ETHNOBIOLOGY AND CONSERVATION

RESEARCH ARTICLE

Ethnobiology and Conservation, 11:22 (09 August 2022)
doi:10.15451/ec2022-08-11.22-1-13
ISSN 2238-4782 ethnobioconservation.com

Participation in subsistence activities and maintenance of traditional skills among indigenous youth in the South Rupununi, Guyana

Nathalie van Vliet[1], Neal Millar[2], Alyssa Melville[2], Oswin David[3] and Leroy Ignacio[2]

ABSTRACT

Over the past few decades, issues including globalization and the transition to the cash economy have increasingly hindered the transmission of Traditional Ecological Knowledge (TEK) in Indigenous communities throughout the world. The imparting of TEK across generations of Indigenous Peoples is essential in sustaining cultural practices and maintaining their subsistence lifestyles. In this study, we used semi-structured interviews to assess the level of participation in subsistence activities and the acquisition of subsistence skills among Indigenous children in Guyana. We also assessed whether the level of participation or acquisition of skills was explained by location and social characteristics such as age, gender, and occupation of mother/father. We found that Indigenous children in the South Rupununi are highly involved in subsistence activities and the majority conserve subsistence-related skills. Traditional gears, such as the bow and arrow are still dominant among Indigenous children in South Rupununi, particularly for hunting purposes, but also for fishing. Results also suggest that children's participation (through work or play) in subsistence activities is key to the acquisition of subsistence knowledge and skills. Among indigenous children in South Rupununi, participation in subsistence activities varies according to gender and is linked to the main occupation of the parents. While participation in subsistence activities is primarily motivated by the need to search for food, those activities are also explicitly described as providing opportunities for skill development and as sources of fun or amusement. The study concludes by advocating the need to revive connections to subsistence ways of life and the integration of more situated learning experiences within the regular school curriculum for indigenous youth.

Keywords: Traditional knowledge; Cultural transmission; Guyana; Wapishan; Makushi..

1 Center for International Forestry Research (CIFOR), Jalan CIFOR Situ Gede, Bogor Barat Bogor 16115. Indonesia.
2 South Rupununi Conservation Society, Lethem, Guyana.
3 Guyana Wildlife Management and Conservation Commission, Ganges Street Sophia, Guyana.
* Corresponding author ✉. E-mail address: NVV (nathalievanvliet@yahoo.com); MN (srcs.rupununi@gmail.com), MA (alymelville@gmail.com); DO (david.wyn100@gmail.com), LI (shulinableroy@yahoo.co.uk)

SIGNIFICANCE STATEMENT

We used semi-structured interviews to assess the level of participation in subsistence activities and the acquisition of subsistence skills among Indigenous children in Guyana. We also assessed whether the level of participation or acquisition of skills was explained by location and social characteristics such as age, gender, and occupation of mother/father. Our study contributes to a better understanding of the drivers of participation in subsistence activities and the level of transmission of subsistence skills, demonstrating the importance of children in producing smaller versions of "adult" material culture. Our study stresses the need to complement the school curriculum with situated learning experiences where children can continue to experiment TEK in a playful manner, maintaining their close linkages to culture and Wapichan / Makushi identity.

INTRODUCTION

Traditional subsistence activities are at the heart of the livelihoods of indigenous peoples and local communities across the globe and contribute to safeguarding food security, cultural reproduction, and income generation (Antunes et al. 2019; Gomez-Baggethun et al. 2012; Pearce et al. 2011). Knowing how to subsist efficiently in a natural environment not only requires unique and site-specific knowledge but also the capacity to use this knowledge through practical skills and the ability to understand beliefs, rules, taboos, and the cosmo-vision of a given society (Berkes et al. 2000). These basic processes are at the core of Traditional Ecological Knowledge (TEK) and their successful transmission through generations is fundamental to the perpetuation of subsistence livelihoods.

The transmission of TEK through generations (hereon referred to as "cultural transmission") has nurtured the relationship between people and their environment over the centuries (Zarger 2002). Cultural transmission is not a simple process. It is guided by a combination of variables including community interest, local needs, personal gain, experience, and family history (Descola and Pálsson 1996) and relies on practical engagements with the local environment (Parathian 2019). As such, cultural transmission often depends on factors, such as age, gender, and other socio-cultural variables (Hewlett and Cavalli-Sforza, 1986). The transformation of TEK is the natural outcome of the changing interactions between people and their environment at different scales and as such, it can only be understood as a dynamic process that connects past and future, rather than a state frozen in time (Gomez-Baggethun et al. 2013; Gómez-Baggethun and Reyes-García 2013). In some contexts, transformations of TEK have provided beneficial opportunities to local people, such as through the provisioning of regular salaries as well as new skills and increased individual or collective resilience (Eyssartier et al. 2011). Nevertheless, in other contexts, the loss of TEK and traditional skills has had significant implications on local livelihoods and the natural environment in which communities live, for example, by reducing people's capacities to deal with pest infestations (Bentley and Rodriquez 2001), reducing the capacity to cope with weather shocks (Colson 1979; Kuhnlein and Turner 2020; Pearce et al. 2010), becoming dependent on highly selected cultivars (Brush et al. 1995), reducing the knowledge and skills to manage natural resources (Atran and Medin 1997; Berkes et al. 2000; Huntington 2000) or threatening health and nutritional status (Reyes et al. 2006) amongst others.

Over the last decades, rapid changes have been observed in indigenous and local communities and their connection to nature. Market access, infrastructure development, in and out-migration, extractive industries, communication technology, and change in the ways of life have impacted the way in which indigenous people and local communities use or depend on their natural resources (Gómez-Baggethun 2009; Gómez-Baggethun et al. 2010; Godoy et al. 2005, Gómez-Baggethun et al. 2013). These changes have been further exacerbated by formal schooling and the widespread loss of indigenous languages (Reyes-García 2013), ongoing struggles for territory, and acculturation linked with colonialism or dominant religions or beliefs (Tang and Tang 2010; Parathian 2019).

