

Balinese spatial reference frames: Linguistic and non-linguistic evidence from the north of Bali[☆]



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Received 18 April 2018; received in revised form 22 August 2018; accepted 23 September 2018

Available online 9 October 2018

Abstract

Systems of spatial reference have been explored by many scholars for evidence that language affects human thought. The main purpose of the current study is to describe how Balinese people living in the north side of Bali use their frames of spatial reference, and to look for evidence that language affects human spatial cognition.

This study employs both linguistic tasks (e.g., object rotation and asking direction techniques) and non-linguistic tasks (e.g., rearrangement of objects). Fifty-one children and six Balinese monolinguals participated in this study. The results of the current study using object rotation, asking direction, and object rearrangement tasks involving the child subjects showed different results. Specifically, an absolute system of spatial reference is dominantly employed by the child subjects in both the object rotation and object rearrangement tasks. Although not dominantly applied, the use of a relative system was also observed in the two tasks. Interestingly, the later system was dominantly used in the asking direction tasks, which is likely affected by subjects' knowledge of the Indonesian relative system. The results exhibited by the child subjects show a developmental trend towards the use of the absolute system exhibited by the adult subjects in the three tasks.

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Keywords: Balinese; Spatial reference; Absolute system; Relative system; Language acquisition

1. Introduction

Systems of spatial reference have been explored by many scholars for evidence that language directs human thought. The study reported in this paper investigated the degree to which adults living on the north side of the island of Bali in Indonesia used an absolute system of spatial reference in their responses in two linguistic tasks (i.e., object rotation and asking direction techniques). The same tasks were used with children living in the same village to test whether they had acquired the adult system of spatial reference. A third task (i.e., rearrangement of objects) examined whether Balinese

[☆] This paper is the output of an international collaboration between the English Department research team, Udayana University and the Linguistics Department, the University of Kansas researcher and is fully funded by the Udayana International Collaborative Research Grant (673-68/UN14.4.A/LT/2017).

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children and adults employ an absolute frame of reference in a non-linguistic task. A correspondence between responses on the linguistic and non-linguistic tasks would show that language can affect human spatial cognition.

The universality of spatial reference frames has become the topic of much debate. Herskovitz (1982, 1986), for example, claimed that a relative frame of reference or egocentric system (i.e., the use of *to the left/to the right* in describing spatial relations between objects) is used by all languages in the world. The Balinese use of the absolute frame of reference indicates that Herskovitz' claim is not confirmed. More interestingly, as pointed out by Levinson (2003) and Boroditsky (2011) differences in the use of relative and absolute linguistic systems affect speakers' cognitive function as evidenced by their performance in non-linguistic tasks that involve spatial relations.

Research on frames of reference can also show how the development of the language faculty and cognition relate to each other. Research on the acquisition of spatial reference (e.g., Herskovitz, 1982, 1986; Aryawibawa, 2010, 2013) shows that a more basic spatial concept (i.e., the topological prepositions *in, on* in English) is acquired earlier than a more complex spatial concept (i.e., non-topological prepositions *to the right/to the left* in English). This study suggests that the development of a child's language depends on the development of their cognitive/conceptual faculty. More specifically, when the child's conceptual development is in a simple state then she can only produce simple linguistic forms. The same pattern seems also to happen in the non-topological relations (i.e., frame of reference). If an absolute system is indeed basic and dominant in nature in Balinese, the system should be comprehended and produced earlier by children. The fact motivates us to further investigate frames of reference on Bali.

The following section of the paper reviews previous research on spatial reference and draws some conclusions about the methods that have been used in this research. The subsequent section provides an overview of the Balinese spatial reference system and previous studies of spatial reference in Bali. This section is followed by a description of the present set of experiments and their results. We conclude with a discussion of the implications of our findings for research on spatial reference.

2. Defining spatial reference

Levinson (1996:128) traces the history of claims about spatial reference back to Newton, who maintained that our senses determine spatial location relative to our bodies. Kant, though, dissented from this relative framework and thought that humans could access notions of absolute space. There is an extensive literature in the brain sciences that discusses among other topics, the coordinate systems our bodies use to drive different motor systems (c.f. Paillard, 1991).

As supposedly rational beings, humans think they know where they are headed at any given moment. Spatial cognition comes so naturally to us that it has long served as an example of a universal cognitive skill constituting part of what Fodor (1975) termed the "language of thought". This perspective supports the view that humans interpret reality through a universal mentalese, and then translate these innate concepts into specific languages (Landau and Jackendoff, 1993; Pinker, 1994). Li and Gleitman (2002:266) express this claim as:

Commonsensibly, the relevant linguistic categories and structures are more-or-less straightforward mappings from a preexisting conceptual space, programmed into our biological nature. This perspective would begin to account for the fact that the grammars and lexicons of all languages are broadly similar, despite historical isolation and cultural disparities among them; moreover, that the language learning functions for young species members look about the same across languages.

