Small gods, rituals, and cooperation
The Mentawai crocodile spirit *Sikaoinan*

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Abstract

Researchers focus on the powerful deities of large-scale societies, yet little work has examined punitive deities in small-scale societies. Here, in a detailed study of Mentawai's crocodile spirit *Sikaoinan* (Siberut Island, Indonesia), we start to fill this gap by addressing three key questions: (1) Are smaller gods believed to enforce cooperation, especially compared to bigger gods in larger-scale societies? (2) Do beliefs in these deities encourage people to incur costs? and (3) Does ritual produce beliefs in these deities? Drawing on systematic interview responses, behavioral data from healing ceremonies, and long-term ethnographic research, we show that *Sikaoinan* is believed to punish people who do not share meat with fellow clan members. Beliefs that *Sikaoinan* has attacked them motivate patients and their families to host costly healing ceremonies in which shamans remove the spirit from the patient's house. The public nature of these ceremonies, involving prestigious individuals speaking to *Sikaoinan* and apologizing to it for the patient's stinginess, reinforce onlookers' beliefs about *Sikaoinan*. Throughout Siberut, the most widely-shared beliefs about *Sikaoinan* are represented in the ritual while beliefs not represented vary considerably, indicating that ritual may be a potent cultural transmission mechanism. These results suggest that moralizing supernatural punishers may be commonplace and that the important trend in the cultural evolution of religion has been the expansion of deities' scope, powers, and monitoring abilities.

Worshiped by the majority of living humans (Pew Research Center 2017), punitive supernatural agents are ubiquitous and important; they seem to promote cooperation beyond the provincial circle regulated by kinship and direct reciprocity (Duhaime 2015; Shariff et al. 2015; Purzycki et al. 2016); and they are associated with the emergence and maintenance of political complexity around the world (Watts, Greenhill, et al. 2015). Yet despite evidence that beliefs in these gods enabled humans' unique levels of cooperation (Norenzayan 2013; Norenzayan et al. 2016), three basic questions remain unresolved:

First, do supernatural agents punish non-cooperative behavior in small-scale societies? According to many researchers, the answer is "no". Pointing to the tendency for gods to become powerful as societal complexity increases (Roes and Raymond 2003; Peoples and Marlowe 2012), these scientists conclude that supernatural forces are largely amoral in small-scale societies (Baumard and Boyer 2013; Whitehouse et al. 2019; Norenzayan 2013; Boyer 2018). Yet other researchers, reviewing descriptions of supernatural beliefs among hunter-gatherers and Austronesian societies, challenge these conclusions (Boehm 2008; Watts, Greenhill, et al. 2015; Purzycki and Sosis 2019). Resolving whether the spirits of hunter-gatherers and horticulturalists are moralistic is crucial not only for properly characterizing the evolution of religion. It also has implications for our models of human cooperation in small-scale societies, especially given humans' exceptional levels of cooperation towards non-kin (Chapais 2014; Hill et al. 2011).

The second unanswered question is: do people *believe* in supernatural punishment? In the same way that they *believe* that germs are dangerous and thus wash their hands before eating, do they hold mental representations of supernatural punishers that encourage them to incur costs? Experimental work suggests that, for believers in world religions, the answer is "yes". Across diverse societies, participants who rated gods as more punitive and knowledgeable were more cooperative with distant co-religionists in economic games (Purzycki et al. 2016; Lang et al. 2019). Moreover, a meta-analysis of 25 experiments showed that whereas religious priming induced prosocial behavior among religious participants, it failed to affect non-religious participants, showing that the effects of priming depended on participants' beliefs (Shariff et al. 2015). In lab settings, at least, supernatural belief seems to nudge behavior.