There is now a large body of research on the conditions that might explain the loss or persistence of TEK in the face of globalization and the way in which TEK systems enrich the resilience of social-ecological systems in responding to global environmental change (Gómez-Baggethun et al. 2013). However, with the exception of a few recent studies mostly conducted in Africa among the Baka and San or in Canada among the Inuit (Lew-Levy et al. 2017; Pearce et al. 2011), less has been documented with regard to the persistence of embodied knowledge which links body, mind, and environment (Raymond et al., 2018). More tangibly, embodied knowledge relates to subsistence skills, which are the heart of traditional livelihoods. This is becoming a topic of growing interest in a context of a vibrant cultural renaissance of indigenous people and renewed political interest from local leaders to protect their cultural identities, traditional livelihoods, and territories (Macfarlane et al. 2021; Velasco-Herrejón 2022; Lindstrom 2022). More recently, the COVID-

19 pandemic also triggered regained interest in traditional medicine and traditional skills as key safety nets supporting adaptation strategies in the face of this transformative health, social and economic crisis (Walters et al. 2021).

To contribute to this knowledge gap, we used semistructured interviews to assess the level of participation in subsistence activities and the acquisition of subsistence skills among Indigenous children in Guyana. We also assessed whether the level of participation or acquisition of skills was explained by location and social characteristics such as age, gender, and occupation of mother/father. Our study draws interesting considerations in support of the effort that Indigenous communities are placing in ensuring mechanisms for cultural transmission.

MATERIAL AND METHODS

Study site

Our research focused on the South Rupununi, in Region 9, Guyana. This region constitutes the Wapichan territory (or Wapichan Wiizi) which has been used by the Wapichan and Makushi people and their ancestors for generations. The Wapichan Wiizi lies between the Takutu (which is the Guyana-Brazil border), Kassikaiytu, and Essequibo rivers. It comprises the South Central and the Deep South Rupununi Districts, which include thirteen indigenous titled lands, plus their respective land extensions which are not yet officially recognized by the Ministry of Ameridian affairs. A large proportion of the Wapichan territory represents open savannah grasslands, with gallery forest, forest islands, and moriche palm creeks. The mountain ranges on the northern and eastern border are covered with lowland mixed tropical forests, and upland mixed tropical forests. The region is characterized by very distinct 'wet' and 'dry' seasons. The dry season lasts from September to April each year, and during this time water levels drop significantly, exposing river and creek beds. The wet season is from May to August and is marked by heavy rainfall which results in extensive flooding and the conversion of dry savannah grasslands into seasonal wetlands.

The traditional language for the Wapishana is Wapichan, a language classified as a member of the Arawak language family (David 2006). Most of the Wapishana have knowledge of English as they attend government primary schools. At least 71% of the population has reached primary school level and 23% have attended secondary school. Portuguese is also widely known due to its proximity to Brazil. Household size is about 5,9 persons in South Central communities and 6,2 in Deep South communities (David 2006). Wapichan livelihoods are based on fishing, hunting, rearing domestic livestock and the cultivation of fruit trees (Henfrey 2002). Forest-based (swidden) agriculture is the main source of starches (cassava, cassava products, ground provision, etc.), vegetables and, domesticated fruits. Forest gardens and riparian forests are also primary hunting grounds. Wildmeat, plants, and fruits are important sources of medicines, vitamins, and minerals important in their traditional diet. A significant number of Wapichan households also engage in wage labor as a source of income—mainly with the central and government office in the villages, schools, and health services. Many also work as ranch hands or miners. Of the communities located in the Wapichan Wiizi, all of them are considered primarily Wapishana communities with the exception of Shulinab Village which has a predominantly Makushi community.

With the increasing presence of external developments in Wapichan wiizi and the growing pressures coming from mining, logging, roads, other activities, and the progressive loss of the language, Indigenous leaders (Toshaos) believe that their collective identity is at risk. In 2014, to revive their Wapichan and Makushi identities, leaders developed a territorial management plan called "Thinking together for those coming behind us". In 2017, they formed the South Rupununi District Council (SRDC) which is the Wapichan's collective representative body, whose objective is to reinforce traditional jurisdiction over shared farming, hunting, fishing, and gathering grounds. In 2019, as a response to the increased concerns about the loss of Wapishan and Makushi identity, the South Rupununi Conservation Society (SRCS), a grassroot NGO, partnered with Wapichan and Makushi communities to develop and implement traditional knowledge classes where knowledge, beliefs, and skills are transmitted by the elders to the younger generations.

Data collection

Our research was part of a baseline assessment that aimed at measuring participation in subsistence activities and land skills prior to the implementation of the aforementioned traditional knowledge classes. Our study focused on the 10 titled communities that the South Rupununi Conservation Society had chosen for the implementation of traditional knowledge classes (out of the 13 in the Wapichan Wiizi). The 10 chosen communities provided a good geographical representation of the South Rupununi:

- Shulinab, Rupunau and Sand creek in the North;

- Shea, Maruranau and Awarewaunau in the North East;
- Aishalton, Karaudarnau in South
- Katoonarib and Sawariwau in Central (see Figure 1).

Subsistence activities and skills that were perceived as good indicators of traditional Wapichan culture were derived from Mistry et al. (2021). In their baseline for assessing traditional knowledge in Guyana, the authors found that communities in South Rupununi identified hunting, fishing, farming, land rights, and gathering food /materials as the main subsistence activities. When looking across gender and age, they found that men highlighted fishing and hunting and women farming and language. These subsistence activities were discussed in each of the communities with the elders (women and men alike) who were asked to rank them according to their importance. Given that our work focused on children aged from 8 to 20 years old, we chose to simplify the list and focus only on the three top subsistence activities: hunting, farming, and fishing, which also represented both genders' interests. Elders were also asked to list and rank skills that, if they were to disappear, would significantly threaten the Wapichan or Makushi identity and way of life. Given the similarity of responses in each of the village communities for the top five most important subsistence skills that characterize a Wapichan or Makushi person, we decided to focus on those five for the rest of the study, namely knowing how to: shoot an animal with an arrow (fish or terrestrial animal), spin cotton, make an arrow, weave a basket, and speak Wapichan or Makushi.

