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Balinese Spatial System: Evidence From Bengkala Village Sign Language

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The present study was designed to show how language affects human cognition by investigating frames of reference used in Bengkala sign language. Three hypotheses were tested: (1) Adult signers in the village employ an absolute system of spatial reference to respond to linguistic tasks; (2) the child signers use the intrinsic, relative, or absolute system of spatial reference in response to the linguistic tasks; and (3) adult and child signers use the absolute system of spatial reference in the nonlinguistic tasks. This study employed two linguistic tasks (i.e., object rotation and asking direction) and one nonlinguistic task (i.e., object rearrangement), involved 10 deaf children and 12 deaf adults, and was administered in both indoor and outdoor settings. The results showed that the child and adult deaf subjects consistently used pointing in the linguistic tasks in the two conditions. In contrast to these results, the child and adult deaf subjects used absolute responses in the nonlinguistic task. The results from the current study demonstrate how language, in this case the signed language, structures linguistic responses independently of cognition. The use of absolute responses by the deaf subjects seems to suggest that cultural practice guides spatial reference in nonlinguistic tasks.

Keywords: sign language, spatial system, absolute system, relative system, spatial cognition

Introduction

Spatial aspect of language (i.e., non-topological relation or frame of reference, as is used in the current paper), has long become a debatable topic among scholars. There are scholars who claim that spatial cognition is universally shared by humans (Fodor, 1975; Landau & Jackendoff, 1993; Pinker, 1994). In contrast to the universalists' view, there are scholars, through their cross-linguistic studies, pointing out that spatial cognition is relative due to cultural differences shared by different languages (Pederson et al., 1998; Wassmann & Dasen, 1998).

A substantial number of studies have investigated linguistic systems of spatial reference for evidence of the tie between language and human cognition (Levinson, 2003; Boroditsky, 2011; Aryawibawa, 2010, 2012, 2016;

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Aryawibawa, Parthama, Putra Yadnya, & Pye, 2018; et al.). The research that we report in this paper extends this investigation to the signs used by the deaf population living in a Balinese village. The study follows a previous investigation of spatial reference used in the spoken language of people living in the same village (Aryawibawa et al., 2018). Additionally, the current study was also expanded in the sense that experiments were administered in two different scenes (i.e., indoor and outdoor) with the main objective to find out if the presence of a landmark affected the signers' responses.

Defining Frame of Reference

In this section, definitions of frame of reference are provided referring to Aryawibawa (2010). The definitions, however, are partly reported here.

The Intrinsic Frame of Reference

An intrinsic frame of reference involves inherent facets or sidedness of reference objects. The procedure to determine the inherent facets varies cross-linguistically. English, for example, determines the inherent facets based upon the functions of objects.

Thus, the front part of a TV refers to the side we attend to when we are watching it. For a car, the front is the part that canonically lies in the direction of motion. On the other hand, there are languages like Tzeltal that use the shape of the object, together with volumetric analysis or internal geometry, to decide the inherent facet. For example, a teapot's parts are identified by its shapes, i.e., the lid of the teapot is called its "mouth", the spout is named its "nose", the teapot handle is called its "ear", and the bottom part of the teapot is named its "bottom". Once the parts are identified intrinsically, they remain the same even though the object is rotated. In other words, the names of the teapot's parts do not depend on an observer's orientation.

The Relative Frame of Reference

The relative frame of reference requires a viewpoint, a located object, and a reference object. In other words, this frame of reference requires triangulation of three points, and employs coordinates based on the speaker's viewpoint to specify the relation between the "Lo" and "Ro". Thus, the English example "The ball is to the left of the tree" illustrates a relative frame of reference.