The universalist view is challenged by research on spatial reference which shows that people living in different cultures have very different senses of location (Pederson et al., 1998; Wassmann and Dasen, 1998). Their spatial sense derives from differences in the frames of spatial reference that give meaning to spatial language as well as guide reactions in nonlinguistic tasks. In discussing the research on spatial reference it is useful to employ terms proposed by Talmy (1978). The anchor point for spatial location is the Ground, whereas the located object is the Figure. Thus, a ball (Figure) is in front of a chair (Ground), if (in English) the ball is located in the direction of the chair's opening to its seat.

From extensive crosslinguistic investigation, Levinson (2001) distinguished three basic frames of spatial reference that are found in different languages: the intrinsic, the relative and the absolute. Broadly speaking, the intrinsic reference frame locates objects relative to a salient feature of another object. English, for example, determines the intrinsic facets of artifacts based upon their function. The front of a chair is the side we approach to sit on it. The term "intrinsic" does not properly convey the crosslinguistic variation to be found in determining the intrinsic features of objects. The Mayan language Tzeltal, for example, uses shape rather than function (Levinson, 1996:140). The intrinsic reference frame is, then, a coordinate system anchored by a salient feature of an object.

A relative frame of reference system locates objects relative to a viewer's perspective of the Ground. The viewer's body establishes the anchor for the directions right, left, front and back, which the viewer projects onto the ground to establish the spatial relation between the figure and ground. Levinson (1996:143) notes there are differences in how languages

map the relative directions between the viewer, figure and ground. The English sentence “The ball is to the left of the tree” denotes a situation in which the ball is located to the side of the tree established by the viewer’s perspective.

The English word “front” is an example of how languages may reflect different frames of reference in the same word. The sentence “The ball is in front of the chair” is ambiguous in English because the word “front” may refer to the intrinsic side of the chair (it’s seat side) or to the side of the chair facing the viewer. These different senses of front correspond in many situations so in order to distinguish between them it is necessary to observe situations in which the intrinsic feature of the object does not correspond to the speaker’s viewpoint, i.e., a situation in which the seat of the chair does not face the speaker. It is also possible to detect the difference between intrinsic and relative frames of reference by using landmark objects like plates and trees that lack culturally proscribed sides. (Plates have faces and bottoms, but their rims are typically uniform.)

There are cultural differences in the ways that languages project the relative terms of spatial reference. English assumes that the tree is facing the viewer and so the front of the tree faces the viewer. The Hausa language assumes that the tree is facing in the same direction as the viewer and so the sentence “The ball is in front of the tree” in Hausa denotes a situation in which the ball is located on the opposite side of the tree from the viewer (Hill, 1982). If we say “The ball is to the left of the tree” an English speaker projects his or her left to the direction from the tree to the ball. A Hausa speaker would do the same, but a Tamil speaker would assume the sentence (in Tamil) expresses the situation in which the ball is on the left side of the tree rather than the left side of the speaker (Levinson, 1996:143). English, Hausa and Tamil all use relative frames of reference, but either map the participant’s viewpoint directly (Hausa), map a complete 180° rotation of the participant’s viewpoint (Tamil) or map a partial rotation through the horizontal axis of the participant’s viewpoint (English).

Levinson (1996) suggests that it is no accident that many languages extend intrinsic relations such as “front” and “back” to relative frames of reference. The intrinsic frame of reference is the more fundamental system used in human spatial cognition rather than the relative frame of reference, contrary to the claims of psychologists, e.g., Clark (1973), Herskovitz (1982), Miller and Johnson-Laird (1976). Levinson (1996:144) observes that many languages lack relative terms for expressing “front, back, left and right” based on a viewer’s perspective.

An absolute frame of reference uses bearings that remain fixed regardless of changes to the viewer’s perspective. The bearings may originate with reference to some environmental landmark (mountain slopes, prevailing wind directions, river drainages, celestial bearings, etc.), but the directions are conceptually abstract and apply without regard to, or out of sight of a proximate place or landmark (Levinson, 2003:90). Thus, to describe a spatial location in an interior situation, e.g., “The knife is to the left of the plate”, a speaker of a language employing an absolute frame of reference says “The knife is north/south/east/west of the plate”. Levinson (1996:145) observes that:

Such a system requires that persons maintain their orientation with respect to the fixed bearings at all times. People who speak such languages can be shown to do so – for example, they can dead reckon current location in unfamiliar territory with extraordinary accuracy, and thus point to any named location from any other (Lewis, 1976; Levinson, 1992).

All three frames of reference can be considered to be relative in the sense that all three locate a Figure relative to a Ground. The critical difference between the three frames of reference is how they reference the relation between the Figure and Ground. The intrinsic framework references a salient feature of the Ground, the relative framework references the perspective of a viewer, and the absolute framework references a fixed coordinate system that exists outside of the Ground and viewer.

