

Assessing Visual Perception in Urban Indigenous Schoolchildren: A Community-Based Study for Early Intervention Planning

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ABSTRACT

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Visual perception plays a crucial role in children's learning, yet research on these skills among Malaysia's urban Indigenous populations remains limited. This study assessed visual perceptual skills in urban Indigenous primary schoolchildren using standardized measures, addressing a critical gap in community health research. This community-based study was conducted at Petaling, Selangor, in 2024, and a cross-sectional design was employed. The visual perceptual skills were measured among 29 Level 1 Indigenous students (ages 7-9) using the Test of Visual Perceptual Skills-4th Edition (TVPS-4). It assessed seven subtests: visual discrimination, memory, spatial relationships, form constancy, sequential memory, figure-ground, and closure. A one-sample Wilcoxon signed rank test was done to compare the participants' median with the median of the normal value (U.S. norms). While overall scores aligned with normative data ($p=0.160$), significant variations emerged in visual discrimination ($p=0.028$), form constancy ($p=0.017$), and visual closure ($p=0.004$), indicating specific developmental differences. Urban Indigenous children demonstrated generally normative visual perceptual development, likely influenced by educational access and modern environmental factors. These findings establish important baseline data while highlighting the need for expanded research across diverse community settings to understand developmental patterns in this population better.

Contribution/Originality: This study provides valuable insights into the amplitude of accommodation and accommodative facility among Orang Asli schoolchildren, offering a reference framework for assessing accommodation anomalies in indigenous populations.

1. Introduction

Visual perception is a fundamental cognitive process through which children make sense of and organise the visual information in their surroundings, forming the basis of learning and development. These skills are the basis for important academic skills like reading fluency, math problem-solving, and spatial reasoning ([Çayir, 2017](#); [Yang & Meng, 2020](#)). There are many subskills involved in this complicated process, such as visual discrimination, form constancy, visual memory, spatial relationships, sequential memory, figure-ground perception, and visual closure ([Brown & Peres, 2018](#)). The progression of visual perceptual skills typically follows a well-established path in normally developing children, with especially swift advancement observed during the primary school years as they engage with increasingly intricate visual materials in educational settings ([Brown & Peres, 2018](#)). However, recent research suggests that this developmental trajectory may be significantly influenced by sociocultural and environmental factors, with particularly notable effects seen in indigenous populations and other marginalised groups ([Asem et al., 2023](#)).

Studies indicate that visual perceptual development is significantly influenced by environmental factors, such as educational access, socioeconomic status, and cultural context ([Josman et al., 2006](#); [Groenewald, 2023](#)). Children who grow up in places with many resources, like structured schools, learning materials, and digital exposure, tend to do better on visual perception tests than children who do not have as many resources ([Groenewald, 2023](#); [Kong et al., 2024](#)). Nonetheless, the majority of these studies have concentrated on Western or non-Indigenous urban populations, resulting in a deficiency in our comprehension of the development of these skills in Indigenous children, especially those residing in urban areas.

1.1 Research Objectives

This study aims to determine the visual perception skills among indigenous primary schoolchildren in Petaling, Selangor.

2. Literature Review

Schoolchildren are a high-risk group for undetected visual impairments, which can disrupt learning and hinder academic achievement. Many children remain unaware of their visual problems, as only a fraction show clear symptoms such as squinting, sitting close to screens, or producing messy schoolwork. These impairments affect essential skills like reading comprehension, writing, and numeracy ([Omar et al., 2019](#); [Jadue & Figueroa, 2017](#); [Ferede et al., 2020](#); [Choi et al., 2022](#)). Evidence consistently links visual impairment with reduced visual perceptual abilities, which in turn contribute to poorer academic performance. This is particularly evident in Indigenous populations, where studies from Malaysia and Australia report reduced visual perceptual and visual-motor integration skills among schoolchildren, correlating with low academic outcomes ([Hopkins, 2014](#); [Ahmad et al., 2022](#)).

In the Malaysian context, Orang Asli children represent a minority group facing persistent educational challenges. Limited entry into secondary school and persistently high dropout rates continue to challenge Indigenous education despite government initiatives. Studies highlight that parents' educational background, socioeconomic status, geographical isolation, and cultural differences contribute to these disparities ([Ahmad et](#)

al., 2022; Rosnon et al., 2022). Furthermore, many Orang Asli parents hold low academic expectations, often due to limited awareness of the importance of education. These challenges not only affect schooling but also restrict early exposure to activities that foster visual perceptual development (Ahmad et al., 2022; Asem et al., 2023). While much of the existing research adopts a deficit-oriented view, recent perspectives emphasize the importance of considering protective factors within urban Indigenous contexts. International evidence indicates that achievement gaps among Indigenous children are strongly shaped by structural determinants of health, including poverty, limited access to early childhood programs, and mismatches between cultural learning methods and mainstream education (Hopkins, 2014). These disadvantages may be buffered when urban Indigenous families have improved access to quality schooling and health-promoting environments (Wood, 2023).

