

12-31-2018

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Recommended Citation

Ajisuksmo, C. R., Baskara, A. H., & Neidhardt, E. (2018). The Advantage of Being Less Protected: Children's Spatial Orientation in the City of Jakarta. *Makara Human Behavior Studies in Asia*, 22(2), 70-74.
<https://doi.org/10.7454/hubs.asia.1221118>

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The Advantage of Being Less Protected: Children's Spatial Orientation in the City of Jakarta

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Abstract

Path integration as a central process in spatial orientation is a basic cognitive competence used to update spatial positioning while walking. Children develop this competence via self-directed path-finding experiences. This study examines the spatial orientation competences of pre-school children in inner-city Jakarta. The influence of parental protectiveness on path integration competence was investigated, and the children's spatial ability was measured using paper-and-pencil tests. Thirty pre-school children from poor families in three different sub-districts of inner-city Jakarta (Jatinegara Cipinang, Besar Selatan, and Bukit Duri) were tested. Results showed that children who were used to roaming more freely performed better in spatial orientation than those whose parents granted them less freedom to wander alone. Small significant correlations between spatial ability tests and path integration competence were observed. However, being able to move freely in everyday life was far more important than spatial ability measured by pen-and-paper tests.

Keuntungan Anak yang Kurang Dilindungi: Orientasi Spasial pada Anak-anak di Kota Jakarta

Abstrak

Integrasi jalur sebagai proses inti dalam orientasi spasial adalah kompetensi kognitif yang sangat mendasar untuk memutakhirkan posisi spasial seseorang saat berjalan. Pengalaman mencari jalan tampaknya dibutuhkan untuk mengembangkan kompetensi ini pada anak. Studi ini bertujuan meneliti orientasi spasial anak prasekolah di Jakarta. Selain itu pengaruh perlindungan orangtua terhadap kompetensi mengintegrasikan jalur dan kemampuan spasial anak juga diteliti. 30 anak prasekolah dari keluarga kurang mampu berpartisipasi di sekitar lingkungan masing-masing, yaitu Jatinegara Cipinang Besar Selatan dan Bukit Duri. Hasil penelitian menunjukkan bahwa anak yang lebih berkesempatan untuk berjalan-jalan seorang diri memiliki orientasi spasial yang lebih baik daripada anak dengan orangtua yang tidak membiarkan anaknya berkeliaran sendiri. Walaupun ada korelasi yang signifikan tetapi rendah antara hasil tes kemampuan spasial dan kompetensi integrasi jalur, pengalaman bebas berkeliaran dalam kehidupan sehari-hari masih jauh lebih penting daripada kemampuan spasial. Anak yang terlalu dilindungi terhambat untuk mengembangkan integrasi jalur sebagai indikasi dari kompetensi orientasi spasialnya.

Keywords: inner-city children, path integration, pre-school children's everyday activities, spatial ability, spatial orientation

Citation:

Ajisuksmo, C. R. P., Baskara, A. H., & Neidhardt, E. (2018). The advantage of being less protected: Children's spatial orientation in the city of Jakarta. *Makara Human Behavior Studies in Asia*, 22(1), 70-74. doi: 10.7454/hubs.asia.1221118

1. Introduction

This study is part of a field-experiment aimed at understanding the conditions necessary for the development of spatial orientation and spatial ability—two fundamental competences in spatial cognition. Spatial orientation can be based on external representations such

as maps. It can also rely on internal cues derived from mental maps and path integration (Wolbers & Hagerty, 2010). Spatial ability or spatial intelligence can be tested in various contexts, such as mental rotation, spatial visualization, pattern recognition, etc. (for a review, see e.g., Uttal et al., 2013). The competences addressed here are

not homogeneous. The aim of this study is to investigate the relations between these specific aspects of spatial cognition and to identify factors influencing spatial orientation and spatial ability.

Children's physical environments define the conditions in which they grow up. In an urban context, giving priority to traffic or to pedestrians may influence both the city's appearance and the development of the inhabitants' basic cognitive competences. For the future development of Jakarta, this is psychologically interesting and worthy of consideration in terms of urban planning and design.