Levinson (1996:148) claims that the intrinsic, relative and absolute frames of reference can be differentiated by their properties under rotation. Table 1 shows the effect of rotating the ground object, the viewer and the whole array (a ball and chair) on the truth values of descriptions that employ the intrinsic, relative and absolute frames of reference. An intrinsic description of a ball in front of a chair will become false if the chair, the ground object, is rotated 180°. The true intrinsic description would then become “The ball is in back of the chair.” Rotating the viewer or rotating the whole array, i.e., the ball and chair together, does not change the truth value of the intrinsic description of the relation between the ball and the front of the chair.

Table 1

The truth values of intrinsic, relative and absolute descriptions under rotation (c.f. Fig. 4.10 in Levinson, 1996:149).

Frame of reference	Description	Rotate ground object	Rotate viewer	Rotate whole array
Intrinsic	“Ball in front of chair”	False	True	True
Relative	“Ball to left of chair”	True	False	False
Absolute	“Ball to north of chair”	True	True	False

The truth value of a relative description of a ball to the left of a chair in English will not change if the chair is rotated. The ball will still be to the left of the chair from the perspective of the viewer. On the other hand, if the viewer switches 180° to the opposite side of the array, or if the entire array rotates 180°, then the ball will be to the right of the chair from the viewer's perspective. An absolute description of a ball to the north of the chair preserves its truth value when the chair or the viewer are rotated 180°, but if the entire array is rotated 180° then the absolute description will become "The ball is south of the chair."

2.1. Experimenting with spatial reference

It is important to observe that the logical distinctions that Levinson makes between intrinsic, relative and absolute frames of reference will only become apparent in specific contexts. In many conditions, a description will be ambiguous between two or more reference frames. Pederson et al. (1998:561) note that "such elicitation tasks create a particularized context with its own dimensions and parameters, and results obtained from any one task can be assumed to be applicable only to substantially similar contexts." Thus, descriptions of any language as intrinsic, relative or absolute oversimplify the types of spatial reference frames available to its speakers. Careful observation is necessary to determine the spatial frames that speakers employ in any given context.

English is an example of a language that uses all three reference frames. The word "front" can be used in an intrinsic sense in reference to the seat of a chair, or in a relative sense in reference to a viewer's perspective. English also has words for cardinal directions, i.e., north, east, south and west, which refer to bearings in an absolute coordinate system. English speakers acquire an understanding of the appropriate contexts for employing each reference frame. The intrinsic frame is used when reference to an intrinsic feature of the ground is handy. The relative frame is used when the ground lacks a salient feature, and the absolute frame is used when compass bearings are available, as when driving on a road labeled Route 1120 North. The claim that English uses a relative frame of spatial reference is actually a claim that English speakers default to the relative frame in specific contexts.

Experiments may elicit either a linguistic or nonlinguistic response. A linguistic response is necessary to distinguish between different uses of the same words, e.g., the intrinsic and relative uses of the word "front". A nonlinguistic response is necessary to determine whether the spatial reference frame embodied in language also guides behavior independently of language. Differences in experimental implementations can lead to different results because the experimental tests are sensitive to particular contexts. Research on frames of spatial reference has advanced partly through an improved understanding of the role context plays in determining the reference frame speakers resort to on particular tasks.

Levinson and his colleagues have done the most to draw attention to crosslinguistic variation in the language of space, although there are important ethnographic precedents, e.g., Brown (1991), Hill (1982), Lewis (1976), MacLaury (1989), Rock et al. (1989) and Talmy (1983). Pederson et al. (1998) published a report on a large scale, crosslinguistic experimental study of spatial reference in 20 different languages. Their observations derive, in part, from observations in the field of the language and gestures that speakers use in relating life histories or navigating across different terrains.

Pederson et al. developed a set of six experiments, including the Men-and-tree, Animals-in-a-row and Route descriptions, that could be used in rural and urban settings in different language communities. The experimental tasks feature a director who looks at the stimulus array and describes the scene to a matcher who is sitting beside the director, but cannot see the director's display. The matcher follows the director's verbal instructions to re-create what the director describes using a duplicate set of objects.

The Animals-in-a-row task involves three animals, all facing in the same direction and lined up on a display table (or mat) in front of a subject from left to right. The subject is told to remember the animals 'just as they are', and is allowed to look at the animals as long as they like. When they signal that they are ready, the experimenter removes the animals from the display table and asks the subject to turn around 180°, walk to another table (or mat), and place the animals on the new table in the same order. A subject using a relative placement order will preserve the left to right order of the animals in agreement with their own viewpoint, whereas a subject using a west-east placement order will place the animals in a right to left order that preserves their absolute order but reverses their original view as shown in (1).

