Supplemental material 1:
The disambiguation task used in Study 1

The set-up of the reference disambiguation task used in Study 1. Participants sat facing the fireplace, with four objects on one side (toward the door) and a matching set of the same four objects on the other side (away from the door).
Supplemental material 2:
Stimuli for Study 1

1) wisi-deŋ mori suwa up.that-gen. adv orange point.2s.nearfut ‘Point to the uphill orange.’

2) ɨmi-deŋ mori suwa down.that-gen. adv orange point.2s.nearfut ‘Point to the downhill orange.’

3) wisi-deŋ tomato suwa up.that-gen. adv tree.tomato point.2s.nearfut ‘Point to the uphill tomato.’

4) ɨmi-deŋ tomato suwa down.that-gen. adv tree.tomato point.2s.nearfut ‘Point to the downhill tomato.’

5) yik abida-ŋ a-wu bag hold-SS s.obj-come.up.2s.nearfut ‘Bring up the bag.’

6) yik abida-ŋ a-bi bag hold-SS s.obj-come.down.2s.nearfut ‘Bring down the bag.’

7) kap abida-ŋ a-wu cup hold-SS s.obj-come.up.2s.nearfut ‘Bring up the cup.’

8) kap abida-ŋ a-bi cup hold-SS s.obj-come.down.2s.nearfut ‘Bring down the cup.’
Supplemental material 3:
Arrays used in the ‘Pig & Corn’ task

“PIG AND CORN” STIMULI

ADULT ARRAYS

A1
A2
A3
A4
A5
A6
A7
A8

CHILD ARRAYS

C1
C2
C3
C4
C5
C6
C7
C8
**Supplemental material 4:**
Complete transcripts of all examples

**Study 2:**

**Example 1. Outdoors, participants facing WSW (position B)**

*director:*

```
bit maluŋ-gok amin tim-ni a-bi isi-don
pig small-dim one nose-3.poss move-2s.DS up.that-loc

iraisa-da yuma-gan on-gan-da y-ipm-ek e
PN-subj area-loc that-loc-adv 3s.obj-put-SS.D and

a-wo-ŋban e piŋan yo gwin yan-gin y-ip-bi
s.obj-go.up-3s.DS and dog too all thus-just 3s.obj-put-2s.fut
```

*translation:* ‘Point the nose of the small pig towards Raisa's area up there. Going up, put the dog just like that too.’

**Example 2. Outdoors, facing WSW (position B)**

*director:*

```
bit meŋ-i-da mibiltok gw-imi-deŋ wusi-k
pig mother-3.poss-subj first secondary-down.that-gen.adv look.for-SS.D

ak-dak
stand-3s.pres

aka pup nan-i yo gwin a-biŋ-ban
disc chicken father-3.poss too all 3s.obj-come.down-3s.DS

imi-deŋ wusi-k ak-dak
down.that-gen.adv look.for-SS.D stand-3s.pres
```

*translation:* ‘The big pig first is looking downwards. The rooster too, coming down—it is looking downwards.’
Example 3. Indoors, facing WSW (position B)

director:

pup nan-i busuŋ-o y-ip-bi
chicken father-3.poss head-poss 3s.obj-put-2s.DS

on ga-ga yik-dal tet-gin tibil a-kan
that 2s-emph sit-2s.pres side-loc turn do-3s.DS.D

isit yut barat-da y-ip-bi
corn plant flat-adv 3s.obj-put-2s.fut

pup nan-i busuŋ-o y-ip-bi i-deŋ
chicken father-3.poss head-poss 3s.obj-put-2s.DS this-gen.adv

w-akan
come.up-3s.DS.D

ga-ga yik-dal-gin w-akan
2s-emph sit-2s.pres-loc come.up-3s.DS.D

isit yut barat-da y-ip-bi imin tironŋ-gin
corn plant flat-adv 3s.obj-put-2s.DS down.that door.area-loc

ki-sak
go-3s.fut

translation: ‘Put the rooster's head facing that side where you are sitting. Put the corn horizontal. Put the rooster's head coming up here, toward where you are sitting. Put the corn plant horizontal toward that door area down there.’

Example 4. Indoors, facing ENE (position A)

director:

kili isit-naŋ aŋ-tibil yomaga-gin y-ipmaŋ-dal
disc corn-s.obj s.obj-turn.SS door-loc 3s.obj-put-2s.pres

y-ip-bi imi-deŋ ki-sak
3s.obj-put-2s.DS down.that-gen.adv go-3s.fut

kili pup nan-i y-ipmaŋ-bi isin
disc chicken father-3.poss 3s.obj-put-2s.DS up.that
yut-dom-gan  tibil-jak
house-wall-loc  turn-3s.fut

*translation:* ‘Okay, turn the corn and put it toward the door. Put it towards down there. Okay, put the rooster turned toward that wall up there.’

**Study 3**

*Example 5. Indoors, facing ENE (position A)*

director:

Bit kwin-da  y-ip-bi  tim-i  imin  abilak
pig above-adv 3s.obj-put-2s.DS  nose-3.poss down.that fire.place

ka-ngan  piki-akan
inside-loc go.down-3s.DS.D

isit y-ip-bi  imin  tet-gan  pikw-an
corn 3s.obj-put-2s.DS  down.that  side-loc go.down-3s.nearfut

*translation:* ‘Put the pig above with its nose going down toward the fire down there. Put the corn down toward that side down there.’

*Example 6. Indoors, facing ENE (position A)*

director:

Pijan-kat  bit  menj-gat  an-tobil  isi-dej  tet-gin-da
dog-com  pig mother-3.poss-com  s.obj-turn.SS  up.that-gen.adv side-loc-adv

y-ipmanj
3s.obj-put.2s.nearfut

*translation:* ‘Put the pig and dog turned toward the side up there.’
Study 3 — Additional example

Example 7. Indoors, facing ENE (position A)

director:

isit barat-da ga-ga yik-dal-on y-ipm-ek
corn flat-adv 2s-emph sit-2s.pres-loc 3s.obj-put-SS.D

a-wo-ŋban piŋan-ŋ isin tet-gan anŋ-tobil ek
s.obj-go.up-3s.DS dog-s.obj up.that side-loc s.obj-turn do.SS.D

y-ip
3s.obj-put.2s.nearfut

matcher:

pom tet
far.from.door side

director:

isin tet-da isin amin yik-gaŋ tet-gan
up.that side-adv up.that people sit-3s.pres side-loc

translation:
Director: ‘Put the corn horizontal where you are sitting. Going up, turn the dog facing the side up there.’
Matcher: ‘The side away from the door?’
Director: ‘The side up there, where those people up there are sitting.’
Supplemental material 5:
Satellite imagery of the terrain

Satellite imagery showing the terrain surrounding Gua village, where the present studies were conducted. Gua is situated in a valley—one of several such valleys within the broader Yupno valley—that is bisected by the Daldal river. When in Gua, the slope toward and away from the Daldal is steep whereas the axis along the river is comparatively gentle.