The ability to deal with problems and tasks that require the estimation, prediction or assessment of spatial relationships between individual objects or figures is known as "spatial ability" (Eliot & Smith in Kveton, Jelinek & Vaboril, 2014). Lohman (in Wang, Lee, & Sun, 2013) defined this as the ability to generate, retain, retrieve, and transform images. Meanwhile, Caroll (in Höffler, 2010) defined it as an individual ability related to visual aspects, such as forms, shapes, and the positions of objects. In these definitions, spatial ability relates to the way individuals perceive visual objects. These objects are reformed as mental representations and manipulated accordingly. Spatial ability, thus, includes the cognitive processes necessary for perceiving, interpreting, and remembering objects. Spatial ability is considered important for scientific, technical, engineering, and mathematical learning (Uttal et al., 2013). The relation between spatial ability and real-life orientation, however, requires further analysis.

Our memory of the spatial environment is very important for navigating in new spaces. Keeping track of our position while moving in complex environments is known as "dead reckoning" or "path integration" (Loomis et al., 1993; Lourenco & Frick, 2014). Path integration is based on visual information from external cues along the path, or on ideothetic cues from the perception of the moving body. As such, it is an important aspect of spatial orientation. Zhang and Mou (2017), however, used the terms differently. Here, dead reckoning based on visual information processing is called "piloting." Path integration, meanwhile, is restricted to our processing of the perception of the moving body. As this study is focused on young children's spatial orientation as a general skill, the specific processes contributing to spatial orientation will not be analyzed. The term "path integration" will be taken to include visual information and body perception processes that allow the child to keep track of his/her position while in motion.

Survey knowledge is another aspect of spatial orientation. In familiar environments, children have an inner representation of their well-known surroundings (Monzel & Neidhardt, 2016). This representation, known as a "mental map" (Tolman, 1948), is generated from the

child's experience of moving in a familiar area. It forms part of the child's long-term memory system. As shown in experiments by Tolman and elsewhere, dead reckoning and mental maps are not restricted to humans. Spatial orientation is a fundamental aspect of almost every species' cognition.

Big cities, such as Jakarta generally give priority to traffic, forcing parents to protect their children against the dangers of navigating busy streets on their own. Previous studies have shown that a child's spatial orientation development may be affected by the environment in which they grow up (Neidhardt & Popp, 2012). Studies conducted in Africa and Germany have shown that children from the African desert who were used to roaming around on their own outperformed German children who lived in a city and are unused to solo wandering (Monzel & Neidhardt, 2016). In most cities worldwide, pre-school children are protected from the traffic by their parents. Most are not allowed to go out by themselves. This helps them to avoid accidents (Graham, McCoy, & Stephens, 2013), and yet they also lack spatial experience in a real-world environment. They have no opportunity to develop basic spatial orientation competences during childhood. However, this is not necessarily the case for certain children in Jakarta.

Path integration competences should be better in children from less protective backgrounds. This study focuses on children from Jakarta who are from a lower socioeconomic background with parents who may, due to a lack of resources, allow their children to roam around unaccompanied. The influence of spatial experience in daily life on path integration and spatial ability is also investigated, as is the relation between these two competences as aspects of spatial cognition. Gender, age, and spatial experiences have been identified as factors relating to spatial orientation and spatial ability. These are, therefore, included when considering the influencing variables.

2. Methods

Participants. Thirty pre-school children aged 5–6 years (16 girls and 14 boys) participated in the study. They were all from poor families living in three areas of inner-city Jakarta: Jatinegara (J, $n = 9$), Cipinang Besar Selatan (C, $n = 10$), and Bukit Duri (B, $n = 11$). Based on the information from the interviews, children from the J area were categorized as having more protective parents. Children from the C and B areas, meanwhile, were categorized as having less protective parents and being allowed to roam around more freely. The mean age was 5.4 years ($SD = 1.0$ year), and there was no significant age effect for the different groups. The Ethical Commission of the Atma Jaya Catholic University of Indonesia provided ethical clearance for the study,

and parents gave informed consent for the involvement of their children.

Instruments. To measure path integration, a Global Positioning System (GPS) tool designed to obtain the GPS coordinates and the direction of the target objects was used. A “pointer” was employed, consisting of a horizontal disk mounted on a tripod. The tripod was adjustable to each individual child’s height, with a rotatable handle ending in a needle on the disk. A compass was fixed laterally on the tripod. The disk had a graduation of 360°. With the help of the compass, the pointer was aligned with “0” on the graduation scale, and set in the north direction. By revolving the handle, the child made the needle point in the intended direction, and the graduation scale made it possible to measure the child’s pointing relative to north. The pointer was used to gain an accurate impression of the child’s bearings. To measure spatial ability, both the Picture Rotation Test (PRT; Hinze, 2002; Quaiser-Pohl 2003) and the Children Embedded Figures Test (CEFT; Witkin, Oltman, Raskin, & Karp, 1971) were used.