- (1) a. Animals-in-a-row display
 Compass direction: west east
 Observed order: horse sheep cow
- b. Animals-in-a-row response (after subject turns around 180°)
 Compass direction: west east
 Absolute response: horse sheep cow [preserves compass order]
 Relative response: cow sheep horse [reverses compass order]

Pederson et al. found that Tzeltal, Longgu and Arandic speakers consistently produced absolute responses in this task, whereas Dutch and Japanese speakers consistently produced relative responses (1998:579–580). Interestingly, the Tamil speakers were divided between subjects who gave absolute responses, subjects who gave relative responses, and subjects who alternated between absolute and relative responses (583). Pederson et al. comment that most of the relative Tamil speakers live in a city, while most of the absolute Tamil speakers live in rural areas (584). Pederson et al. conclude that their results support the hypothesis that the type of spatial language speakers use guides their behavior on non-linguistic tasks, and thus undermines the universalists' claims.

Li and Gleitman (2002) tested the claims by Pederson et al. using a modified version of their Animals-in-a-row task. Li and Gleitman showed that with certain modifications they could elicit either relative or absolute responses from a group of American students. Instead of finding a link between language and spatial cognition, as Pederson et al. claimed, their results showed that changes to the experimental context could elicit relative or absolute responses from monolingual English speakers. In other words, they claimed that all humans share the same basic construal of spatial relations, but that specific environmental features, e.g., riverine systems or ducks on a pond, and not language would lead speakers to produce absolute responses. Their results preserve the universalist claim by assuming that all humans can access either absolute or relative frames of spatial reference, although they have to give up the claim that only the relative frame is universal.

Levinson et al. (2002) suggested that Li and Gleitman's had mistaken intrinsic responses in their experiment for absolute responses. Li and Gleitman added a duck pond to one end of their experimental and display tables, thereby adding an intrinsic feature to their context. We have already noted that English speakers will use an intrinsic response if a salient feature is present in the Ground. Table 1 above shows that the intrinsic and absolute descriptions have the same truth value when the subject rotates 180°. Levinson et al. claimed that Li and Gleitman tested the difference between intrinsic and relative descriptions, and that their English-speaking subjects were able to produce intrinsic descriptions as predicted.

A larger point in this dispute is the finding that subtle features of the experimental procedure will affect the experimental result. This is hardly a new discovery, but it does underline the need for great care in running an experiment on spatial reference, and interpreting the results as evidence for an intrinsic, relative or absolute frame of reference. Beyond this point, there is the finding that speakers of individual languages may use different frames of spatial reference in different contexts. There is clearly a complex ecology of situations in which speakers must decide between using one of the three reference frames. If this assumption is true, then the universalists can still claim that humans have access to all three types of reference frame, but that the local environment and language will guide their choice of spatial description on specific occasions. This interpretation of the universalist position nevertheless recognizes the role of language in guiding the habitual choice of reference frame.

2.2. The Balinese spatial reference system

The absolute system of spatial reference used in Balinese is not fixed absolutely, but varies as one travels around the island. The island of Bali is dominated by its central volcano Gunung Agung (3142 meters). In the south of the island, the use of the Balinese spatial term *kaja* "north" is associated with the location of the volcano, which is located to the north, and *kelod* "south" is associated with the location of sea, which is to the south of the island. The directions *kangin* "east" and *kauh* "west" are associated with the directions where the sun rises and sets respectively. The same associations are also reported for Balinese speakers living in villages on the north side of the island, but with a difference. On the north side of the island, the location of volcano and therefore the reference of the term *kaja* is to the south, and the term *kelod* is associated with the location of sea which is now to the north. The directions, east and west, remain associated with the places where the sun rises (east) and sets (west). (The associations are more complicated on the east and west coasts.)

To avoid any confusion in discussing the use of the Balinese spatial terms by people living on both the north and south sides of the island, we translate the term *kaja* into English as "uphill" rather than "north". We translate the term *kelod* into English as "seawards" rather than "south". The directions *kangin* "east" and *kauh* "west" remain the same on the north and south sides of the island, and so we retain their translations.

The reason why the uphill direction is associated with the volcano is motivated by Hindu religious practice in Bali (Aryawibawa, 2010, 2012, 2016; Arka, 2005:7). In the Balinese Hindu religion, the volcano is considered a sacred place because it is the dwelling place of the Gods. This belief is mirrored in many facets of Balinese life where a family's temple is always placed in the direction of the volcano inside the family compound. This belief also guides Balinese everyday life. When sleeping Balinese place their head toward the volcano's location or to the east. The uphill direction is different from the seaward direction, which is not considered sacred. Its function is to purify bad things such as sickness. The cultural significance of the Balinese spatial system has been described by many investigators, including Bateson and Mead (1942), Geertz (1973), Wassmann and Dasen (1998) and summarized in Aryawibawa (2010).

Given that the fixed coordinate system reflects the cultural values of Balinese people, it is important to investigate how Balinese people use their spatial reference system in linguistic as well as nonlinguistic tasks. Specifically, the Balinese system of spatial reference may extend beyond the Balinese language and organize how Balinese people organize space in nonlinguistic situations. Put another way, research on Balinese could offer further evidence of the ability of language to shape cognitive functions (Levinson, 2003; Boroditsky, 2011).