Subsequently, a semi-structured questionnaire was applied to 181 children from the 10 communities, with 12 to 23 surveys per community, depending on the number of children that were part of the traditional knowledge classes implemented by SRCS (Table 1). The questionnaires were administered by the schoolteachers of each community, in the official language of Guyana (English) as part of their first traditional knowledge class. The teachers explained that the responses would remain anonymous, that no sharing of information was allowed between children, that the responses had to be true, and that no grade or judgment would be placed by the teachers on the responses provided. The questionnaire was structured in three main sections. The first section inquired about the socio-economic background of the children (age, gender, main occupation of mother/-father, and place of residence). The second section of the questionnaire inquired about the frequency of participation in each of the main three subsistence activities (hunting, fishing, and farming). For hunting and fishing, we asked about the last animal caught, the harvesting technique used, and the purpose of the catch. For farming, we asked about the specific activities in which the children were involved (clearing bush, weeding, ploughing, planting, picking crops). The last section of the questionnaire asked whether they considered themselves fully skilled in each of the five most important skills identified by the elders during the group discussion explained above. Skills that were perceived as partially acquired were marked as not acquired to ensure that our assessment would remain conservative. The answer to each skill was therefore binary (Yes or No).

Data analysis

To test whether the frequency of participation in subsistence activities was explained by socioeconomic variables, we computed three different Discriminant Analysis, with each of the subsistence activities (hunting, fishing, or farming) as the dependent variable and place of residence (categorical), gender (binary), age (categorical), and the main occupation of mother/father (categorical) as qualitative explanatory variables. Subsequently, to test whether the acquisition of a given skill was determined by the frequency of participation in subsistence activities and socio-economic variables, we computed a Discriminant analysis with each of the skills as a dependent variable and the frequency of participation in hunting, fishing, and farming (categorical), place of residence (categorical), gender (binary), age (categorical), and the main occupation of mother/father (categorical) as qualitative explanatory variables. Statistical analysis was done using ©Xlstat2022.

Ethical considerations

Our work was conducted following a free, prior, and informed (FPIC) consent process at the level of each participating community. An FPIC form was signed by the village leader after consultation with all community members and advice from the village councilors. The directors of the schools agreed to participate in this study and provided all necessary support for the implementation of the methodology in their respective schools. Parents were invited to a meeting where the objectives of this study were explained. They were also told that this study was part of the traditional knowledge classes put in place by SRCS. The oral consent of the parents was requested after the presentation meeting. No parents expressed concern. In general, village leaders and parents agreed that this topic of research was important for their community and traditional identity and was therefore very supportive and encouraged the participation of their children.

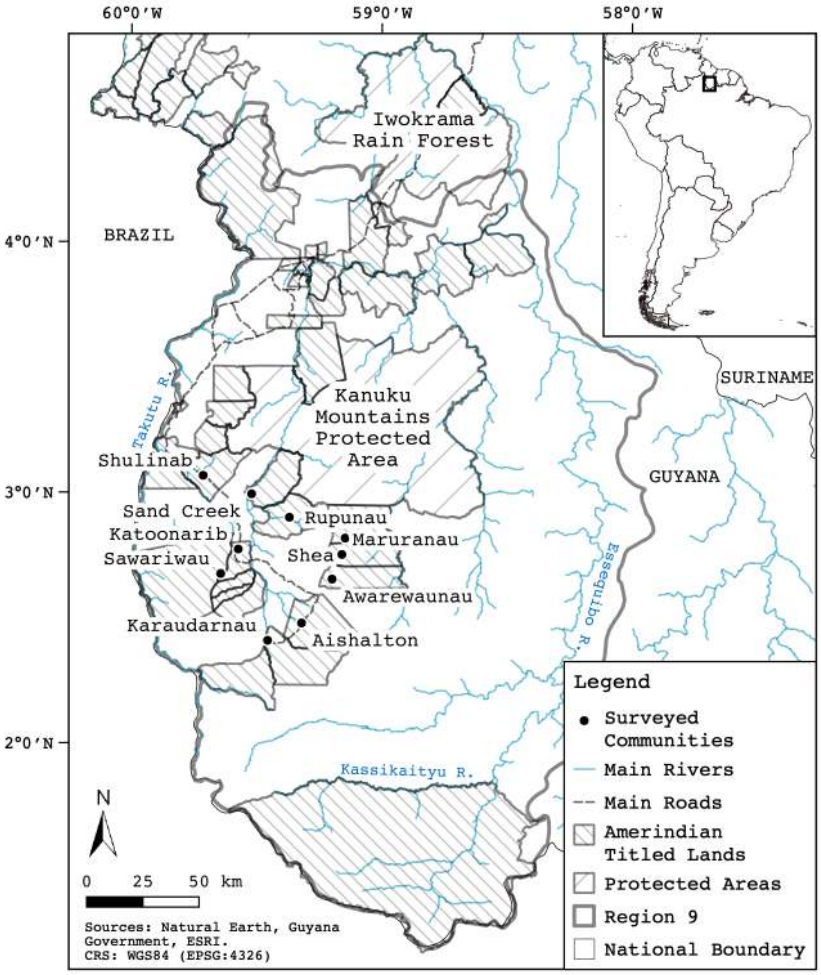

Figure 1. Map of Rupununi showing the location of the communities that participated in this study

Table 1. Number of children interviewed in each of the communities that were included in this study

Name of the community	# of children interviewed
Aishalton	15
Awarewaunau	20
Karaudarnau	23
Katoonarib	22
Maruranau	12
Rupunau	20
Sand Creek	19
Sawariwau	10
Shea	20
Shulinab	20
Total	**181**

RESULTS

Out of the 181 children interviewed, 67% participate in hunting, 88% practice fishing, and 92% participate in farming activities. Participation in subsistence activities occurs mostly after school, on weekends, and during school holidays.

