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Construct-related Validity of the Preschool Sound Production Test in Indonesian-Speaking

Rexsy Taruna[1], Jumiarti[2]✉, Hikmatun Sadiah[3], Stella Rosalina Phandinata[4]
Universitas MERCUBAKTIJAYA, Indonesia(1)
Politeknik Arutala Johana Hendarto, Indonesia(2,3)
Pantai Indah Kapuk Hospital, Indonesia(4)
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Abstract
The availability of a speech intelligibility test that is in accordance with Indonesian with good psychometric evidence is needed for clinical practice needs. This study aims to evaluation whether the Tes Produksi Bunyi Prasekolah (*Preschool Sound Production Test*) has evidence of construct validity. Seventy-eight preschool children were divided into three groups. Typical Groups I and II were children without speech sound disorder who lived in Jakarta and Padang. Group III was children with speech sound disorder. Participants in each group consisted of 26 children. Ten participants were 4 years old and 5 years old, and 6 participants were 6 years old for each group. Speech intelligibility, percentage of consonants correct, and percentage of vowels correct were assessed individually using the Preschool Speech Sound Production Test. Based on the analysis results, it was found that the speech intelligibility index in the SSD group was lower than in Typical Group I (MD = -43.9; $p < .001$) and Typical Group II (MD = -41.96; $p < .001$). Referring to the results obtained, it can be concluded that the Preschool Sound Production Test has construct validity.

Keywords: *Speech intelligibility, Preschool Sound Production Test, Speech sound disorder*

✉ Corresponding author: Jumiarti
Email Address: jumiarti@atw-ybw.ac.id (Jakarta, Indonesia)
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Introduction
Achieving developmental milestones at preschool age is believed to be a very important achievement for the child's later life, such as motor development (fine motor skills, gross motor skills), adaptive behavior, cognitive, social emotional, communication, language and speech development (Dale et al., 2025). Not surprisingly, many studies explain that abilities in certain developmental areas are good predictors in predicting a child's readiness to move on to a higher stage (eg, communication, reading, and spelling readiness), one of which is speech intelligibility (Hayiou-Thomas et al., 2017). Speech intelligibility is an important aspect of preschool children's development.

Speech intelligibility refers to a child's ability to pronounce words clearly so that they are easily understood by others (Bauman-Waengler, 2016). At preschool age, children are in a stage of rapid language development, and the ability to speak clearly is essential to support effective communication. The importance of speech intelligibility lies in its ability to increase children's confidence when interacting with peers and adults, as well as facilitating better

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learning in the preschool environment. Children who are able to speak clearly tend to be more able to understand instructions, express their needs and desires, and build positive social relationships (Simoni et al., 2019). Therefore, parents and professional need to pay special attention to the development of children's speech intelligibility in order to support their readiness to enter the world of formal school.

Speech intelligibility can be defined as a child's ability to produce speech sounds well in the context of verbal communication (Bernthal et al., 2017). In children, the acquisition of speech intelligibility is a result of the integration of phonological representational abilities, speech motor programming, neuromuscular systems, and mature articulatory (Duffy, 2013; Raphael et al., 2011; Taruna, 2024). In the early years of life, children display the process towards mastering speech intelligibility through vocalization, babbling, canonical babbling, imitation, functional word production with predictable errors (phonological process) until they are able to produce sounds clearly like adults (Bowen, 2015; McLeod & Baker, 2017).

Based on research by Jumiarti et al. (2024), 4-year-old Indonesian-speaking children have an average speech intelligibility of 81.32%, percentage of consonants correct (PCC) 88.57%, and percentage of vowels correct (PVC) 92.60%. As age increases, such as age 5, speech intelligibility increases to 86.13%, PCC 90.57%, and PVC 93.99%. Then, at age 6, speech intelligibility increases to 96.40%, PCC 95.19%, and PVC 97.21% (Jumiarti et al., 2024). Similar things were also found in several non-Indonesian language speakers, such as Arabic, Danish, German, English, French, Hungarian, Malay, Portuguese, Swahili, Setswana, Turkish, and Xhosa that the accuracy of PCC and PVC at the age of 4 years was not less than 90% (McLeod & Crowe, 2018).

In clinical practice, a high speech intelligibility index represents that the child has good abilities in phonological representation, speech motor programming, speech neuromuscular system, and articulation (Stackhouse et al., 2007). Children who have significant problems in speech intelligibility in clinical practice are referred to as children with speech sound disorders. Speech sound disorders is a diagnostic terminology that refers to children with low speech intelligibility index (APA, 2013). This can occur due to problems in one or more underlying factors, such as auditory perceptual problems, phonological representation problems, speech motor programming problems, and speech motor execution problems (neuromuscular and articulatory) (Dodd, 2014).