2.3. Previous research on Balinese spatial reference

Wassmann and Dasen (1998) investigated spatial reference in Balinese, and showed that the relative frame of reference could still be observed in Balinese, although not dominantly. They employed two different non-linguistic tasks in their study (1998:702–704).

In their first task Wassmann and Dasen (1998:702–704) used Animals in-a-Row, a series of three familiar animals, e.g., duck, goat, frog, tortoise, provided to their subjects on the first table for five successive trials following a demonstration task. The animals were faced alternately to the right, i.e., kaja “uphill”, and to the left, i.e., kelod “seaward”. The subjects were told to remember the arrangement. They were asked to turn 180° and reproduce the arrangement on a second table after a 30-s delay.

In their second experiment, Steve's Mazes, a drawing of a landscape that consists of a house, rice-fields and trees was presented to the subjects on the first table. A path was indicated on it with a winding course stopping a short distance from the house. The researcher told the subjects that they had to find the way to the house without having to cross the woods or the rice-fields. The researcher indicated the solution by tracing a path on the drawing with a finger. The researcher told the subjects to memorize this path. On the second table, three cards were placed, showing different path segments, one representing the relative solution, another showing the absolute solution, one representing an irrelevant solution. The task consisted of five of these drawings in addition to a demonstration trial (Wassmann and Dasen, 1998:702–704).

Wassmann and Dasen classified the subjects as absolute or relative users if the subjects gave four or five answers of a single type out of five trials; if they give three answers of one type, they are classified respectively as absolute or relative. The experiment involved twenty-eight subjects, i.e., eight children aged 7–9 (up to 2 years of schooling), eight children aged 11–15 (2–5 years of schooling) and twelve adults between 20 and 60 years of age (up to 6 years of schooling), with a virtually equal distribution between sexes (Wassmann and Dasen, 1998:702–704).

Wassmann and Dasen (1998) found that subjects in their Animals in-a-Row experiment used the absolute solution, while in the Steve's Mazes experiment only one quarter of the subjects employed an absolute frame of reference systematically. Most of them mixed absolute and relative frames of reference. Another quarter produced systematic responses using relative frames of reference. They concluded that even though the absolute system was dominantly used by their Balinese subjects, the use of the relative system is used in some contexts. Balinese has terms for right and left which are *tengawan* and *tengebot* respectively, but they are used to refer to body parts such as *lima tengawan* “right hand” and *lima tegebot* “left hand” (Aryawibawa, 2010:222).

The Wassmann and Dasen results contrast with the results from previous research by Aryawibawa (2010). Working with three adult monolingual Balinese speakers using both linguistic tasks (i.e., object rotation and asking direction techniques) and non-linguistic tasks (i.e., rearrangement of object techniques), his adult subjects used the absolute system exclusively. The study, however, did not include child subjects.

3. The current study

The research reported in this article replicates the previous studies by Aryawibawa with Balinese speakers living in a village on the north side of the island of Bali. The north side of Bali is less accessible than the south and consequently, less studied. Research in villages on the north side of Bali is necessary in order to document the degree of variability embodied in the Balinese system of spatial reference.

The current study used linguistic and non-linguistic tasks derived from Aryawibawa's previous study (2010) to test the spatial reference systems used by adult and child speakers in Desa Kolok (Bengkala village). Bengkala Village is located in the Buleleng regency, in the north of Bali island. According to the village profile (2017), it is a small village with 3031 inhabitants where most of its people are farmers. While young people (children attending school) are Indonesian-Balinese bilinguals, the adults generally speak Balinese in their everyday lives.

We used the elicitation tasks to test three hypotheses.

Hypothesis 1. Adult speakers living in a rural village on the north side of Bali use an absolute system of spatial reference in linguistic elicitation tasks as evidenced by their use of the words *kaja* “uphill”, *kelod* “seaward”, *kangin* “east” and *kauh* “west”.

Hypothesis 2. Children living in the same village switch between 6 and 12 years old from an intrinsic system to an absolute system of spatial reference in the same linguistic elicitation tasks. This hypothesis follows Levinson's (1996) suggestion that the intrinsic frame is more basic.

Hypothesis 3. Children and adult Balinese speakers use the absolute system on the nonlinguistic task as well as on the linguistic tasks.

3.1. Research design

3.1.1. Definition of data

We define the frame of reference as a description of the spatial relation between a figure and a ground. Data were elicited using stimuli designed for speakers of the Balinese language to describe spatial relations. The stimuli have predesignated sides that disambiguate the intrinsic, relative and absolute reference frames. The data consist of spatial expressions that encode a relative system (e.g., *the book is to the left/right of the TV*, defined by the perspective of the viewer), an intrinsic system (e.g., *the book is in front/at the back of the TV*, defined by the orientation of the TV, not the viewer), or an absolute system (e.g., *the book is uphill/seaward/east/west of the TV*, defined by the location of the central mountain, the sea and the sun's rising and setting). The data consist of both linguistic and non-linguistic responses using the procedures described below.

