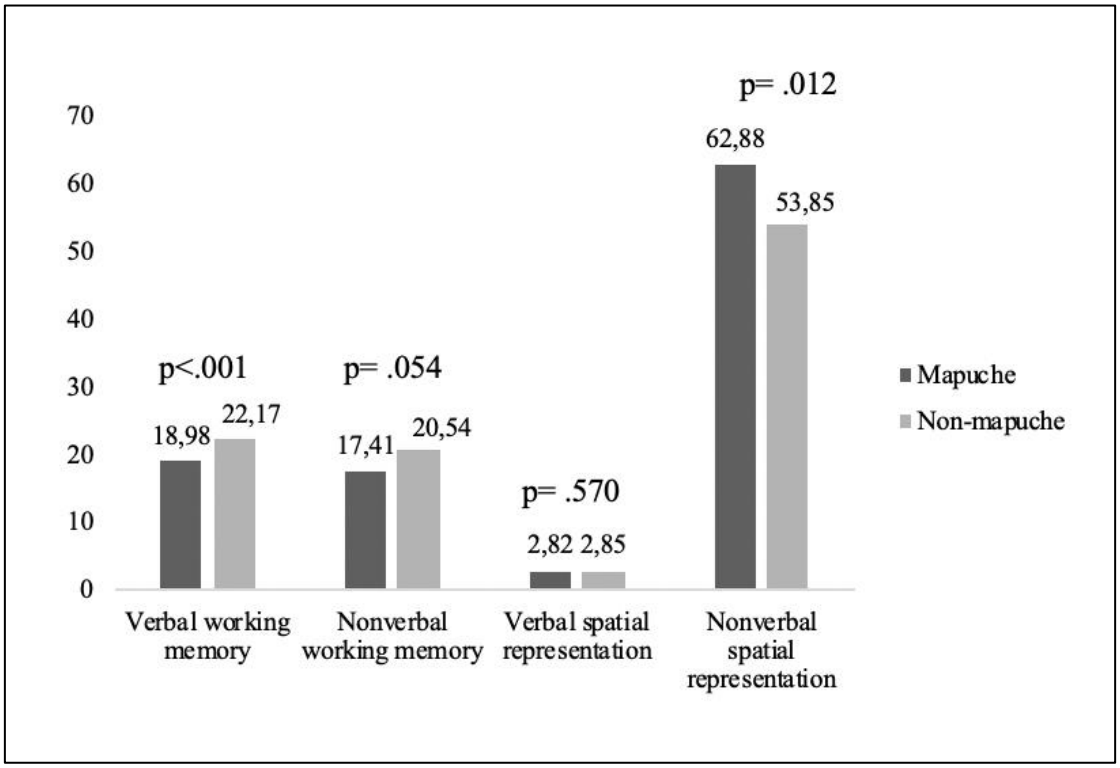
Note: The values in parentheses indicate standard deviation.

In accordance with the specific objectives, in the first place, it was established that performance in verbal memory tasks differed significantly between Mapuche and non-Mapuche children. It was observed that Mapuche schoolchildren scored lower than non-Mapuche schoolchildren in verbal working memory tasks ($F(1,92) = 13.52$, $p < .001$, $\eta^2 = .128$).

In relation to the objective of measuring the performance in working memory tasks in non-verbal format in Mapuche and non-Mapuche children, it was found that the differences between both groups of schoolchildren are marginally significant ($F(1,92) = 3.81$, $p = .054$, $\eta^2 = .040$).

Regarding the performance in the spatial representation tasks, it was found that in the verbal format there were no significant differences in both groups of children ($F(1,92)= 0.325$, $p = .570$, $\eta^2 = .004$). However, in the spatial representation tasks in non-verbal format, Mapuche children scored higher than their non-Mapuche peers ($F(1,92) = 6.62$, $p = .012$, $\eta^2 = .067$).

Figure 1
Mean scores by cultural group



Discussion

The objective of this study was to determine whether there are differences in the performance of working memory and spatial representation tasks in verbal and non-verbal modalities in Mapuche and non-Mapuche children from La Araucanía region. The results of this study suggest that there are differences in performance in verbal working memory tasks, as non-Mapuche children obtain better results. On the other hand, it was found that Mapuche children performed better in nonverbal spatial representation tasks.

The first objective of the study was to measure the performance in working memory tasks in verbal format in Mapuche and non-Mapuche children. The results are consistent with the literature; it has been observed that non-indigenous students tend to develop verbal aspects of memory, while indigenous students obtain lower scores in this format (Andrade & Amodeo, 2007; Fierro et al., 2018). The reason why non-Mapuche students have obtained a better performance in verbal working memory tasks may be due to the fact that the instructional format used in school is predominantly linguistic. Thus, in urban schools they develop verbal skills, while in the rural community family context, non-verbal skills are favored, being culturally competent in their communities of origin (Rogoff et al., 2015; Suina & Smolkin, 2014).