Among those who participate in hunting (67%),

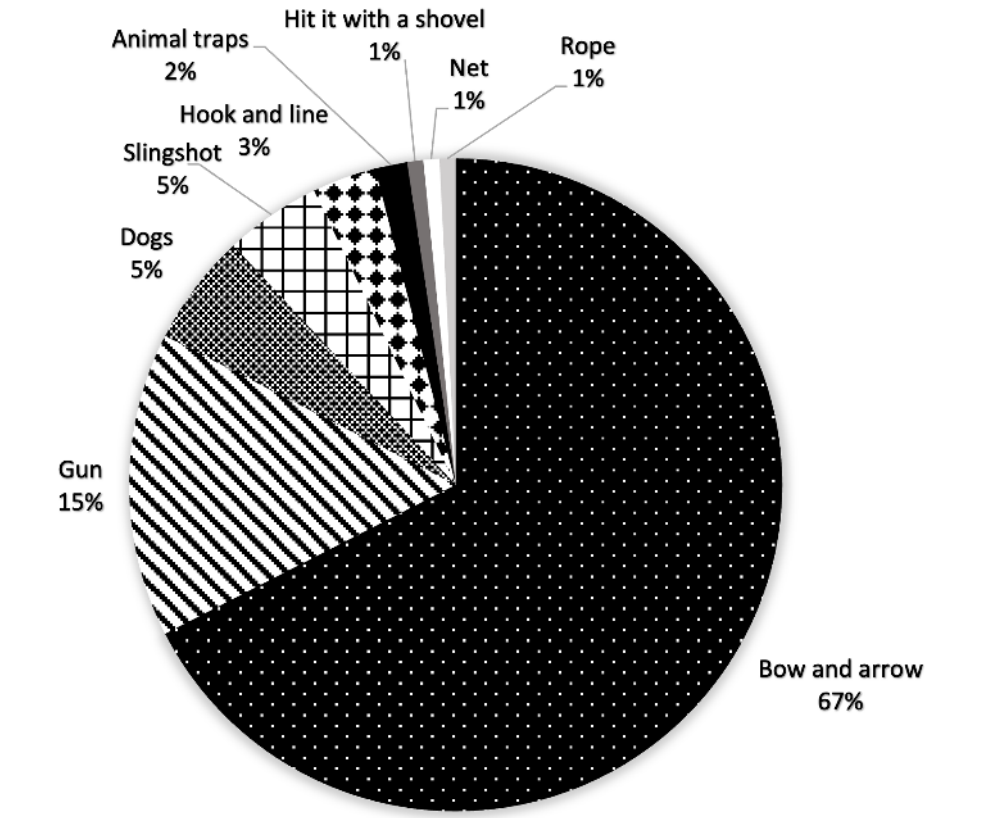

Figure 2. Use of different hunting techniques by children in South Rupununi (the percentage indicates the portion of children using each of the techniques as a response to: "Which of the hunting techniques do you use the most?").

37% do so once a week, 40% do so once a month, and the rest practice hunting once every three months. The most used hunting technique is bow and arrow (used by 67% of the children). Other techniques include guns, dogs, slingshots, hook and lines, animal traps, etc. (Figure 2). Over the year prior to the interview, children have been involved mostly in hunting agouti (*Dasyprocta leporina*), labba (*Cuniculus paca*), and armadillos (*Dasypus novemcinctus*; *Dasypus kappleri*) (Figure 3). Other commonly hunted species include deer (Mazama americana; Mazama nemorivaga; Odocoileus virginianus), peccari (Pecari tajacu; Tayassu pecari) and birds (black curassow (Crax alector), ducks (Cairina moschata), etc.). Hunting is mostly practiced for food (in 89% of the responses), but other reasons include self-defense (5%), hunting for trade (2%), hunting to protect livestock (2%), hunting for fun (1%) and hunting to keep as a pet (1%). The probability of never participating in hunting significantly increases for girls ($p < 0,0001$) and for children residing in Shea ($p = 0,02$). The probability of participating in hunting at least once a week increases for children between 12 to 15 years old. All other relationships are non-significant.

Fishing is practiced by 88% of the children. Among those, a few fish every day (2%), the majority fish once a week (48%), and the rest fish once a month (34%) or once every three months (16%). The most used fishing gears are hook and line (48%) and seine (31%) (Figure 4). Traditional fishing techniques, such as bow and arrow and cast nets were only mentioned by 6% in each of the cases respectively. Other fishing techniques include poison, cutlass, rod, and diving. Twenty-four species of fish were mentioned by the children as part of the list of fish most recently caught (Table 2). The most caught fish are Huri (*Hoplias malabaricus*), Mangi (*Pimelodus blochi*), Tiger fish (*Pseudoplatystoma fasciatum*), Daray (*Leporinus* sp.), and Patwa (*Cichlasoma bimaculatum*). For most children, fishing is practiced to secure food (92%), sell (4%), practice the skills (3%), or for fun (1%). The probability to be involved in fishing and the frequency of fishing significantly decreases for girls ($p < 0,0001$), for children younger

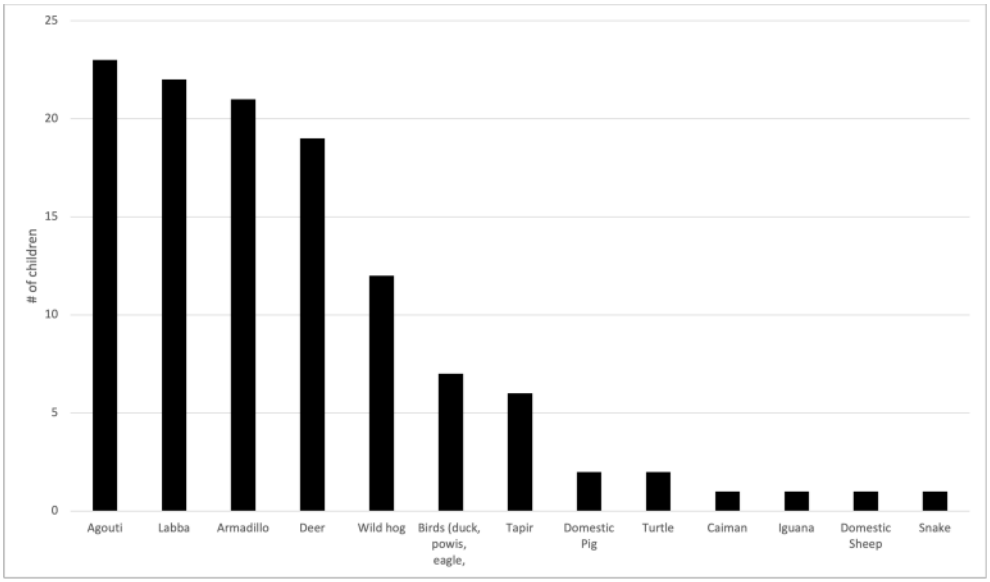

Figure 3. Most hunted species by children in the South Rupununi (the graph shows the number of children that mention having killed a given species in their last hunting party as a response to: "What is the last species you hunted")