The relative frame of reference relies upon planes through the human body which establish sets of oppositions, i.e., up/down, front/back, and right/left. This kind of coordinate system can be considered to centre on the main axis of human body, i.e., front is anchored to the human chest. Having determined the front, the other directions can be found by clockwise rotation from front to right, back, and left (Herskovits, 1982). The use of the main axis of the body is one way to anchor the coordinates. Another possibility is to use human vision, i.e., the direction of gaze in defining "behind". Therefore, the relative frame of reference is closely related to human visual perspective.

The Absolute Frame of Reference

An absolute frame of reference uses fixed bearings or cardinal directions corresponding to the directions related to compass bearings, e.g., "north", "south", "east", and "west". The cardinal directions, conceptually, are very abstract. In other words, they cannot be thought of as a proximate place or landmark (Levinson, 2003, p. 90). Thus, to describe a spatial situation "The girl is to the left of the tree", a speaker of the language employing an absolute frame of reference says "The girl is north/south/east/west of the tree" instead.

Previous Research on Balinese Spatial Reference

Aryawibawa et al. (2018) investigated the use of Balinese spatial systems in the north of Bali island and reported that adults used an absolute system exclusively in object rotation tasks. For child participants, nevertheless, even though the use of the absolute system was dominant, the employment of relative, intrinsic, and other systems (i.e., the use of demonstratives "here" and "there") were also observed. Interestingly, it was also observed that there was a developmental trend in using the three spatial systems by children. More concretely, there was an increase of using the absolute system from 23% by the younger children (6-8-year-old) to 68% by the older children (9-12-year-old), and a decrease in using the intrinsic system from 47% by the younger children to 12% by the older children. The employment of the relative system by the two groups was stable (from 18% by the younger children to 20% by the older children).

For the second linguistic tasks (i.e., the asking direction tasks), the usage of the absolute system by the adults was again exclusive. Unlike the results of the object rotation tasks, the child participants' operation of the relative system for the task was dominant (63%). Their use of the absolute system was only 35% and the use of the deictic responses "here" and "there" was 2%. In this task, the child participants, who used to get exposed to Indonesian when they attended schools in the capital city Denpasar, switched to the Indonesian relative system *sebelah kiri/kanan* "to the left/right side". We interpreted the use of *sebelah kiri/kanan* as the application of the Indonesian relative system.

The significant evidence to show that language directs human cognition can be pointed out from the results of the nonlinguistic tasks (i.e., object rearrangement tasks). Of six codable responses produced by adults, 84% of them applied the absolute system, while 16% used the relative system. For the child participants, of 25 codable responses exhibited; 72% of them employed the absolute system and 28% of them applied the relative system. The pattern was similar to the results of the object rotation tasks. Interestingly, the developmental trend in using the two systems was again observed. In more specific terms, there was an increase of using the absolute system from 60% by the younger children to 75% by the older children. The adult's responses to the three tasks and the developmental changes in the object rotation and the object rearrangement tasks by the child participants suggest that there is a correspondence between the child and adult responses to both linguistic (i.e., object rotation task) and nonlinguistic task (i.e., object rearrangement tasks). In other words, the results seem to suggest that language directs human cognition.

In relation Bengkala sign language, there are several studies on the sign language used in Bengkala village. The sign language is commonly called *Kata Kolok* (literally translated as "Deaf Talk") by Balinese. For examples, Marsaja (2015) describes the sociolinguistic aspects of the sign language and Putri (2018) explains the grammar of the sign language (e.g., the pronoun, modality, time, place) and its socio-cultural aspects. A study by de Vos (2012) comprehensively addressed the frame of reference used by local signers in the village. The study employed linguistic tasks (i.e., Man and Tree Game) and nonlinguistic tasks (i.e., Animals in a Row) involving 12 signers in each task. The original version of the first task consists of pictures with a tree and a man holding a stick. But there are also pictures with other objects such as balls and other stimuli showing two men. In the experiments conducted by de Vos (2012), objects were used, not pictures. The main objective of the Man and Tree task is

> for one participant (known as the director) to describe a spatial array to another participant (the matcher). The descriptions of the director are used as linguistic data, and the interpretations of those descriptions by the matcher provide insight into the semantics of these constructions. (De Vos, 2012, p. 287)