Comparative research using coded ethnographic data provides further evidence that supernatural punishment beliefs alter behavior. Several studies demonstrated an association between the power and omnipotence of societies' moralistic deities ("high gods") and their political complexity, presumably because the fear of supernatural punishments prevents discord (Peoples and Marlowe 2012; Roes and Raymond 2003). Some studies have even found evidence that supernatural punishment *drove* or *helped sustain* higher levels of social complexity (Watts, Greenhill, et al. 2015), leading scholars to conclude that supernatural punishment beliefs crucially contributed to human ultrasociality (Norenzayan 2013; Purzycki et al. 2016).

Despite this growing evidence, however, many influential researchers remain skeptical (Boyer 2018; Baumard and Boyer 2013). They point to alternative explanations for associations between complexity and high gods (Baumard et al. 2015), as well as evidence showing that religious beliefs affect "reflective" beliefs (those that participants report) but not "intuitive" beliefs (those that affect decision-making) (Barrett 2000). In addition to these concerns, much of the existing empirical evidence comes from experimental rather than naturalistic data, leaving it unclear to what extent beliefs in supernatural punishment affect real-world behavior (although see Shariff and Rhemtulla 2012; Barro and McCleary 2006; Edelman 2009). These gaps are even more pronounced given that almost all of aforementioned studies have been conducted with

participants in large-scale societies, with little research investigating whether supernatural belief affects real-world outcomes in small-scale settings.

The final unanswered question is: what is the relationship between ritual and belief? Scientists have investigated many mechanisms by which ritual might provide group-level benefits, including enabling coordination (Chwe 2001), enhancing group identification (Clingingsmith, Khwaja, and Kremer 2009; Yanagizawa-Drott and Madestam 2012; Whitehouse and Lanman 2014), and maintaining social complexity through demonstrations of political power (Watts et al. 2016). Researchers have also described how people's social contexts and evolved cognitive adaptations contribute to religious belief (Boyer 2001; Atran and Norenzayan 2004; Lanman and Buhrmester 2017; Gervais and Henrich 2010). But these lines of research remain disconnected. With the exception of research on children's belief (Woolley, Boerger, and Markman 2004; Kapitány et al. 2019), very little empirical work has examined the interaction between belief and ritual (although see Barth 1975). This gap is all the more striking given that some scholars hypothesize that ritual is a critical mechanism for transmitting religious belief (Henrich 2009; Sosis 2006). Without ritual, some propose, the transmission of such beliefs would be impeded by cognitive adaptations for protecting against misinformation.

These questions remain unanswered partly because of a dearth of targeted ethnographic and quantitative data on religion in small-scale societies. Many anthropologists have published promising observations, such as that so-and-so god cares about such-and-such behavior (Boehm 2008; Purzycki and Sosis 2019). But few, if any, studies systematically investigate (a) how people in small-scale societies think about their deities, (b) whether beliefs shift real-world behavior, and (c) the relationship between rituals and belief. These gaps become all the more acute given the uncompromising spread of Abrahamic faiths and the transfiguring mark they leave on indigenous belief systems (Watts et al. 2018).

Here we present ethnographic and quantitative data on the rituals and beliefs surrounding a punitive small god – the Mentawai's crocodile spirit, *Sikaoinan*. Our aim is to offer a rich description of this spirit while addressing the three questions just outlined. Our report draws on three sources of data: ethnographic interviews about *Sikaoinan* conducted with 96 participants across four cultural regions of southern Siberut; systematic data covering 66 healing ceremonies, most of which occurred in the Buttui-Ugai region of Siberut in 2017; and participant observation occurring over 11 months in the Buttui-Ugai region.

The Mentawai of Siberut Island

The Siberut Mentawai reside in the river valleys of Siberut Island (Indonesia), the largest island of the Mentawai Archipelago (4,030 km^2; about 150 km west of Sumatra) (Tulius 2012) (Figure 1). The island is covered by at least 11 major rivers, each branching into dozens of smaller waterways. Given the distance between rivers and the historic frequency of headhunting, people infrequently traveled to other rivers, driving cultural differences among people living in distinct river valleys (Schefold 2007). While communities in the same valley speak the same language and have similar tattoos and taboos, those in separate valleys speak distinct dialects and have diverging aesthetic and religious practices. We refer to the set of communities who speak a common dialect and live in the same river valley as a cultural region.