Speech sound disorder (idiopathic) has five types of disorders, consisting of articulation disorder, phonological delay, inconsistent phonological disorder, consistent phonological disorder, and childhood apraxia of speech (idiopathic) (Dodd, 2014). Each type of speech sound disorder has low speech intelligibility when compared to typical children who do not have speech sound disorders. The fundamental difference lies in the underlying problem of the disorder in each type (Bernthal et al., 2017).

Speech sound disorder not only significantly affects effective communication, but also affects decoding (word recognition) and encoding (spelling) abilities which will ultimately affect academic abilities. There are many studies that explain that children with SSD have significantly lower decoding and encoding abilities than children without SSD (Peterson et al., 2009; Skebo et al., 2013). Considering the relationship between speech intelligibility and decoding and encoding abilities, it is important for speech therapists to objectively assess children's speech intelligibility abilities at preschool age as a preventive measure. Of course, in practice, the availability of valid, reliable, and standardized test instruments in Indonesia is still a challenge faced by Indonesian speech therapists (Jumiarti et al., 2024).

Based on a literature search using Google Scholar, the only standardized test that can be used in clinical practice to assess speech intelligibility in preschool-age children in Indonesia was found, called the Preschool Sound Production Test (Tes Produksi Bunyi Bicara Prasekolah). The Preschool Sound Production Test is the first test published scientifically and explains the evidence of construct validity by showing significant differences and relationships between each age group on the word-level speech intelligibility index,

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percentage of consonants correct (PCC) and percentage of vowels correct (PVC) (Jumiarti et al., 2024).

Considering the need and existing scientific evidence, this study seeks to provide additional evidence in terms of construct validity by explaining whether the Preschool Sound Production Test can differentiate children with typical from atypical speech intelligibility. The approach used refers to the known-ground method. This method explains that when a test tool is able to distinguish the abilities of two groups that are scientifically known to be different, then the test tool can be said to have construct validity (Hattie & Cooksey, 1984).

Methodology

This study involved 78 preschool children who were divided into three groups. The first group was a group of children who did not have speech sound disorders in the Jakarta area (Typical Group I). The second group was children who did not have speech sound disorders in the Padang area (Typical Group II) and the last group was children with functional speech sound disorders (SSD). The number of participants in each group is fairly similar. Typical group I consists of 26 children, typical group II consists of 26 children, and SSD group consists of 26 children. The age variation in each group is also fairly similar, namely 10 participant aged 4 years, 10 participant aged 5 years, and 6 participant aged 6 years.

The instrument used in data collection was the Preschool Sound Production Test. This test is a standard test to measure whether a child has typical speech intelligibility or not when compared to their age group. This test was developed by Rexsy Taruna, Jumiarti and Stella Phandinata in 2024 (Jumiarti et al., 2024). This test has evidence of construct validity with the known group method. Based on the results of his research, this test is able to differentiate speech intelligiblity in children aged 4, 5, and 6 years. Then, this test shows a correlation between speech intelligibility at the age of 4 years and 5 years, and at the age of 5 years and 6 years.

Each participant in this study was tested individually by a speech therapist and a speech therapist student who had been trained and supervised in its implementation. Each participant was asked to name 31 familiar items with colored pictures, which represented Indonesian consonants complete with their positional variations; initial, medial, and final. The participant's responses were recorded and then transcribed phonetically. A score of 1 was given to items that were responded to correctly without SODA, while a score of 0 was given to items that were responded to incorrectly. The total score was then determined to assess three variables; (1) word-level speech intelligibility, (2) percentage of consonants correct (PCC), and (3) percentage of vowels correct (PVC).

Results and Discussion

Descriptive Analysis

The speech intelligibility index of the SSD group (M = 42.5; SD = 27.31) was lower than that of the typical group I (M = 86.4; SD = 13.23) and typical group II (M = 84.5; SD = 14.84). The same pattern of results was also found in percentage of consonants correct (PCC), where the SSD group (M = 67; SD = 22.14) had a lower PCC compared to the typical group I (M = 94.5; SD = 6.26) and typical group II (M = 90; SD = 10.73).

One-way ANOVA analysis showed that there was a significant difference between speech intelligibility in the SSD group when compared to the typical group (I and II). Speech intelligibility in the SSD group was significantly lower when compared to the typical group I (MD = -43.9; p < .001) and typical group II (MD = -41.96; p < .001). Furthermore, in the percentage of consonants correct (PCC) variable, it was also found that the SSD group had a lower score when compared to the typical group I (MD = -27.5; p < .001) and typical group II (MD = -22.92; p < .001).