The total of 26 stimuli were used in the experiments and the 12 signers were grouped into six pairs each comprising of director and matcher. The experiments were divided into four stages. In Stage 1, the researcher asked the director to look at the object arrangement. The researcher and the director then talked for about 30 seconds to make sure that the director did not memorize the arrangement. When this happened, the objects were taken, and moved to another table and the position of the director was rotated 90 °from his earlier position. The researcher afterwards gave the objects to the director to be rearranged on a table (Stage 2). In Stage 3, the director described the arrangement to the matcher so he could do the arrangement as instructed by the director. Thus, in Stage 4, the matcher reconstructed the object position. Please note that there is a board screening the director from the matcher so the matcher could not see the object rearrangements constructed by the director.

In the nonlinguistic task (i.e., Animals in a Row), the participant was presented three objects (of four objects, such as a pig, a cow, a horse, and a sheep) by the researcher. The three objects were arranged on a table outside a room. The researcher asked the participant to look at the position of the three objects well. When the participant felt confident, the objects were taken by the researcher and moved to another table inside a room. When they were moving away, they talked using *Kata Kolok* for about 30 seconds to also make sure that the participant did not memorize the arrangement he saw earlier. In the next stage, the researcher, after the participant rotated 180 ° from his original position, asked him to reconstruct the objects as he saw earlier. Please note that the tasks are similar with those used in the current study.

The results showed that for the Stage 2 of the Man and Tree task (after 90 °rotation of the director), of 130 stimuli, 93 responses (72%) use an egocentric solution and 37 (28%) employed a geocentric system. The results do not confirm the hypothesis that Bengkala sign language practices the absolute system of frame of reference. For the rearrangement by the matcher (Stage 4), however, different results surfaced. Of 55 responses, 43 (78%) used absolute translation (based on the geographic location), 10 (18%) employed mental rotation (based on the participant/director's perspective), and two (4%) practiced mirror images/spatial blends, which were considered irrelevant because the responses were not consistent.

For the Animals in a Row task, the findings show that of 60 responses, 20 (33%) practiced the egocentric solution, 18 (30%) employed the geocentric system, and 22 (37%) utilized the diagonal, which were unexpected.

The Current Study

Methodologically and theoretically, this study replicates Aryawibawa et al.'s study (2018). Specifically, it operated both linguistic tasks (i.e., object rotation and asking direction) and non-linguistic tasks (i.e., object rearrangement). Unlike the previous study that was dedicated to examining the Balinese frames of reference spoken in Bengkala village, the current study was aimed at finding out how deaf signers in the village apply their spatial reference. Specifically, the current study was designed to test the following three hypotheses:

Hypothesis 1. Adult signers in the village employ an absolute system of spatial reference to respond to the linguistic tasks.

Hypothesis 2. The child participants use the intrinsic, relative, or absolute system of spatial reference in response to the linguistic tasks.

Hypothesis 3. Adult and child signers use the absolute system of spatial reference in the nonlinguistic tasks.

Research Methods

Definition of Data

We define a frame of reference as a description of the spatial relation between one object and another. Thus, the data consist of signs expressing reference frames such as a relative system (e.g., "The book is to the left/right of the TV"), an intrinsic system (e.g., "The book is in front/at the back of the TV"), an absolute system (e.g., "The book is north/south/east/west of the TV"), and a deictic, or pointing, response. Data were elicited using stimuli designed for signers to describe the frame of reference under study. The data consisted of both linguistic and non-linguistic ones using certain procedures as specifically described below.

Participants

We worked with 10 deaf children (10-14-year-old) and 12 deaf adults (18-75-year-old) who use the local sign language in Bengkala village. A native assistant (Ketut Kanta) who is proficient in using both sign and spoken languages was employed to help us recruit and elicit data throughout this study.