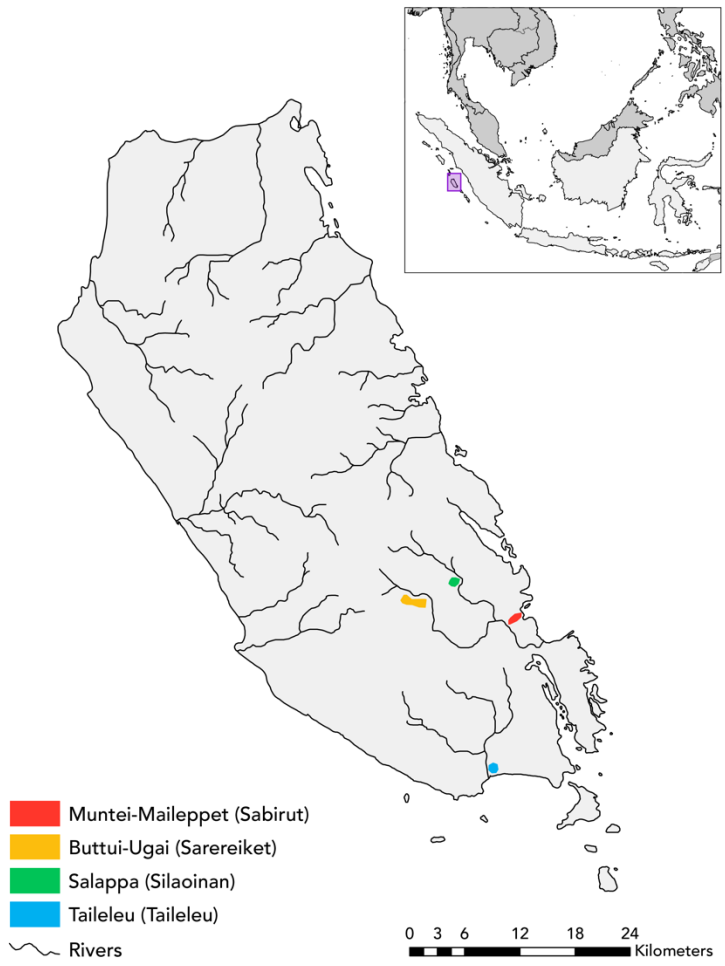

Figure 1. Siberut Island, the largest island of the Mentawai Archipelago (Indonesia). The different study sites are colored. The legend shows the villages studied with the cultural region in parentheses. Indonesia is light gray in the inset, while other countries are dark gray.

The Siberut Mentawai subsist primarily on starch extracted from sago palm. They also cultivate taro, cassava, and an assortment of fruit trees, including durian, mangos, coconuts, bananas, and rambutan. They raise pigs and chickens, as well as ducks, geese, cows, and buffalo, although animal domesticates aside from pigs and chickens are recent introductions and, with the exception of ducks, very rare. The Mentawai supplement their diet with foraged foods, such as primates, wild pigs, and freshwater fish. Market foods, especially rice, noodles, and sugar, are ubiquitous on the island and highly preferred.

The Mentawai are organized into patrilineal clans (known as *uma*), traditionally residing either in longhouses (also known as *uma*) or small houses constructed nearby (Tulius 2012; Schefold 1988). Following settlement programs by the government, most people have shifted to villages (*barasi*), which host schools, mosques, churches, and clinics. Settlement villages alter residence patterns by placing families in close proximity and positioning clans much closer to each other than they have traditionally lived. Still, many families maintain several residences, traveling between a small house or longhouse in the forest, where they tend to pigs and conduct

ceremonies, and a house in the settlement village. Some families, typically those of shamans, spend most or all of their time in these forest residences. Families with school-age children, meanwhile, tend to remain in settlement villages.