Through daily tasks such as reading, sorting shapes, and problem-solving, students develop abilities like form constancy, visual discrimination, and spatial awareness, showing that classroom learning plays a crucial role in shaping visual perceptual skills (Williams, 2019; Lin, 2019). Urban Indigenous children, who encounter structured school systems and modern environments, may experience perceptual advantages compared with rural counterparts, who often face poorly resourced schools and culturally misaligned teaching practices (Al-Mekhlafi et al., 2011; Salim et al., 2020). Formal literacy instruction enhances form constancy, while urban contexts expose children to diverse visual stimuli such as traffic systems and digital interfaces that strengthen perceptual skills like visual closure (Kamran, 2021).

Despite these insights, research on Indigenous visual perceptual development remains limited. Existing studies primarily focus on rural communities, leaving urban Indigenous populations underexplored (Chen et al., 2011; Hairol et al., 2021). By employing a comprehensive assessment such as the TVPS-4 in an urban setting, this study addresses a critical gap in the literature and provides a more nuanced understanding of visual perceptual development in Malaysia's Indigenous schoolchildren.

3. Methodology

3.1. Study Design

This study utilized a cross-sectional design conducted over 10 months, from October 2023 to July 2024, in the urban Petaling District of Selangor, Malaysia. The target population comprised Level 1 Indigenous primary schoolchildren aged 7 to 9 years. The urban setting was intentionally selected to explore visual perceptual development within an environment offering greater access to educational resources and modern infrastructure, in contrast to traditional rural Indigenous communities. This age group was chosen because it marks a crucial period for the development of core visual perceptual skills essential for academic success. The extended study duration supported thorough data collection and accommodated potential seasonal fluctuations in school attendance. The cross-sectional design provided a snapshot of developmental status in relation to established norms, while reducing the burden on participants. Conducting the research within school settings enhanced ecological validity by capturing children's performance in familiar, real-world environments rather than artificial testing conditions.

Participants were selected through purposive sampling from the school's enrolment records. A power analysis using a one-sample Wilcoxon test with an alpha level of 0.05 indicated that 22 participants were required to achieve 80% power to detect a clinically meaningful difference of 1.5 scaled score points (effect size $d=0.6$) in TVPS-4 subtest scores compared to U.S. norms. Accounting for a 20% attrition rate, the study aimed to recruit 28 participants. Ultimately, 29 Indigenous schoolchildren completed all assessments, exceeding the minimum sample requirement while maintaining almost balanced gender representation (17 female, 12 male). Data collection began after the participants had completed and signed the consent and assent forms and were informed about the study's purpose. Those who provided consent filled out the forms, which were retained as proof. Participants were then screened through preliminary assessments, including a visual acuity and stereoacuity test.

3.2. Inclusion and Exclusion Criteria

The inclusion criteria for the subject selection were Level 1 students with normal receptive language abilities, which refers to the ability to understand words and language either in verbal or written formats. Normal receptive language is essential among the indigenous children in this study to communicate successfully. It allowed the students to understand the instructions for each subtest properly during the TVPS-4 assessment to ensure reliable results. They must have a good habitual near visual acuity of at least N6 or better in each eye. The stereo acuity should be within the normal range for ages 7 to 9 years old, which is at least 60 seconds of arc or better ([Elamurugan et al., 2022](#)). They also must be able to understand spoken *Bahasa Melayu*. The exclusion criteria included any neurological disorder, intellectual disability, psychotic disorder, and visual impairment that prevented them from cooperating ([Zhang et al., 2020](#)). Visual perceptual deficits are prevalent among these conditions.