The Tasks

In the current research, data for frames of reference were elicited using linguistic tasks (i.e., object rotation, asking direction) and nonlinguistic tasks (i.e., object rearrangement). For each of the following tasks, it was experimented twice (inside and outside a room). There was an interval of about 30 minutes between the inside and outside room experiments. When the test was administered inside a room, all the curtains were closed; therefore, the signers could not see a landmark (i.e., a mountain) outside the house. On the other hand, when the task was tested outside a room, the landmark was clearly present. The main purpose of administering the experiments in the two scenes was to find out if the presence/absence of the landmark affects the signers' response in employing the spatial systems.

The Object Rotation Task

For this task (following Levinson, 2003, p. 52), certain objects were arranged in such a way to elicit signers' response containing spatial systems. For example, a cup was placed next to a remote control. The native assistant then asked the signers to describe the location of the cup in relation to the remote control in their sign language. The cup was then rotated 180 °. The assistant again asked them to specify the current spatial relation between the two objects. The total object arrangements for this task were 40 (4 x 10) for children and 48 (4 x 12) for adults in each scene. The sign language used to elicit spatial information employing this task is as follows.

Eliciting sign language by the native assistant:

you

look

that (the glass) the glass (using his fingers)

sit (using his fingers) that (the key)

sit (using his fingers) where

Figure 1. Native assistant's description of objects using object rotation task.

The free translation of the sign language shown in the pictures is "You, please look at the glass, the glass is here. That is the key. Where is the location of the glass in relation to the key?"

Subject's response:

pointing (to the glass)

Figure 2. Native assistant's description of objects using object rotation task.

We counted subjects' points to the object as deictic responses.

The Asking Direction Task

The asking direction technique required signers to describe a location of a place (e.g., a temple, a house, a kitchen, etc.) asked by the native assistant operating their local sign language. There were four places asked by the native assistant; therefore, the total responses from the signers were 40 (4 x 10) for children and 48 (4 x 12) for adults in each scene.

Eliciting sign language by the native assistant:

pray | wavy hand (for the sea temple)

wavy hand (for the sea temple) | where

Figure 3. Native assistant's description of objects using asking direction task.

The free translation of the sign language is "Where is the location of the *Pura Segara* 'Beach temple'?"

Subject's response:

pointing (to the temple location)

Figure 4. Subject's response in asking direction task.

We counted subjects' points to the object as deictic responses.

The Object Rearrangement Task

A similar task as used by Levinson (2003) and de Vos (2012) was employed for this task. The assistant and the signer sat at the same table (i.e., the table was in the north-south axis). They were facing each other. The assistant then arranged three different objects (e.g., a pen, keys, and a remote control) on the table. The assistant told the signer to look at the position of the objects and remember it well. After that, the signer took the three objects and switched the seat with her. There was an interval of three-quarters of a minute delay between the stimulus presentation and the rotation (following Levinson). The assistant had a conversation during the delay. The purpose of such an interval was to minimize specific short-term memory effects that could trigger the participants to use relative orientation since a visual image automatically encodes an egocentric viewpoint (Wassmann & Dasen, 1998, p. 702). But a visual image is normally replaced by new visual information and has a natural decay period of below 30 seconds (Baddeley, 1990, p. 31 in Wassmann & Dasen, 1998, p. 702). The assistant then asked her to rearrange the same objects exactly in the way she saw earlier. When the rearranged objects followed the north-south axis as the original arrangement, it was marked as an absolute system. If the rearrangement was according to the signer's left/right orientation, it was identified as a relative system. However, if the rearrangement was mixed (i.e., not following the north-south axis or signer's left/right orientation), it was considered unidentifiable (other). For this nonlinguistic task, there were 10 object arrangements for children and 12 for adults in each scene.

Eliciting sign language by the native assistant:

Figure 5. Native assistant's description of objects using object rearrangement task.