3.2. Participants

We worked with 51 children (ages about 6–12 years old) who speak the Balinese language. The participants were tested using object rotation tasks and asking direction techniques. In addition to the child subjects, six adult monolingual Balinese speakers (age between 45 and 60 years old) also participated in the study. Like the child subjects, the adult subjects were also tested employing the same three tasks. We were assisted in collecting data by the research assistant Ketut Kanta, who is a Bengkulu native. He helped us contact the participants and work with them throughout the experiments.

3.3. The object rotation task

The object rotation task described in Levinson (2003:52) was used to elicit linguistic data as evidence for the frames of reference. For example, a man is standing next to a chair as shown in [Picture 1](#) in the appendix. The research assistant then asked a participant to describe the location of the man in relation to the chair in Balinese. The chair was then rotated 180° so that it faces in the opposite direction. The research assistant again asked him/her to specify the new spatial relation between the man and the chair. Responses that referenced a direction, e.g., uphill, east, etc., were coded as absolute, whereas responses that referenced the speaker's perspective, e.g., left, right, were coded as relative. Responses that referenced a feature of the chair, e.g., front, back, were coded as intrinsic. The relative and intrinsic uses of left/right, front/back on this task are unambiguous as shown in [Picture 1](#).

3.4. The asking directions task

For the asking direction task, a participant was asked a location of a place in the village (e.g., a temple, a market, etc.). Once again, responses that referenced a direction, e.g., uphill, east, etc., were coded as absolute, whereas responses that referenced a feature of a nearby landmark were coded as intrinsic if they used the terms front or back in relation to the landmark rather than the speaker's perspective, and relative if they used the terms left or right relative to the speaker's perspective.

3.5. The object rearrangement task

We used a nonlinguistic task described by Levinson (2003) to elicit responses that did not require overt linguistic encoding. The research assistant and the participant sat at the same table facing one other. The research assistant then arranged three different unfeatured objects (e.g., a watch, a pencil, and keys) on the table as illustrated in [Picture 2](#) in the appendix. The research assistant told the participant to look at the position of the objects and remember it well. After that, the research assistant took the three objects and switched seats with the participant (a 180° rotation). There was an

interval of three-quarters of a minute delay between the stimulus presentation and the rotation (following Levinson). The research assistant had a conversation with the participant 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 and Dasen, 1998:702). But a visual image is normally replaced by new visual information and has a natural decay period of below 30 s (Baddeley, 1990:31 in Wassmann and Dasen, 1998:702). The research assistant then asked the participant to rearrange the same objects exactly in the way he saw earlier. The resulting arrangement, as shown in [Picture 3](#) in the appendix, was coded as absolute if the objects were placed in the same absolute relation. The arrangement was coded as relative if the objects were placed so that the same object remained on the participant's right side.

4. Results

4.1. The object rotation task

The six adult participants in the object rotation task produced 30 responses containing sentences describing spatial relations. As shown in [Table 2](#), all of the adult responses employed the absolute system. The adult responses uniformly support [Hypothesis 1](#) in that the adults all used the Balinese absolute spatial reference terms.

Child participants in the object rotation task produced 84 responses containing sentences describing spatial relations. As shown in [Table 2](#), only 42 (50%) of the children's responses used the absolute spatial system (i.e., using uphill/seaward/east/west directions), 16 (19%) used the relative system (i.e., using to the right/to the left of), 22 (26%) used the intrinsic system (i.e., using the intrinsic features of the objects such as in front of/in the back of), and 4 (5%) used another strategy such as the use of the demonstratives *here* and *there* instead of the three spatial systems.

These results suggest that the child subjects were in the process of learning how to employ the absolute frame of reference as consistently as the adults. The presence of intrinsic features on the objects (i.e., a chair with back and front intrinsic features) clearly played a role in eliciting the use of the intrinsic reference system by the children as can be seen in (2).

2. Pak Ngurah me¹-jujuk muka kursi-e²
 Pak Ngurah act-stand front chair-the
 'Pak Ngurah is standing in front of the chair'.

The use of the intrinsic features, however, was absent when a located object is placed next to a reference object that does not have intrinsic features as illustrated in (3).

3. Kunci-e dauh bal-e
 Key-the west ball-the
 'The key is to the west of the ball'.

The examples are evidence that the two systems are different, and the presence of salient intrinsic object features is crucial to the children's use of the intrinsic system. The intrinsic system is also distinct from the relative system. In the context of (2), when the located object moved to the side of the chair that does not present the front and the back parts one child employed the relative system as shown in (4) by the use of the relative term *sebelah kanan* 'to the right'.

4. Pak Ngurah me-jujuk sebelah kanan kursi-e
 Pak Ngurah act-stand side right chair-the
 'Pak Ngurah is standing to the right of the chair'.