3.3. Ethics Clearance and Data Analysis

The study adhered to the ethical guidelines of the Declaration of Helsinki, and it was approved by the Research Ethics Committee of Universiti Teknologi MARA (Ethics code: REC/01/2024 (ST/MR/11)). Additionally, approval was obtained from the Ministry of Education [KPM. 600-3/2/3-eras (18955)]. The data collected from this study were analyzed using SPSS Statistical Software version 27.0.1.0. The study implemented a within-subject study design where the participants participated in all experiment conditions. Descriptive statistics for all demographic variables were tabulated in terms of the number of participants and percentages. Normality and homogeneity of variances were tested to ensure no assumptions were violated. The Shapiro-Wilk test of normality was used to analyze all the subtests. Inferential statistics were further analyzed. A one-sample Wilcoxon signed rank test was implemented to compare the median of TVPS-4 scores with the U.S. normative score for each subtest. The significance level, α , 0.05, was set for all statistical tests.

3.4. Study Protocol

The independent variable of this study is visual perceptual skills, including visual discrimination, visual memory, spatial relationships, form constancy, sequential memory, visual figure-ground, and visual closure. To identify the visual perceptual scores, TVPS-4 was used to test the subjects, and it was estimated to take around 25 minutes to complete. The test was conducted after determining the visual functional profile to

detect any uncorrected refractive error or abnormal depth perception among the subjects. For convenience, the TVPS-4 included line drawings in black and white that were shown in an easel-style brochure. The test questions were multiple-choice and only required basic answers, such as pointing or a small amount of spoken speech. There were eighteen items in each of the seven visual-perceptual categories ([Academic Therapy Publication, 2023](#)). The test was given one-on-one, without a timer, and took roughly twenty-five minutes to complete on average. The scoring process was simple: each subtest's raw results were transformed into scaled scores and percentile ranks. Age-equivalent scores for both subtests and the overall performance were also provided, as well as the total standard score and percentile rank ([Academic Therapy Publication, 2023](#)).

Before the test began, the subjects had to undergo visual acuity and stereo acuity testing. The tests were done to determine whether the subjects fulfilled the inclusion criteria of this study. The subjects that passed both criteria and were able to understand spoken Bahasa Melayu were then prepared for the TVPS-4 assessment. The subjects were given explanations of the test procedures and were ensured to understand the instructions before proceeding with the test. The time required to complete this assessment was 30 minutes. However, the subjects were encouraged to respond quickly if possible. The average time to complete each selection was within 20 seconds, except for the subtests of Visual Memory and Sequential Memory with a timed component. Once the new plate was shown, the previous plate could not be displayed again because the normal values were acquired from the subject's performance after viewing the images once. The assessment began by administering example plates. There were two example plates and 18 testing plates arranged according to the difficulty level. When administering example plates, the subjects were ensured to understand the subtest instructions. Once the testing plate was administered, further teaching of the task was not allowed.

The test began with the first subtest, which was visual discrimination. In this component, the subjects were asked to find an image that exactly matches the target image from a field of five similar images. The test continued with a visual memory subtest. In this component, the subjects were asked to memorize the target image after being presented for five seconds. Then, the subject must find the image among the four images on the next page. The next subtest was a spatial relationship in which the subjects were required to find an image different from the others among five images. The fourth subtest was the form constancy test. In a field of four/five images, the subjects were required to find one image that matches the target image, in which the matching image can be rotated, enlarged, or reduced, and/or embedded in a larger design. The fifth subtest was a sequential memory test, which required the subject to remember the sequence of elements of the presented image within 5 seconds. The subjects were then required to find the same sequence image among four images presented on the following page. The test continued with a visual figure-ground subtest. In this component, the subjects were asked to find the embedded image similar to the target image in a field of four complex designs. The visual closure subtest was then carried out by asking the subject to match an incomplete target image to the correct completed image among four images.

4. Results and Discussion

A total of 29 schoolchildren participated in this study. All the participants were Temuans, an indigenous group from Peninsular Malaysia. The majority of the participants have a

household income of less than RM3000. Most participants' maternal and paternal education was at the primary school level. The majority of the participants' maternal occupation status was unemployed, while their paternal occupation status was employed. The demographic data of the participants are presented in [Table 1](#).

Table 1: Sociodemographic data of the participants

Characteristics		Frequency (n)	Percentage (%)
Gender	Female	17	58.6
	Male	12	41.4
Ethnicity	Orang Asli (Semenanjung), Temuan	29	100.0
Household Income	<RM3000	18	62.1
	≥RM3000	3	10.3
	NIA	8	27.6
Maternal Education	Bachelor's Degree	1	3.4
	Diploma	1	3.4
	Secondary School	8	27.6
	Primary School	14	48.3
	NIA	5	17.2
Paternal Education	Diploma	2	6.9
	Secondary School	6	20.7
	Primary School	12	41.4
	NIA	9	31.0
Maternal Occupation	Employed	9	31.0
	Unemployed	14	48.3
	NIA	6	20.7
Paternal Occupation	Employed	17	58.6
	Unemployed	3	10.3
	NIA	9	31.0