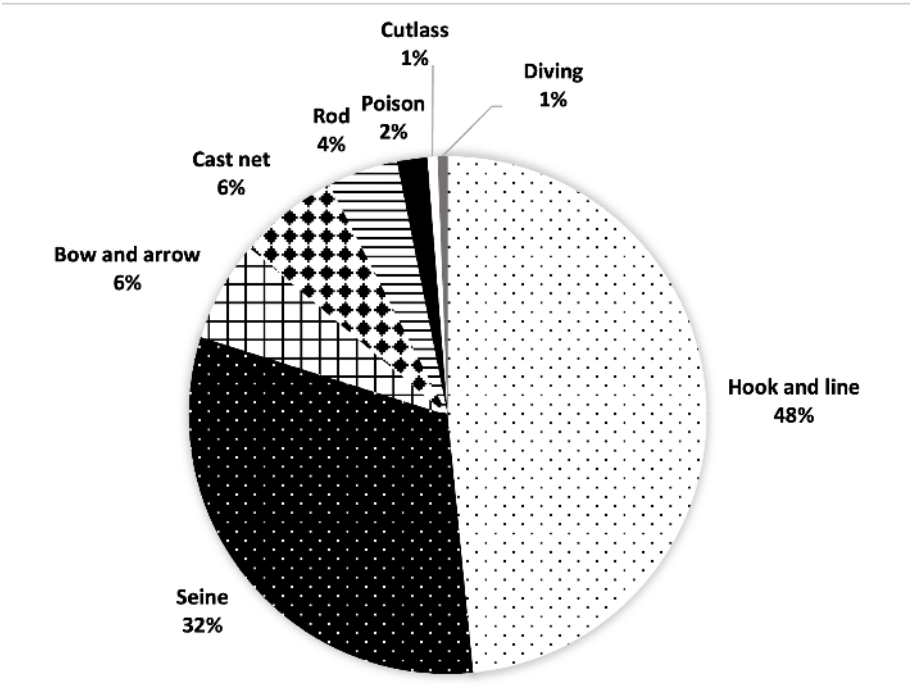

Figure 4. Use of different fishing techniques by children in South Rupununi (the percentage indicates the portion of children using each of the techniques as a response to: "Which of the fishing techniques do you use the most?").

than 11 years old ($p = 0,042$), and for children residing in Shulinab ($p < 0,0001$). All other associations are not significant.

Farming is practiced by almost all the children interviewed (92%) and most are involved in farming-related activities on a regular basis: 3% of them

participate in farming every day, 53% of them on a weekly basis, and 28% of them at least once a month. Only 9% participate in farming less than once every three months and 7% of them never participate in farming. Children are mostly involved in weeding (55%), ploughing, (24%), and picking crops (11%). Only 6,5% of them participate in planting and 3,5% in clearing the bush. Participation in farming is significantly determined by age, site of residence, and profession of father and mother. The odds of never participating in farming increase significantly for children whose mother is a government employee (p=0,0002), whose father is self-employed (p=0,003), and for residents from Shulinab ($p = 0,045$). The likelihood of farming once a month increases for children older than 15 years old ($p = 0,027$) and whose mother's main occupation is farming ($p = 0,004$). Children from Shea have a lower probability of farming every day ($p < 0,0001$).

Our expert group members identified five main traditional skills which identify the Wapichan culture: Speaking their traditional language (namely Wapishana except for Shulinab where the local dominant language is Makushi), being able to shoot an animal with an arrow (fish or terrestrial animal), cotton spinning, making an arrow and basket weaving. Most children that participated in our survey were skilled in speaking their traditional language (76%) and shooting an animal with a bow and arrows (50%). Children skilled in basket weaving, cotton spinning, and making arrows represented 31%, 34%, and 42% respectively. Acquisition of skills appeared to be dependent on socio-economic characteristics and level of participation in land-related activities. For example, children that go hunting at least once a month ($p < 0,009$), those that go fishing at least once a week ($p < 0,0001$), and children that go farming at least once a week (p=0,004) are more likely to know how to shoot an animal with a bow and arrow. Being a boy ($p < 0,0001$), having a father whose primary occupation is farming (p=0,02), and coming from Aishalton (p=0,015) significantly increase the chances to know

Table 2. Species of fish caught by the kids.

Local name	Scientific name	# of kids
Huri	*Hoplias malabaricus*	38
Mangi	*Pimelodus blochi*	20
Tiger fish	*Pseudoplatystoma fasciatum*	15
Darai	*Leporinus* sp.	10
Patwa	*Cichlasoma bimaculatum*	10
Lukunani	*Cichla ocellaris*	9
Piab	*Jupiaba* sp.	8
Koti	*Brycon falcatus*	7
Red Perai	*Pygocentrus nattereri*	6
Kiizip	*Oxydoras niger*	4
Sunfish	*Crenicichla alta*	4
Kassi	*Rhamdia quelen*	4
Banana Fish	*Phractocephalus hemioliopterus*	2
Cat fish	*Pseudoplatystoma tigrinum*	2
Haimara	*Hoplias aimara*	2
Pacu	*Piaractus brachypomus*	2
Yarrow	*Hoploerythrinus unitaeniatus*	2
Duburo	*Potamotrygon orbignyi*	1
Hassa	*Megalechis thoracata*	1
Sorik	*Ancistrus nudiceps*	1