Procedures. Each of the participating children was led along a path for several hundred meters within his/her residential area, starting at the origin (an NGO-run learning center) and stopping at three different locations along the way. At each location, the child was asked to point to the origin (internal target) and to a landmark, such as a local mosque, beyond the path (external target) that was known to all the children independently. At each of the three stops, the children were asked to point with their outstretched arm and index finger first to the internal and then to the external target. They were then asked to repeat this action with the pointer. On the return journey, the children stopped at the same three locations. Once again, they were asked to designate the internal and the external targets with their fingers and the pointer. The targets could not be seen from any of the pointing locations. Pointing accuracy to the origin measured the child’s path integration competence while pointing accuracy to the external target measured their survey knowledge. Dependent variables were calculated as absolute differences between correct bearings (as measured by the GPS) and the child’s “pointed” bearings.

After finishing the walk and measuring the child’s spatial orientation, data collection continued with the PRT and CEFT tests. In the PRT, the children were given 17 questions in the form of pictures, each with three possible alternatives. They had to mentally rotate the figure and decide quickly whether the picture was similar to one of the three alternatives. In CEFT, the children were asked to find the pattern of a tent corresponding to a similar image that they had been given earlier. If the child was able to answer (even if this involved only one correct answer) they were given a more complex prob-

lem in which a house had to be detected among the rest of the pictures. However, if the child was not able to answer any of the 11 questions correctly, the test did not proceed any further.

3. Results

For spatial orientation, the means of absolute differences between pointing directions (in degrees of a circle, with north as 0) and correct bearings were calculated for all six pointing locations. An ANOVA with the factors “gender” and “pointing method” (finger vs. pointer) revealed that the children had difficulties in using the pointer to locate the origin. The mean deviation from the correct bearing of the origin was significantly larger for the pointer than for the finger ($F(1, 28) = 9.73, p < 0.01, \eta^2 = 0.26$). There was no significant gender effect and no significant interaction effect. Therefore, only finger pointing was used in the analysis.

The Influence of Parental Protection on Spatial Orientation. A 2x3 ANOVA with the “target” (internal vs. external) as the within factor and “area” (J, C, B) as the between factor resulted in a main effect for the target ($F(1, 27) = 11.78, p < 0.01, \eta^2 = 0.30$) and a main effect for the area ($F(2, 27) = 10.35, p < 0.001, \eta^2 = 0.43$). There was no significant interaction effect. As can be seen from Figure 1, pointing to the origin was much better than pointing to the external target for all groups. The more protected group (J) performed much worse when pointing to both targets than the two less protected groups (B, C). (Note that as deviations are the dependent variables, larger values indicate worse performance).

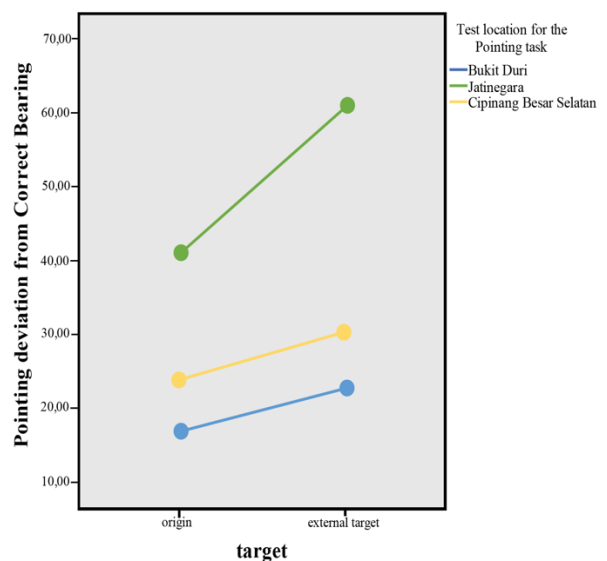


Figure 1. Deviations From Correct Pointing for the Three Area Groups when Pointing to the Internal and External Target