Interestingly, the 6–8-year-old children occasionally resorted to the use of demonstrative expressions (i.e., using *here* or *there* instead of employing the absolute, relative, and intrinsic systems). Their use of demonstratives might be explained as the retention of a more basic system that is eventually replaced by the adult spatial reference systems.

Concrete evidence for the children's developing spatial reference ability is found in the differences between the younger and older children's responses in the object rotation task. As shown in [Table 2](#), the use of the absolute system

¹ me = active marker.

² e = definite marker.

Table 2
Spatial reference frames used by Balinese subjects on the Object Rotation Task.

Response type	Children 6–8	Children 9–12	Adult
Absolute	8	34	30
Relative	6	10	
Intrinsic	16	6	
Other	4		

increased from 8 responses (23%) for children 6–8-years-old to 34 responses (68%) by children 9–12-years-old. The younger children relied upon the intrinsic system (16 responses, 47%), which decreased to 6 responses (12%) for the older children. The use of the relative system by the two groups of children was stable (from 6 responses (18%) by the younger children to 10 responses (20%) by the older children). Interestingly, the use of demonstratives *here* and *there* was applied 4 times (12%) by the younger children, but was absent from the responses by the older children.

The children's results on the Object Rotation Task in Table 2 support Hypothesis 2. The chi-square test showed that the children's responses changed significantly between the two age groups ($\chi^2 = 17.75$, $p = .05$, $df = 2$). The evidence suggests that the younger children could use the absolute system when distractors such as salient intrinsic object features were not present. Younger children resorted to the use of demonstratives when they could not access the intrinsic or absolute reference systems.

4.2. The asking direction task

The six adult participants in the asking direction task produced 30 responses containing sentences describing spatial relations. All of the adult responses employed the absolute system. The adult results on the asking direction task uniformly support Hypothesis 1 in that the adults all used the Balinese absolute spatial reference terms.

The 9–12-year-old child participants in the asking direction task produced 75 responses containing sentences describing spatial relations. The 6–8-year-old child participants did not produce codable responses on this task. Of the seventy-five-response obtained from the older children, the use of the relative system by the child subjects was dominant in this task. Specifically, 47 (63%) of the children's responses used the relative system, and only 26 (35%) used the absolute system. Two responses (2%) applied the other strategy (i.e., the demonstratives *here* and *there*).

The child subjects used the relative system on the asking direction task when they switched codes to the Indonesian relative system. As illustrated in (5), they switched to the use of the Indonesian phrase **sebelah kiri** “on the left side” (shown in bold). We interpreted this code-switch as the children's use of the relative system in the task. The children producing the relative system in the Ask Direction task used to stay in the southern city Denpasar where Indonesian was used at school and in many other domains (e.g., home, market, offices, etc.). This history explains their use of the relative system in the task.

5. Umah-ne Dhimas **sebelah kiri** jalan
House-the Dhimas side left street
'Dhimas's house is on the left side of the street'

The Indonesian responses were not expected and illustrate the complexity of doing linguistic research in multilingual communities. At first glance, the children's responses on the Asking Directions Task disconfirm Hypothesis 2 that the older children would be more likely to use an absolute spatial reference system. When we split their responses into responses in Balinese and Indonesian, however, we find that the children using directions in Balinese used the absolute spatial reference system. The results actually provide strong support Hypothesis 2 by showing that exposure to languages using different spatial reference systems affect the use of spatial system of their speakers.

4.3. The object rearrangement task

Adult participants in the object rearrangement task produced 6 codable responses. Five (84%) of the adult subjects employed the absolute system, while 1 (16%) employed the relative system (see Table 3). The results support Hypothesis 3 in that the adults' use of the absolute system on linguistic tasks correspond to their use of an absolute response on a nonlinguistic task. The small number of adult subjects made a statistical test of their results unreliable.

Table 3
The use of spatial systems by child and adult subjects on the Object Rearrangement Task.

Response type	Children 6–8	Children 9–12	Adults
Absolute	3	15	5
Relative	2	5	1

Child participants in the object rearrangement task produced 25 codable responses. The children used the absolute and relative systems for this task. As shown in Table 3, there was a steady increase in the use of the absolute system across the three age groups. In more specific terms, 72% of responses used the absolute system, while the relative system was used in 28% of the responses. The pattern in general was similar to that of the object rotation task, where the use of the absolute system was also dominant.

Once again we observed a development in the use of the absolute system between the two groups of children in the Object Rearrangement Task. The use of the absolute system increased from 60% by the younger children to 75% by the older children. The use of the relative system decreased from 40% of the younger children to 25% of the older children. This change supports Hypothesis 2. The variation in the responses from the older children was similar to that for the adults. When we combined the results for the 9–12-year-old children with those for the adult subjects, there were a total of 20 absolute responses out of a total of 26 trials. The result is statistically different from equal numbers of absolute and relative responses on the binomial test at $p = .05$.