how to shoot an animal with a bow and arrow. The likelihood of knowing how to make an arrow significantly decreases for children that never participate in hunting ($p < 0,0001$) or fishing (p=0,018). Knowing how to spin cotton is significantly biased by gender: the likelihood of knowing how to spin cotton decreases for boys ($p < 0,0001$). Girls (p=0,049) and children coming from Katoonarib ($p = 0,015$) are significantly more likely to know how to weave baskets. In contrast, children from Shulinab ($p = 0,001$) and those that never participate in hunting ($p = 0,004$) are not likely to know how to weave baskets. Children who practice hunting ($p = 0,003$) are more likely to speak the local language than those that never practice hunting ($p = 0,03$), those that only go fishing less than once a month ($p = 0,02$), and those that go to the farm less than once a month ($p = 0,002$) or never ($p = 0,044$). Acquisition of language skills is also determined by the site of residence and age: children from Katoonarib are more likely to speak the local language ($p = 0,006$) than those coming from Shulinab ($p < 0,0001$) or from Sand Creek ($p = 0,009$). Younger children (< 11 years old) are also less likely to speak the local language than elder children ($p = 0,002$).

DISCUSSION

Based on semi-structured interviews, our study provides an assessment of the level of participation in main subsistence activities and acquisition of skills among Indigenous children in South Rupununi. While the use of semi-structured interviews does not allow to capture detailed information on the learning processes and the circumstances that promote or constraint learning, our methodology can serve as a basis for more in-depth ethnographic research on the topic.

We found that Indigenous children in the South Rupununi are highly involved in subsistence activities and the majority conserve subsistence-related skills. As observed by Kawabe (1983) among Gidra children in Papua New Guinea, attendance at school does not prevent Wapichan and Makushi children to participate in subsistence activities on a regular basis. Children use after-school time, weekends, and holiday seasons to participate in hunting, farming, or fishing. As observed in other hunter-gatherer communities, Indigenous adolescents in the South Rupununi are already competent food collectors, though they may refine more complex skills, such as hunting, throughout their adult life (Lew-Levy et al. 2017). Nevertheless, our study pointed out that one community, located closer to the regional capital, is characterized by lower participation in subsistence activities and a lower acquisition of subsistence skills, including language. Road networks and cash economies are known to influence traditional language skills transmission and also affect food choices (Kik 2021). People living closer to urban areas tend to spend less time in subsistence activities and usually transition to industrial diets at the expense of traditionally harvested food (Kuhnlein et al. 1996).

Our results emphasize that traditional gears, such as the bow and arrow are still dominant among Indigenous children in South Rupununi . Bow and arrow is the most common hunting technique among Wapichan children. While in most neotropical indigenous communities, bow and arrow hunting was replaced by shotguns from as early as the middle of the 18th century (Hames 1979), this traditional hunter-gatherer technology is still alive among the younger Wapichan generations. Wapichan children learn how to shoot but also how to make their own bow and arrow from middle childhood. Arrow making seems to carry symbolic importance for the identity of Wapichan boys and men, such as that described for the Awá in Brazil (Gonzalez-Ruibal et al. 2011). Before adolescence, children are already proficient at hunting small-sized species (e.g., birds; agouti) with bows and arrows, but when they reach 12 years old, the frequency of participation in hunting increases and they target bigger game (e.g., labba, armadillo, deer, peccary). Bow and arrows are also used for fishing, although children seem to have more widely adopted modern fishing gears such as hook and line and seines.

Our findings are in line with the theory of "Situated learning", proposed by Lave and Wenger (1991), which suggests that children's participation (through work or play) in subsistence activities has relevance to the acquisition of subsistence knowledge and skills. Among the Wapichan children, participation in subsistence activities clearly influences the acquisition of subsistence skills. For example, children that participate in any of the three top subsistence activities are more likely to know how to shoot an animal with a bow and arrow. The likelihood of knowing how to make an arrow significantly decreases for children that never participate in hunting or fishing. Children who practice hunting are more likely to speak the local language and those never participating in hunting are less likely to know how to weave a basket. In addition, participation in subsistence activities and transmission of skills is also related to the occupation of the parents, which supports the theory of vertical cultural transmission. Father's involvement in farming increases the chances to know how to shoot an animal with a bow and arrow. Children whose mother's main occupation is farming, are more likely to practice fishing on a regular basis. This is because children accompanying parents have ample op-

portunity to watch and experiment with subsistence (Hewlett et al. 2011). In small-scale societies where adult activities are not segregated from those of children, children observe adults and learn by imitating their behaviors (Lew-Levy et al. 2017). In contrast, children whose parents' main occupation is a government employee or self-employed, are less likely to participate in farming and are therefore less exposed to learning by doing. Learning is in fact characterized by processes of trial and error and is embedded in the context of living in close quarters and having the opportunity to observe others through everyday tasks and conduct (Naveh 2014). In line with previous ethnological studies which have pointed out the differentiated gender roles in the ways of knowing, using, and conceptualizing nature (Ladio 2020), we show that the acquisition of skills is unequal across gender groups. As also observed among the Pumé in Venezuela (Gragson 1992), girls spend little time in food procurement subsistence activities. Wapichan girls are less likely to participate in hunting and fishing but are more likely to know how to weave a basket. In contrast, boys are more likely to know how to shoot an animal with an arrow, and less likely to know how to spin cotton. This is consistent with the traditional division of tasks between genders among the Wapichan: women are in charge of childcare, cooking, cassava processing, preparing drinks, housework, cotton spinning, planting, harvesting, transporting farm products, washing, and fishing, while men are responsible for cutting and plowing, basketry, hunting, harvesting non-timber forest products, collecting construction materials, carpentry and are also involved as vaqueros, miners, and drivers (Wilson 2006).

While participation in subsistence activities is primarily motivated by the need to search for food, those activities are also explicitly described as providing opportunities for skill development and as sources of fun or amusement. The playful aspect of participating in subsistence activities is important because it also draws attention to the vertical learning transmission processes in place, when children teach other children, through playgroups, particularly during early childhood (Lehmann et el. 2013).