The indigenous Mentawai religious system is known as *Arat Sabulungan*. Missionaries and government programs largely destroyed *Arat Sabulungan* elsewhere in the Mentawai Archipelago, yet it continues to thrive in Siberut, partly due to the resistance of local communities, awareness efforts by the anthropologist Reimar Schefold, and the protective, malarial swamp-forest covering the island. Nevertheless, tourism, the spread of Islam, development agendas, and the expansion of formal education are rapidly transforming Mentawai social and cultural life (Delfi 2013; Delfi 2017; Hammons 2010), making current ethnographic investigations invaluable.

The traditional Mentawai religion is animist: Every *thing* is believed have a soul (Loeb 1929a; Schefold 1988). Pigs, plants, wild deer, tiny rats, new canoe motors, even the different materials composing a house – all are animated. All have invisible essences that can be inadvertently disturbed and which must be appeased to protect against misfortune. Humans have souls too, and illness is commonly said to occur because a person's soul has wandered too far from their body. Other stated reasons for falling ill include witchcraft, broken taboos, encounters with the forest spirit *Silakikio*, and punishment by the crocodile spirit *Sikaoinan*, as well as eating too much, too little, or at irregular times.

The traditional healers in Mentawai are *sikerei* (shamans), a class of men set apart by their ability to see invisible spirits (Singh and Henrich 2019; Loeb 1929b). As healers, *sikerei* are experts in herbal medicine and the special songs used for communicating with souls and spirits. A man hoping to become a *sikerei* must host a series of ceremonies, find another *sikerei* to teach him songs and herbal medicines, and have his eyes magically treated. In some cultural regions, *sikerei* are marked by their continued use of the loincloth and their full-body tattoos.

Sikerei treat ailments in *pabetei*, healing ceremonies that range in length from half a day to a week. The family hosting the healing ceremony sacrifices pigs or chickens, which are shared with the *sikerei* (as a kind of payment) and close kin. Healing ceremonies are like doctor's appointments: All of them share common elements, but each is also geared to target a particular ailment. The intervention regarded as most paradigmatic of the *sikerei* institution is *lajok simagre*, an all-night treatment during which *sikerei* dance and summon beneficent spirits. When some of the good spirits possess the dancing shamans, they enter trance.

Sikaoinan

Throughout southern Siberut, people describe a water-dwelling spirit that causes illness, is appeased in shamanic healing ceremonies, and is often referred to as "aunt" (*meinan*). We here refer to this spirit as *Sikaoinan* (lit. "that which is in the water"). The word, which also means "crocodile" in many Mentawai dialects, is the main term used for the spirit in several of the study regions (Schefold 1988). Other names for the spirit include *Silabbualai* ("that which hits with hair") and *Sibeuleppei* ("that with big clothes"), although these names were more variable than *Sikaoinan* and some respondents regarded them as distinct spirits. In line with the spirit's various names, some people describe it as the soul of a crocodile or as a crocodile with long hair (see

Figure 2 for some illustrations). Others described it as a long-haired figure or a spirit-being with big clothes who, according to some, associates with the crocodile and directs it to attack people.