The free translation of the sign language is "Look at the position of the objects carefully!" They then switched the seat and the subject had to rearrange the objects exactly as she saw earlier.

Subject's response:

rearranged objects

Figure 6. Subject's response in object rearrangement task.

Results

The Object Rotation Task

Table 1

Spatial Reference Frames Used by Signers on the Object Rotation Task (Inside Room)

Response type	Children (10-14)	Adults (18-75)
Absolute	-	-
Relative	-	-
Intrinsic	-	-
Deictic (pointing)	40	48

Table 2

Spatial Reference Frames Used by Signers on the Object Rotation Task (Outside Room)

Response type	Children (10-14)	Adults (18-75)
Absolute	-	-
Relative	-	-
Intrinsic	-	-
Deictic (pointing)	40	48

As Table 1 shows, of 40 responses exhibited by the 10 children participated in the inside a room experiment, 40 (100%) of them used pointing interpreted as deictic response. For the adults, there were 48 responses produced and 48 (100%) of them utilized pointing also interpreted as a deictic response. The same pattern is presented for the experiment outside a room as exhibited in Table 2.

The Asking Direction Task

Table 3

Spatial Reference Frames Used by Signers on the Asking Direction Task (Inside Room)

Response type	Children (10-14)	Adults (18-75)
Absolute	-	-
Relative	-	-
Intrinsic	-	-
Deictic (pointing)	40	48

Table 4

Spatial Reference Frames Used by Signers on the Asking Direction Task (Outside Room)

Response type	Children (10-14)	Adults (18-75)
Absolute	-	-
Relative	–	-
Intrinsic	-	-
Deictic (pointing)	40	48

For the asking direction task, the exact same patterns as the object rotation task in both the inside a room and outside a room experiments surfaced as Tables 3 and 4 show.

The Object Rearrangement Task

Table 5

Spatial Reference Frames Used by Signers on the Object Rearrangement Task (Inside Room)

Response type	Children (10-14)	Adults (18-75)
Absolute	8	9
Relative	-	2
Deictic (pointing)	-	-
Other (unidentified)	2	1

Table 6

Spatial Reference Frames Used by Signers on the Object Rearrangement Task (Outside Room)

Response type	Children (10-14)	Adults (18-75)
Absolute	8	11
Relative	-	-
Deictic (pointing)	-	-
Other (unidentified)	2	1

Unlike the results of the previous two tasks, signers' responses for the object rearrangement task varied. Specifically, for the inside a room experiment, of 10 responses exhibited by children, eight (80%) utilized the absolute system, while the other two (20%) were unidentifiable (i.e., the rearrangement was neither relative nor absolute). In other words, the rearrangement was mixed by the two child subjects. For the adult signers' responses (inside room), nine (75%) of them used the absolute system, two (17%) utilized the relative system, and one (8%) was unidentified. And for the object rearrangement task administered outside a room, there was an increase of using the absolute system to 11 (91%) by the adults, while one (9%) was unidentifiable. The child responses for this experiment was exactly the same as the one inside a room. None of the subjects used a deictic response on this task.

Discussion

As showed in the results, the adult and young signers exclusively preferred the deictic (pointing) response in the two linguistic tasks (i.e., object rotation and asking direction) both inside and outside a room experiment. However, there is a caveat regarding the results. The signers uniformly employed a pointing strategy to describe a location of a figure without reference to a ground, even for a spatial relation that included a ground that had a front/back sides like a chair (e.g., "Someone is standing in front/back of a chair"). The point at issue in this regard

is how we confirm that the pointing is the absolute, relative, or intrinsic system (in the sense of the definition provided earlier in this paper). To tackle the issue, we modified the experimental procedure. For the object rotation task (Figure 1 above), for example, after giving the response by pointing to a figure (in relation to a ground), the experimenter asked the native assistant to switch the seat with the signer and asked him again to describe the relation of the same figure relative to the same ground. The exact same pointing to the same figure was utilized by the signer. The exact same pointing strategy was even applied for the spatial relations that included a ground with an intrinsic feature (e.g., "Someone is standing in front/back of a chair").