The developmental changes that we observed on the Object Rotation and the Object Rearrangement Tasks provide additional support for Hypothesis 3. Not only is there a correspondence between the children's responses on the linguistic (Object Rotation Task) and nonlinguistic tasks (Object Rearrangement Task), but the older children produced more absolute responses than the younger children. The children's exposure to Balinese was shaping their responses on a nonlinguistic task.

5. Discussion

The adult subjects in this study showed a clear preference for the absolute reference frame on all three tasks. The results confirm the findings in Wassmann and Dasen's study as well as the results from Aryawibawa's (2010) study. The results support Hypotheses 1 and 3 showing that Balinese adults employ an absolute frame of spatial reference on linguistic and non-linguistic elicitation tasks. The relation between their use of the absolute system in the linguistic tasks and the non-linguistic tasks is evidence that individual languages guide human cognitive function, especially in solving spatial reference tasks.

The children's responses on the three tasks were more varied than the adult responses, but this variation yields additional insight into extraneous factors that increase the task demands for the children more than the adults. The younger children's reference to salient features of the Ground on the Object Rotation Task show how easy it was for them to be distracted by intrinsic features of the ground. This finding suggests that linguistic development proceeds along different pathways for children acquiring languages with absolute and intrinsic spatial reference systems. Salient features of the ground such as faces and backs provide a starting point for children learning how to extend such features to grounds that lack obvious faces and backs in languages with an intrinsic reference system. For children acquiring languages with absolute reference systems, however, the salient features of the ground present a distraction that they must overcome in order to become proficient in the use of the absolute system.

The employment of the relative system was dominant for the older children in the asking direction task. According to the research assistant, the children providing the relative responses in the task used to go to schools in Denpasar (the capital city of Bali province) where Indonesian is used at schools, as well as in other domains such as home, market, offices, etc. Thus, the children's use of the Indonesian language motivated their use of the relative system to solve this task. More clear evidence that the Indonesian relative system influenced some of the child subjects to use the relative system in solving the task is from their switch to the Indonesian terms *sebelah kiri/kanan* "left/right side" in their descriptions of how to go to a certain location. All of the adult subjects, unlike the child subjects, are Balinese monolinguals who do not speak Indonesian in daily contacts in the community. These results offer further support for Pederson et al.'s observation of a split between rural and urban speakers in that all of the adults were living in a rural environment, whereas the older children had lived in an urban environment in Denpasar.

We observed some variation in the adult responses to the Object Rearrangement Task. The small number of adult subjects limit the conclusions that we can draw from this observation. However, we observed a similar variation on this task for the 9–12-year-old children. When we combine the results for the adults and the 9–12-year-olds, we find a statistically significant preference for the absolute reference frame on the non-linguistic task. The combined results confirm [Hypothesis 3](#): Children and adult Balinese speakers use the absolute system on the non-linguistic task as well as on the linguistic tasks. Unfortunately, the same children did not participate on the non-linguistic and linguistic tasks, so we do not have direct evidence for a tie between language and thought for individual children. We can only make such a claim for the adult participants.

[Wassmann and Dasen \(1998\)](#) also found more variation in their subjects' responses in their non-linguistic task than in their linguistic tasks. We interpret this evidence to show that, like children, adult speakers will sometimes use other systems of spatial reference in certain contexts. The adult use of the absolute reference system is far from an all-or-nothing affair, and responds to features of specific contexts. It seems that there is still room for improvement to the design of nonlinguistic experiments on spatial reference.

6. Conclusion and suggestion

The current study using linguistic and non-linguistic tasks showed that older children and adults in the village of Bengkulu use an absolute system of spatial reference (i.e., the use of uphill/seaward/east/west terms). The terms are related to local landmarks (e.g., the volcano and the sea). The volcano is considered important not only by people living in Bengkulu village, but for the Balinese people in general. Thus, the location of the volcano is used as the anchor to decide direction. The opposite direction is seaward, while the east and west directions are associated with the locations where the sun rises and sets.

The findings from two linguistic tasks offer confirmation for [Hypothesis 1](#) that adult Balinese speakers use an absolute spatial reference system. The findings for the children also offer confirmation for [Hypothesis 2](#), although we also found evidence for the effects of sociolinguistic variation. The findings for the non-linguistic task confirm [Hypothesis 3](#). The group responses for the adults and older children on the non-linguistic task correspond in the group responses on the linguistic tasks. In other words, the findings show that the absolute system is consistently used in both linguistic and nonlinguistic tasks by older child and adult Balinese subjects. The different responses by the younger and older groups of children offer striking confirmation that language can affect the way in which humans construe spatial relations as they acquire the adult way of referencing space.

Appendix



Picture 1. Linguistic tasks (object rotation tasks).



Picture 2. Non-linguistic tasks (original object arrangement for the object rearrangement tasks).



Picture 3. Non-linguistic tasks (rearranged objects for the object rearrangement tasks).

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