On the other hand, in the second objective, there is a tendency for non-Mapuche children to have a better performance in the nonverbal working memory task. This could be because in the span task of drawings corresponding to the WISC-V, drawings which are not contextualized to the cultural reality are presented, lacking ecological validity. Moreover, this type of memorization is more developed and used in the traditional school experience (Rogoff, 2003).

In relation to the third objective, in both groups (rural Mapuche and urban non-Mapuche) performance is relatively low. This may be due to some bias and/or sample size; it is also possible that the known path task could be cognitively demanding, since it requires evoking information without an immediate stimulus and elaborating sentences consistent with what is requested. Finally, the low performance observed may be due to developmental reasons; studies show that some dimensions of spatial skills, which require absolute reference frames, are not yet fully developed by the end of school age (Alonqueo & Silva, 2012; Silva, 2019).

Finally, the fourth objective shows that rural Mapuche children obtained better results in nonverbal spatial representation tasks than their urban non-Mapuche peers, which is consistent with the study conducted by Ávila and García (2018), who suggest that rural indigenous children have greater ability to locate and orient themselves in space in a global and organized way, as well as to represent landmarks. In addition, it was observed that Mapuche children used natural spatial categories (trees, rivers) to represent the environment and facilitate the memory construction, in comparison with non-Mapuche children, who mention more non-natural categories (churches, houses, supermarkets, commercial stores). The Mapuche educational model is strongly based on the child being a person with social integrity, but also active in his or her natural and cultural environment (Course, 2017).

Overall, these results suggest that Mapuche children perform better on nonverbal tasks than on verbal tasks. Indigenous peoples present learning strategies and cognitive processing strategies centered on observation, intense attention, and predominance of nonverbal patterns (Fierro et al., 2018). It has been observed that traditional schooling would not consider the daily context of each student, outside the testing situation (Hein et al., 2015). It is necessary for tests to manage to reduce the influence of language, to generate more accurate scores by considering the non-verbal format (Veloso, et al., 2016). In schools, children perform tasks and face difficulties through the cognitive skills they have culturally acquired; processing methods may not coincide with those used and validated in educational establishments, which becomes an obstacle in the learning process (Villar, 2016). This research can contribute to school practices and their assessment formats regarding the cognitive performance of students.

One of the strengths of this study is the use of instruments developed under the approach of situated cognition. From this perspective, the aerial photography and known path tasks were oriented towards everyday actions and prior knowledge in the activities they were asked to perform, considering the task and also the cultural context of those being evaluated (Restrepo, 2019). By using the representativeness of the construct and the activities that the individual performs in his or her natural environment, ecological validity is ensured (Tirapu-Ustárroz et al., 2011). To the extent that the experiment and the real-world situation present the same ecologically valid cues to the subject, the experiment itself can be said to be ecologically valid (Kihlstrom, 2021).

It is important to consider a larger sample size to increase statistical significance in the analyses. In addition, only rural Mapuche and urban non-Mapuche students were considered, so it is necessary for future research to determine if there is an effect of origin (urban and rural) and of cultural group (Mapuche and non-Mapuche) as a whole. Furthermore, it would be interesting to inquire into how other cognitive processes occur in culturally diverse contexts and to include working memory tasks related to stories, where the material is more similar to daily life (ideas, images, stories) and to the context of the students, since people use different cultural tools to make sense of the memory (Wagoner et al., 2019). This could determine whether contextualized stories relevant to the Mapuche context produce positive effects on the recall of the materials. These ad hoc

tasks, which could be sensitive to cultural variability, can contribute to studies that compare cultural groups; considering aspects of the natural environment would be useful for the design of pedagogical material for Mapuche students. Likewise, longitudinal studies can contribute to determine the incidence of developmental progression with respect to pedagogical interaction and to achieve curricular advances with respect to the development of working memory and spatial representation.

Funding

Acknowledgments to the FONDECYT 1170360 project "Learning at school and learning at home: cultural learning and sociocognitive processes in Mapuche schoolchildren in the Araucanía Region", from which this research was derived.

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How to cite: Marilicán-Contreras, M. F., Alonqueo Boudon, P., & Oliva-Vásquez, E. (2023). Working memory and spatial representation in mapuche and non-mapuche schoolchildren from La Araucanía. *Ciencias Psicológicas, 17*(1), e-2873. https://doi.org/10.22235/cp.v17i1.2873

Authors' participation: a) Conception and design of the work; b) Data acquisition; c) Analysis and interpretation of data; d) Writing of the manuscript; e) Critical review of the manuscript.
M. F. M-C. has contributed in a, b, c, d, e; P. A. B. in a, b, d, e; E. O-V. in c, d.

Managing scientific editor: Dra. Cecilia Cracco.