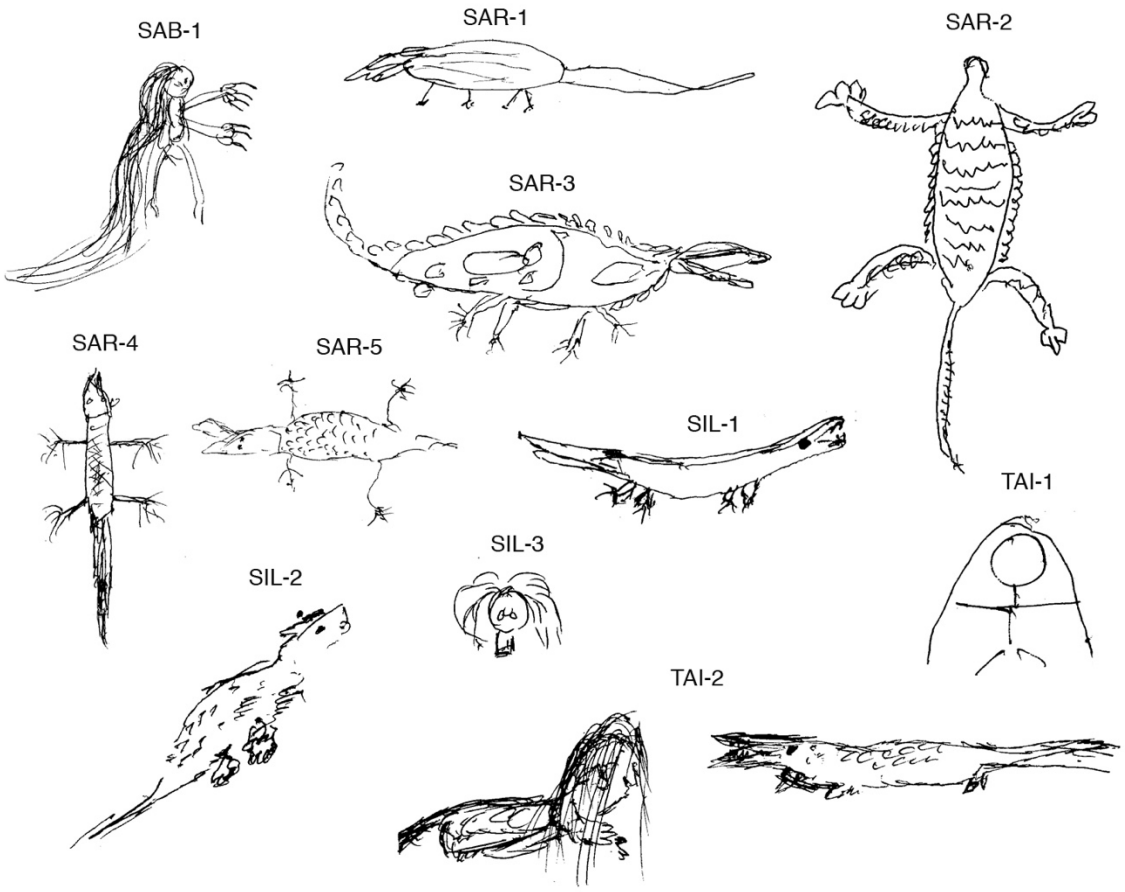

Figure 2. Illustrations of *Sikaoinan* by Mentawai people in the regions of Sabirut (SAB), Sarereiket (SAR), Silaoinan (SIL), and Taileleu (TAI). Illustration TAI-2 distinguishes between the physical body of *Sikaoinan* (a crocodile) and its soul (a long-haired figure with the torso and limbs of a crocodile).

***Sikaoinan* has moral concerns, but they are limited in scope and domain**

Across four cultural regions of southern Siberut, participants near-unanimously reported that *Sikaoinan* attacks people who fail to share (Figure 3A). Moreover, the participants who specified *which* items must be shared almost exclusively mentioned meat, although a tiny minority mentioned money and *kat* (edible plant food, such as sago, taro, and fruit) (Figure 3B). We did not collect data on who food must be shared with, but food-sharing norms in Mentawai dictate that people share with social intimates, especially clanmates, affines, and neighbors who live nearby (Hammons 2010; Schefold 1982). *Sikaoinan* has moralistic concerns, but they are limited in domain (sharing meat) and scope (clanmates and other relatives).