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Table 1. Group Descriptives

	SSD Group n = 26	Typical Group I n = 26	Typical Group II n = 26
Speech intelligibility	42.5 (27.31)	86.4 (13.23)	84.5 (14.84)
PCC	67.0 (22.14)	94.5 (6.26)	90 (10.73)
PVC	84.9 (18.88)	97.9 (2.17)	92.7 (9.26)

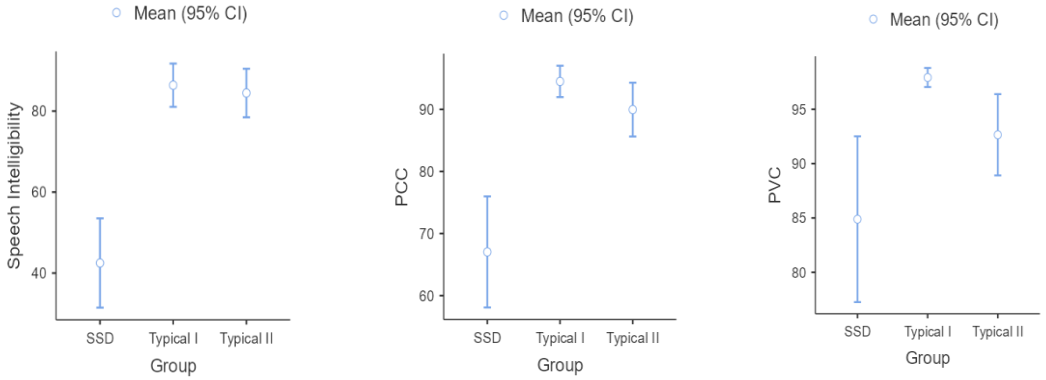

Figure 1. Descriptives Plots

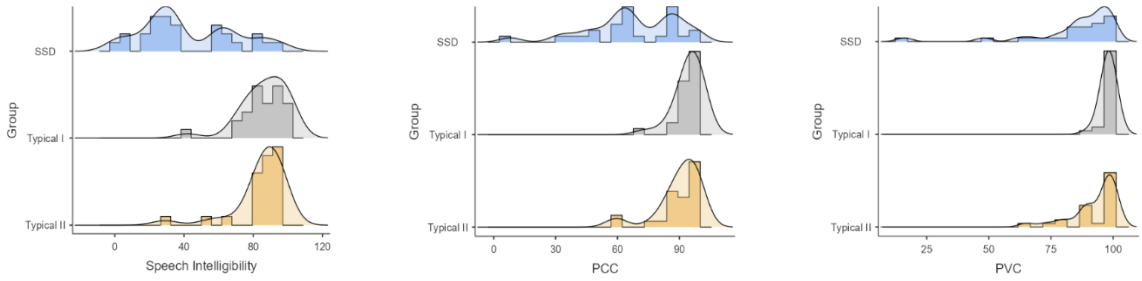

Figure 2. Density Plots

The results of the comparative test in this study are basically no different when compared to previous studies. Hodge and Gotzke (2014) in their research also found that there was a significant difference in the speech intelligibility index between children with SSD when compared with children without SSD at preschool age ($F_{(3, 115)}$ = 61.08, p < 0.001). In another study, consistently identified that speech intelligibility in children with SSD was significantly different when compared to children without SSD (Hustad et al., 2015, 2019, 2021).

This study also identified that the percentage of consonants correct (PCC), and the percentage of vowels correct (PVC) in the SSD group were lower when compared to the typical group (I and II). Similar findings were also found in previous studies. Roepke and Brosseau-Lapré (2021) in their study found that children aged four to five years with SSD had more errors in producing vowels when compared to children with normal speech abilities. The same thing was also found in the ability to produce consonants. Consonant production was significantly lower in the SSD group.

Referring to the literature review, low PCC and PVC are basically the main causes of low speech intelligibility index. Mastery of consonant production is often used as a reference and representation of mature speech sound production ability (Bauman-Waengler, 2016; Edwards & Beckman, 2008; Stackhouse et al., 2007). On this basis, the PCC level in clinical practice can be used to support the diagnosis of SSD and determine the severity of SSD (Dodd, 2014; McLeod & Baker, 2017).

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Low speech intelligibility index can be assumed to occur for several reasons, such as auditory perceptual deficits, phonological representation deficits, speech motor programming deficits, speech neuromuscular deficit (Bauman-Waengler, 2016; Bowen, 2015; McLeod & Baker, 2017). Deficits in auditory perceptual and/or articulatory function are basically the underlying causes of functional articulation disorders, while deficits in phonological representation cause children to have phonological problems (phonological delay, consistent phonological disorder, inconsistent phonological disorder). Furthermore, deficits in speech motor programming and speech neuromuscular are the main causes of children having motor speech disorders (childhood apraxia of speech and dysarhtira).

Although all types of SSD have low speech intelligibility index, PCC, and PVC, each type can occur for different reasons. Considering the many possible underlying causes of low speech intelligibility index, PCC, and PVC, a comprehensive assessment is needed to determine the underlying problem and specific diagnosis of SSD (Dodd, 2014).

Conclusion

This study empirically provides additional evidence that the Preschool Sound Production Test has construct validity through the known group approach. In clinical practice, the preschool sound production test differentiates children with SSD from children without SSD. Although the Preschool Sound Production Test has good evidence of validity and can differentiate children with SSD from children without SSD, it cannot be used to make a specific diagnosis of SSD.

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