CONCLUSION

Our study contributes to a better understanding of the drivers of participation in subsistence activities and the level of transmission of subsistence skills, demonstrating the importance of children in producing smaller versions of "adult" material culture. Our study stresses the need to complement the school curriculum with situated learning experiences where children can continue to experiment TEK in a playful manner, maintaining their close linkages to culture and Wapichan /Makushi identity. The integration of TEK at pre-school, primary, and secondary levels may increase rates of intergenerational knowledge transmission, in part by legitimizing TEK for younger generations and giving it the same status as western knowledge (McCarter and Gavin 2011). Innovative ways to revive early nature experiences and connections to subsistence ways of life are particularly timely, at a point in time, when millions of indigenous peoples across the globe are struggling to avoid the fading of their identities. Moreso, the transmission of TEK, through situated learning has a key role to play in the transgenerational establishment of sustainable futures (Giusti et al. 2018).

ACKNOWLEDGMENT

The authors would like to extend their gratitude to the schoolteachers who assisted with the data collection for this study. They would also like to thank the children who participated in the interviews. The authors would also like to acknowledge the graphics contribution of Mr. Simón Quintero to this article. Finally, the authors thank the Village Councils from each of the 10 communities for their permission to conduct the study. This research is part of the SWM Programme, an Initiative of the Organisation of African, Caribbean, and the Pacific States, which is funded by the European Union with co-funding from the French Facility for Global Environment (FFEM) and the French Development Agency (AFD), implemented through a consortium partnership, which includes the Centre for International Forestry Research (CIFOR), the Food and Agriculture Organization of the United Nations (FAO), Wildlife Conservation Society (WCS) and the French Agricultural Research Centre for International Development (CIRAD).

DATA AVAILABILITY

Data collected in this research is available upon request to the corresponding author.

CONFLICT OF INTEREST

The authors declare no conflict of interest of any sort with regard to the findings of this research.

CONTRIBUTION STATEMENT

Lead the writing of the manuscript and the analysis of data: NvV.
Coordinated data collection and participated in the analysis of data: NM, AM.
Provided technical guidance for the research from

planning, implementation, and analysis: LI, OD.

REFERENCES

Antunes AP, Rebêlo GH, Pezzuti JCB, Vieira MARM, Constantino PDAL, Campos-Silva JV, Fonseca R, Durigan CC, Ramos RM, Amaral JV, Pimenta NC, Razni TJD, Lima NAS, Harvey G, Shepard Jr GH (2019) **A conspiracy of silence: Subsistence hunting rights in the Brazilian Amazon.** *Land Use Policy* 84:1-11.

Atran S, Medin DL (1997) **Knowledge and actions: Cultural models of nature and resource management in Mesoamerica.** In: Bazerman MH, Messick DM, Tenbrunsel AE, Wade-Benzoni KA (eds) Environment, ethics, and behavior: The psychology of environmental valuation and degradation. The New Lexington Press/Jossey-Bass Publishers, pp. 171–208.

Bentley J, Rodríguez G (2001) **Honduran folk entomology.** *Current Anthropology* 42:285-301.

Berkes F, Colding J, Folke C (2000) **Rediscovery of traditional ecological knowledge as adaptive management.** *Ecological applications* 10:1251-1262.

Beryl D, Percival I, Angelburt J, Johnson L, Pugsley M, Ramachindo C, Winter G, Winter Y (2006) **Wa Wiizi - Wa Kaduzz. Our territory - our custom. Customary use of biological resources and related traditional practices within Wapichan Territory in Guyana: an indigenous case study.** [https://www.forestpeoples.org/nl/node/629] Accessed 25 July 2022.

Brush S, Kesseli R, Ortega R, Cisneros P, Zimmerer K, Quiros C (1995) **Potato diversity in the Andean center of crop domestication.** *Conservation Biology* 9:1189-1198.

Colson E (1979) **The Harvey Lecture Series. In good years and in bad: food strategies of self-reliant societies.** *Journal of Anthropological Research* 35:18-29.

Descola P, Pálsson G (1996) **Nature and society: anthropological perspectives.** Routledge, London, UK.

Eyssartier C, Ladio AH, Lozada M (2011) **Traditional horticultural knowledge change in a rural population of the Patagonian steppe.** *Journal of Arid Environments* 75:78-86.

Giusti M, Svane U, Raymond CM, Beery TH (2018) **A framework to assess where and how children connect to nature.** *Frontiers in Psychology* 8:2283.

Godoy R, Reyes-García V, Broesch J, Fitzpatrick IC, Giovannini P, Rodríguez MRM, Huanca T, Leonard WR, McDade TW, Tanner S, TAPS Bolivia Study Team (2009) **Long-term (secular) change of ethnobotanical knowledge of useful plants: separating cohort and age effects.** *Journal of Anthropological Research* 65:51-67.

Gómez-Baggethun E (2009) **Perspectivas del conocimiento ecológico local ante el proceso de globalización.** *Papeles de relaciones ecosociales y cambio global* 107:57-67.

Gómez-Baggethun E, Reyes-García V (2013) **Reinterpreting change in traditional ecological knowledge.** *Human Ecology* 41:643-647.

Gómez-Baggethun E, Reyes-García V, Olsson P, Montes C (2012) **Traditional ecological knowledge and community resilience to environmental extremes: A case study in Doñana, SW Spain.** *Global Environmental Change* 22:640-650.

Gómez-Baggethun E, Mingorria S, Reyes-García V, Calvet L, Montes C (2010) **Traditional ecological knowledge trends in the transition to a market economy: empirical study in the Doñana natural areas.** *Conservation Biology* 24:721-729.

González-Ruibal A, Hernando A, Politis G (2011) **Ontology of the self and material culture: Arrow-making among the Awá hunter–gatherers (Brazil).** *Journal of anthropological archaeology* 30:1-16.

Gragson TL (1992) **Strategic procurement of fish by the Pumé: a South American "fishing culture".** *Human Ecology* 20:109-130.