NIA: No Information Available

The one-sample Wilcoxon signed rank test was done to compare the participants' median with the median of the normal value (U.S. norms). All 29 participants were included in this analysis. The Wilcoxon signed rank test revealed a statistically significant difference between the obtained median and the normal value for visual discrimination ($Z = 2.199$, $p = 0.028$), form constancy ($Z = 2.385$, $p = 0.017$), and visual closure ($Z = 2.865$, $p = 0.004$). The overall standard score showed an insignificant difference from normative scores ($Z = 1.145$, $p = 0.252$). The result of the Wilcoxon signed rank test was tabulated in [Table 2](#).

This study's results provide a more differentiated perspective on visual perceptual development in urban Indigenous schoolchildren, countering some widely cited claims in existing literature. The participants' visual perceptual abilities aligned closely with U.S. normative standards, showing no statistically significant difference in overall standard scores ($p = 0.160$). Such findings diverge from prior research on rural Indigenous populations, which has indicated measurable deficits in comparable tasks ([Hopkins, 2014](#)). This is in line with ecological systems theory, which emphasises how environmental and socioeconomic factor contexts shape cognitive outcomes, and

suggests that the urban environment, which is marked by increased educational access and enriched visual stimuli, may serve as a protective factor supporting typical visual perceptual development (Hairol et al., 2021). With structured learning opportunities like literacy instruction and visual games that support the development of particular skills like form constancy and visual closure, urban schools serve as important microsystems. Furthermore, these skills are probably reinforced through ongoing engagement by the larger urban landscape, which is full of varied and repetitive visual cues like digital screens and signage (Johnson & Levitan, 2022; Trott et al., 2025). These results suggest that rather than being due to inherent developmental limitations, the visual perceptual delays observed in rural Indigenous groups may be primarily caused by educational and environmental factors that can be changed.

Table 2: Comparison between the study participants and the U.S. Norms for TVPS-4 standard score (normative median: 100±15) and scaled scores (normative median: 10±3)

TVPS-4 Score	Study Participants	The U.S. Norms	Z-statistic	P-value
Visual Discrimination	10.00 ± 3	10 ± 3	2.20	0.028
Visual Memory	10.00 ± 1	10 ± 3	1.45	0.147
Spatial Relationships	9.00 ± 3	10 ± 3	-1.81	0.070
Form Constancy	11.00 ± 4	10 ± 3	2.39	0.017
Sequential Memory	11.00 ± 3	10 ± 3	1.72	0.086
Visual Figure-Ground	10.00 ± 2	10 ± 3	0.04	0.971
Visual Closure	11.00 ± 2	10 ± 3	2.87	0.004
Overall Standard Score	102.00 ± 9	100 ± 15	1.41	0.160

In comparison to normative data, the analysis showed noticeably better performance in form constancy ($p=0.017$) and visual closure ($p=0.004$). These improved skills result from unique elements of Indigenous children's educational and environmental experiences in urban areas. One fundamental skill that is methodically developed through formal literacy instruction is form constancy, which is the ability to recognise letters, numbers, and shapes in a variety of orientations and sizes (Yang & Meng, 2020). Compared to traditional learning environments, urban educational settings offer more consistent reinforcement of these skills. Extensive exposure to complex visual stimuli found in urban landscapes, such as digital interfaces and built environments, may also contribute to superior visual closure performance. These results are consistent with well-established frameworks of neuroplasticity that suggest cognitive systems adjust to repeated demands from the environment (Khabbache & Ait Ali, 2024).

Despite maintaining median values within normative ranges (median=10), the analysis showed significant variability in visual discrimination performance ($p=0.028$), with scores showing greater dispersion than other domains. This intricate pattern might be a reflection of variations in visual processing development mediated by culture. Recent research indicates that differences in early perceptual experiences and environmental

visual salience influence how visual discrimination skills develop differently across cultural contexts ([Çayir, 2017](#)). Since visual discrimination essentially involves symbol recognition, which may be impacted by bilingual exposure (Bahasa Melayu and indigenous languages) in these populations, an alternate explanation takes linguistic influences into account ([Abd Jalil et al., 2023](#)). The lack of notable variations in figure-ground skills, visual memory, spatial relationships, and sequential memory raises the possibility that these areas reflect more universal developmental competencies or are less susceptible to the effects of urban environments. When proper environmental support is provided, many visual perceptual skills develop similarly to normative expectations, although urban Indigenous children may benefit from targeted support in specific areas. This pattern has significant implications for educational practice. These results cast doubt on deficit-based theories of Indigenous cognition and emphasise how crucial it is to take context into account when evaluating developmental stages.