The same strategy was also used when the signers were told to tell the native assistant about the location of a place (e.g., a house, temples, and a cemetery) as illustrated in Figure 2 earlier. When a signer was asked to tell us the location of the *Pura Segara* "Beach village", he/she pointed to a south direction, where such a temple is usually located in Bali. We asked the native assistant if his/her pointing was correct to inform the temple's location. He said that the pointing was exactly and directionally correct. Furthermore, the pointing was also employed to describe the location of the kitchen which is next to his/her bedroom. The pointing was practiced when the experiments were administered in both inside and outside a room.

The best experimental technique to test that both young and adult signers indeed use the absolute system in solving spatial tasks is by the object rearrangement tasks as showed in Figure 3 above. Table 5 (experiment inside a room) indicates that the two different group of signers used the absolute system dominantly. Specifically, of 10 responses exhibited by children eight (80%) utilized the absolute system, while the other two (20%) were unidentifiable (i.e., the rearrangement was neither relative nor absolute, and inconsistent). In other words, the rearrangement was just mixed by the two child subjects. For the adult signers' responses, nine (75%) of them used the absolute system, two (17%) utilized the relative system, and one (8%) was unidentified.

And for the object rearrangement task administered outside a room, there was an increase of using the absolute system to 11 (91%) by the adults, while one (9%) remained unidentifiable. Put in other words, the two adult signers that used the relative system in the inside room experiment employed the absolute system in the outside room experiment. The possible reason that might factor in to explain the finding is that the clear presence of the mountain, which is to the uphill, as the local landmark to anchor north-south axis, might influence the increase of practicing the absolute system.

The child responses for this experiment were exactly the same as the ones inside room. Regarding the unidentifiable response by the same young and adult signers, it is unclear how that happens. We suspect that the signers perhaps did not understand what they needed to do to respond to the tasks.

The results show that the object rearrangement results are the only direct evidence we have to claim that the absolute system is indeed applicable in the deaf village. The signers used deictic responses when solving the two "linguistic" spatial tasks (i.e., object rotation and asking direction techniques). Moreover, provided with all the evidence, the first two hypotheses are disconfirmed in this study (i.e., Hypothesis 1: Adult signers use the absolute system for the linguistic tasks; Hypothesis 2: The child participants use the intrinsic, relative, or absolute system of spatial reference in response to the linguistic tasks). The results only confirm Hypothesis 3: Both child and adult signers use the absolute system for the nonlinguistic tasks. We found that there was not a correspondence in the use of the absolute system for both linguistic and non-linguistic tasks.

The results contrast with the findings of the Aryawibawa et al.'s study (2018) investigating spatial systems used by Balinese speakers in the village. The study found that both young and adult Balinese speakers preferred

the absolute system in their responses to the linguistic and nonlinguistic tasks. The contrast in the linguistic responses between the deaf and hearing speakers offers further evidence for the hypothesis that the nature of the linguistic system affects responses to nonlinguistic tasks. The evidence further suggests that the absolute system is practiced in the absence and presence of the local landmark.

Conclusions

Referring to the results of the current study, it clearly informs that the absolute system is practiced by the signers. More important to note from the findings is how the grammar of the Balinese sign language structures responses in the linguistic tasks. The results from the two studies show the contrast between the grammar of spatial reference in the signed and spoken languages.

The absolute system use is associated to the mountain. It is considered important not only by people living in Bengkala village, but it is true for Balinese people in general. Thus, the uphill, which is associated with the location of the mountain, is used as the anchor to decide the direction. The opposite is the south, while the east and the west are associated with the location where the sun rises and sets down. The system affects the nonlinguistic responses of both deaf and hearing individuals. In short, the findings suggest that cultural practices beyond language affect the way humans think in particular in using the spatial systems.

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