The Relation between Spatial Ability and Spatial Orientation. One of the children in group C refused to participate in the spatial ability test; therefore, the analysis was carried out with 29 subjects. Dependent variables were the percentage of correct answers in the tests. There was no significant gender effect for the spatial ability tests. A 2x3 ANOVA with “test” (CEFT, PRT) as the within factor and “area” (J, C, B) as the between factor resulted in a significant test effect ($F(1, 26) = 67.18, p < 0.001, \eta^2 = 0.72$) and a significant effect for area groups ($F(2, 25) = 4.1, p < 0.04, \eta^2 = 0.24$). There was no significant interaction effect. As figure 2 indicates, CEFT was much more difficult than PRT, and for both tests, the children in the J group performed less well than those in the B and C groups.

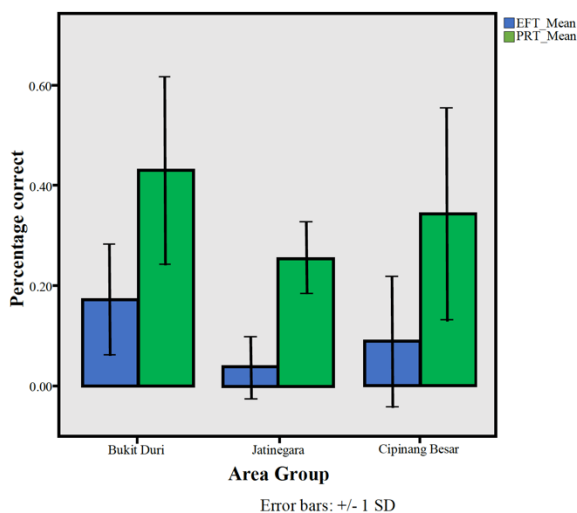


Figure 2. Spatial ability tests for the three groups

The two spatial tests were significantly correlated ($r = 0.53, p < 0.01$). There was no significant correlation between PRT and either finger pointing to the internal or the external target. There was a tendency correlation between CEFT and pointing to the internal target ($r = -0.32, p < 0.10$), and a significant correlation between CEFT and pointing to the external target ($r = -0.38, p < 0.05$). The correlations were negative because better test performance is indicated by higher values, whereas better pointing performance is indicated by lower values.

4. Discussion

All three groups showed better performance for path integration (dead reckoning, pointing to the origin) compared to survey knowledge (pointing to the external target). This is in line with earlier results from a similar study conducted with German preschoolers (Neidhardt, 2002). Significant differences were observed between the three groups, with the group from the J area per-

forming worst. These children, who had higher levels of parental protection, did not show the same spatial orientation competences as the other groups. Their more limited experience of their surroundings appears to have hindered the development of their spatial orientation. The groups also differed with respect to the spatial ability tasks. As there was no hypothesis predicting better performance for the less protected groups, interpretations should thus be treated with caution. Nevertheless, there was a (marginal) significant correlation between spatial orientation competences and spatial ability tests. The spatial ability effect was much smaller than the testing area effect (i.e., parental protectiveness) on spatial orientation. While this small correlation suggests that spatial orientation and spatial ability may share a portion of cognitive resources, it also justifies considering them as separate aspects of spatial cognition.

Our data do not allow us to distinguish between the reported effects. All of the participants come from poor families. Children from families in richer areas should perhaps be even more protected, as traffic is a risk factor for children roaming the streets in any big city, especially one such as Jakarta. Children from higher social status families were expected to perform worse in spatial orientation tasks and survey knowledge tasks. However, they could be expected to perform better in spatial ability tasks, as they are probably more used to using a paper-and-pencil. Hence, it is possible to separate the influence of parental protection both for spatial orientation and spatial ability. We could hypothesize that children from poorer families benefit from their freedom of movement in terms of their spatial orientation; and that children from more affluent families have an advantage in terms of spatial ability. Jakarta, with its dense traffic and its wide social variance, would make a compelling environment for such a future study.

5. Conclusion

The study showed the benefits of children being able to roam freely, despite an urban setting that often prevents parents from allowing them to do so. Physical experience was shown to be more important than spatial ability, as measured by paper-and-pencil tests, in developing path integration. However, the scope of this study was limited, and further research including other social variables relevant to cities like Jakarta is required. Future work in this area could provide useful data for urban planners and city administrators, as well as parents and educators.

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