From a methodological standpoint, using TVPS-4 had a number of benefits, but it also had some noteworthy drawbacks. Beyond the global scores usually reported in prior studies, the extensive seven-subtest structure enabled detailed profiling of visual perceptual strengths and weaknesses ([Brown & Peres, 2018](#)). Despite being widely applied globally, Western-developed norms might not adequately consider cultural differences in visual processing styles. Qualitative observations of visual perceptual behaviours in naturalistic environments or culturally tailored assessments could be used to augment standardised measures in future studies.

One important consideration when interpreting the study's findings is its urban setting. The well-established educational system, such as in Petaling, which includes well-equipped schools and qualified teachers, probably offers visual perceptual stimulation on par with that which non-indigenous urban children can access ([Wood, 2023](#)). These stand in stark contrast to the resource limitations that rural indigenous schools frequently encounter. Furthermore, children may be exposed to a variety of visual stimuli that foster particular perceptual abilities due to urban indigenous families' increased access to digital technology. Future multi-site research comparing indigenous populations in urban, semi-urban, and rural areas is necessary, as the study's single-site design restricts our capacity to distinguish particular urban influences.

Longitudinal studies that monitor visual perceptual development over the course of primary school years are the first important research avenues highlighted by this study. These studies could shed light on developmental trajectories and possible windows for intervention. Furthermore, comparative studies between indigenous communities in urban, semi-urban, and rural areas are required to investigate the ways in which different environmental and socioeconomic contexts impact perceptual abilities. Additional research on environmental factors at home and at school, such as parental participation, access to learning materials, and screen time, may clarify how these factors influence visual perceptual abilities. In order to ensure that assessments take into consideration linguistic and cultural variations that could influence test performance, culturally appropriate assessment instruments must be developed using local normative data. Together, these lines of inquiry would improve our knowledge of how Indigenous populations develop their visual perceptions and guide more equitable clinical and educational approaches.

5. Conclusion

This study concludes by offering strong evidence that urban indigenous schoolchildren in Petaling, Selangor, have visual perceptual abilities that are on par with standardised norms, with form constancy and visual closure showing particular strength. These results underline the transformative potential of urban learning environments and cast doubt on oversimplified narratives about Indigenous cognitive development. The study adds to a more complex, strengths-based understanding of Indigenous development and guides initiatives to maximise educational support for this population by capturing the abilities of these urban Indigenous children. The findings lay the groundwork for further studies on visual cognitive development in various cultural contexts and highlight the significance of taking the environment into account when evaluating the development of Indigenous children. According to this study, Indigenous children living in urban areas face particular visual perceptual difficulties that could affect their academic achievement and long-term educational results. For Malaysia's Indigenous populations, early identification and focused interventions can help avoid learning challenges, lessen educational inequities, and advance health equity.

Several limitations must be acknowledged when interpreting these findings. The modest sample size ($n=29$) restricts statistical power and generalizability, particularly for subgroup analyses. The cross-sectional design precludes examination of developmental trajectories over time. Furthermore, the study did not assess potential mediating variables such as home learning environment, screen time exposure, or parental education levels that might help explain individual differences in visual perceptual development.

Despite these limitations, the study has important practical implications. Since no similar study has been conducted in the Petaling district, Selangor, Malaysia, this research identifies the key factors influencing the visual perception of the schoolchildren among the Indigenous population in this region. For educators, the results suggest that urban Indigenous children arrive at school with visual perceptual capacities largely comparable to normative expectations, reinforcing the importance of maintaining high academic expectations. The identified strengths in form constancy and visual closure could be leveraged in literacy instruction, while the variability in visual discrimination might warrant targeted support for some students. For healthcare providers, the findings indicate that vision screening protocols for urban Indigenous children should not assume perceptual delays but rather assess each child's profile individually.

Ethics Approval and Consent to Participate

The researchers used the research ethics provided by the Research Ethics Committee of Universiti Teknologi MARA (Ethics code: REC/01/2024 (ST/MR/11)). All procedures performed in this study involving human participants were conducted in accordance with the ethical standards of the institutional research committee. Informed consent was obtained from all participants according to the Declaration of Helsinki.

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Conflict of Interest

The authors declare no conflict of interest.

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