Hames RB (1979) **A comparison of the efficiencies of the shotgun and the bow in neotropical forest hunting.** *Human Ecology* 7:219-252.

Henfrey TB (2002) **Ethnoecology, resource use, conservation and development in a Wapishana community in the South Rupununi, Guyana.** University of Kent at Canterbury, UK.

Hewlett BS, Cavalli-Sforza LL (1986) **Cultural transmission among Aka pygmies.** *American Anthropologist* 88:922-934.

Hewlett BS, Fouts HN, Boyette AH, Hewlett BL (2011) **Social learning among Congo Basin hunter–gatherers.** *Philosophical Transactions of the Royal Society B: Biological Sciences* 366:1168-1178.

Huntington HP (2000) **Using traditional ecological knowledge in science: methods and applications.** *Ecological* applications 10:1270-1274.

Kawabe T (1983) **Development of hunting and fishing skill among boys of the Gidra in lowland Papua New Guinea.** *Journal of Human Ergology* 12:65-74.

Kik A, Adamec M, Aikhenvald AY, Bajzekova J, Baro N, Bowern C, Colwell RC, Drozd P, Duda P, Ibalim S, Jorge LR, Mogina J, Ruli B, Sam K, Sarvasy H, Saulei S, Weiblen GD, Zrzavy J, Novotny V (2021) **Language and ethnobiological skills decline precipitously in Papua New Guinea, the world's most linguistically diverse nation.** *Proceedings of the National Academy of Sciences* 118:e2100096118.

Kuhnlein HV, Receveur O (1996) **Dietary change and traditional food systems of indigenous peoples.** *Annual review of nutrition* 16:417-442.

Kuhnlein HV, Turner NJ (2020) **Traditional plant foods of Canadian indigenous peoples: nutrition, botany and use.** Routledge, London, UK.

Ladio AH (2020) **La etnobiología en áreas rurales y su aporte a la lucha para desentrañar sesgos patriarcales.** *Ethnoscientia* 5:1-13.

Lave J, Wenger E (1991) **Situated learning: Legitimate peripheral participation.** Cambridge University press.

Lehmann L, Wakano JY, Aoki K (2013) **On optimal learning schedules and the marginal value of cumulative cultural evolution.** *Evolution* 67:1435-1445.

Lew-Levy S, Reckin R, Lavi N, Cristóbal-Azkarate J, Ellis-Davies K (2017) **How do hunter-gatherer children learn subsistence skills?.** *Human Nature* 28:367-394.

Lindstrom GE (2022) **Accountability, relationality and Indigenous epistemology: Advancing an Indigenous perspective on academic integrity.** In: Eaton SE (ed) Academic Integrity in Canada. Springer, Cham, Switzerland, pp. 125-139.

Macfarlane D, Olive A (2021) **Whither Wintego: Environmental Impact Assessment and Indigenous Opposition in Saskatchewan's Churchill River Hydropower Project in the 1970s.** *Canadian Historical Review* 102:620-646.

McCarter J, Gavin MC (2011) **Perceptions of the value of traditional ecological knowledge to formal school curricula: opportunities and challenges from Malekula Island, Vanuatu.** *Journal of Ethnobiology and Ethnomedicine* 7:1-14.

Mistry J, Jafferally D, Xavier R, Albert G, Robertson B, Benjamin R, Mendonca S, Ingwall-King L (2021) **Assessing the state of traditional knowledge at national level.** *Global Environmental Change* 71:102409.

Naveh D, Bird-David N (2014) **How persons become things: economic and epistemological changes among N ayaka hunter-gatherers.** *Journal of the Royal Anthropological Institute* 20:74-92.

Parathian HE (2019) **Understanding Cosmopolitan Communities in Protected Areas: A Case Study from the Colombian Amazon.** *Conservation & Society* 17:26-37.

Pearce T, Ford J, Willox AC, Smit B (2015) **Inuit traditional ecological knowledge (TEK), subsistence hunting and adaptation to climate change in the Canadian Arctic.** *Arctic* 68:233-245.

Raymond CM, Giusti M, Barthel S (2018) **An embodied perspective on the co-production of cultural ecosystem services: toward embodied ecosystems.** *Journal of Environmental Planning and Management* 61:778-799.

Reyes-García V, Guèze M, Luz AC, Paneque-Gálvez J, Macía MJ, Orta-Martínez M, Pino J, Rubio-Campillo X (2013) **Evidence of traditional knowledge loss among a contemporary indigenous society.** *Evolution and Human Behavior* 34:249-257.

Reyes-Rodríguez ML, Gulisano M, Silva Y, Pivarunas B, Luna-Reyes KL, Bulik CM (2016) **"Las penas con pan duelen menos": The role of food and culture in Latinas with disordered eating behaviors.** *Appetite* 100:102-109.

Tang CP, Tang SY (2010) **Institutional adaptation and community-based conservation of natural resources: the cases of the Tao and Atayal in Taiwan.** *Human Ecology* 38:101-111.

Velasco-Herrejón P, Bauwens T, Friant MC (2022) **Challenging dominant sustainability worldviews on the energy transition: Lessons from Indigenous communities in Mexico and a plea for pluriversal technologies.** *World Development* 150:105725.

Walters G, Broome N, Cracco M, Dash T, Dudley N, Elías S, Hymas O, Mangubhai S, Mohan V, Niederberger T, Achtone C, Kema N, Lio AO, Raveloson N, Rubis J, Toviehou M, Van Vliet N (2021) **COVID-19, indigenous peoples, local communities and**

natural resource governance. *Parks* 27:57-62.
Wilson EK (2006) Gendered geographies and participatory processes-mapping natural resource use with Wapichan women in Southern Guyana. Doctoral dissertation, Carleton University.

Zarger RK (2002) Children's ethnoecological knowledge: situated learning and the cultural transmission of subsistence knowledge and *skills among Q'eqchi'Maya*. Doctoral dissertation, University of Georgia.

Received: 01 June 2022
Accepted: 29 July 2022
Published: 09 August 2022

Editor: Rômulo Alves