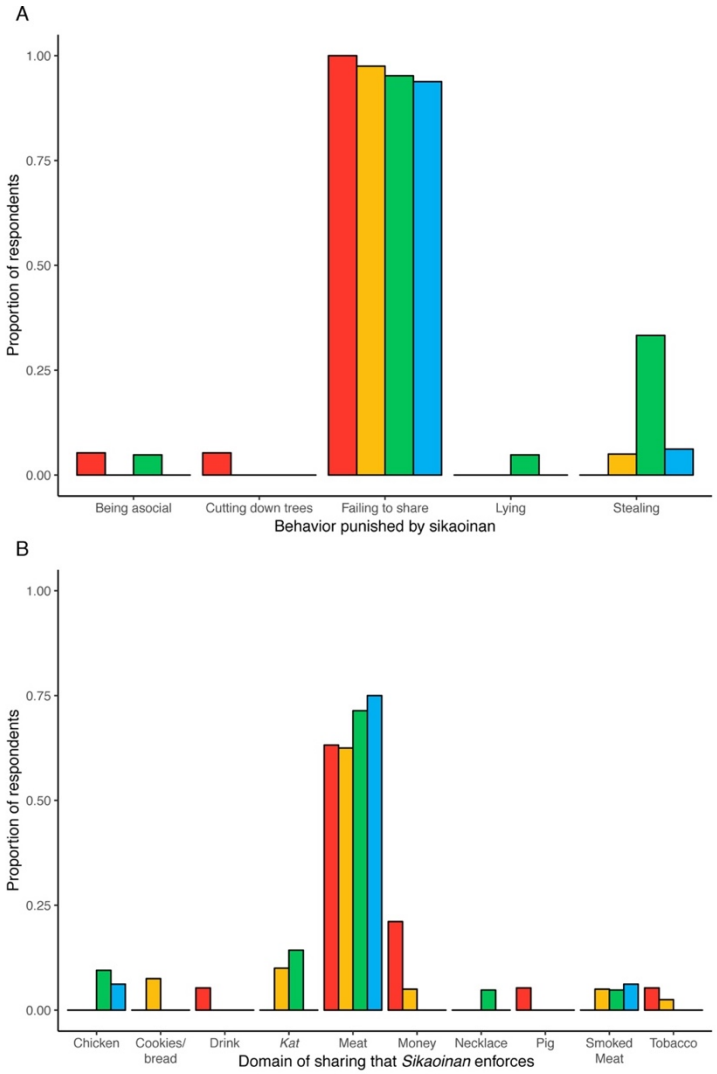

Figure 3. The reasons *Sikaoinan* attacks people, according to free responses (N = 96). Colors correspond with cultural regions: red = Sabirut; yellow = Sareireket; green = Silaoinan; blue = Taileleu. Panel A shows the proportion of respondents reporting different reasons that *Sikaoinan* attacks people. Panel B shows the proportion of respondents reporting different domains of sharing that *Sikaoinan* enforces.

Unprompted, respondents sometimes suggested that the fear of *Sikaoinan* causes people to share. One woman noted that the Mentawai have no need for foreign religions and moralistic prescriptions because *Arat Sabulungan* (indigenous Mentawai religion) already deters wrongdoing. Sorcery prevents people from stealing, she noted, and *Sikaoinan* ensures that they share.

An older woman also observed the instrumental effect of *Sikaoinan*: "That's why we give meat to other people; that's why we give plant-food. We give them plant-food; we give them meat. They see our food, we give it. [Otherwise, *Sikaoinan*] carries us to the bottom [of the river]. The body [of the crocodile] – not just a spirit. To the bottom it carries us."

People suspect *Sikaoinan* after many kinds of harms

People believe that *Sikaoinan* watches them. When asked where it lives, some reported that it drifts through the air like wind; one respondent compared it to the regional government – "wherever we go, it knows." Others said that it lives in people's houses. Most respondents said that *Sikaoinan* lives in water, such as the river or the small puddles that collect in broken bamboo (Figure 4).

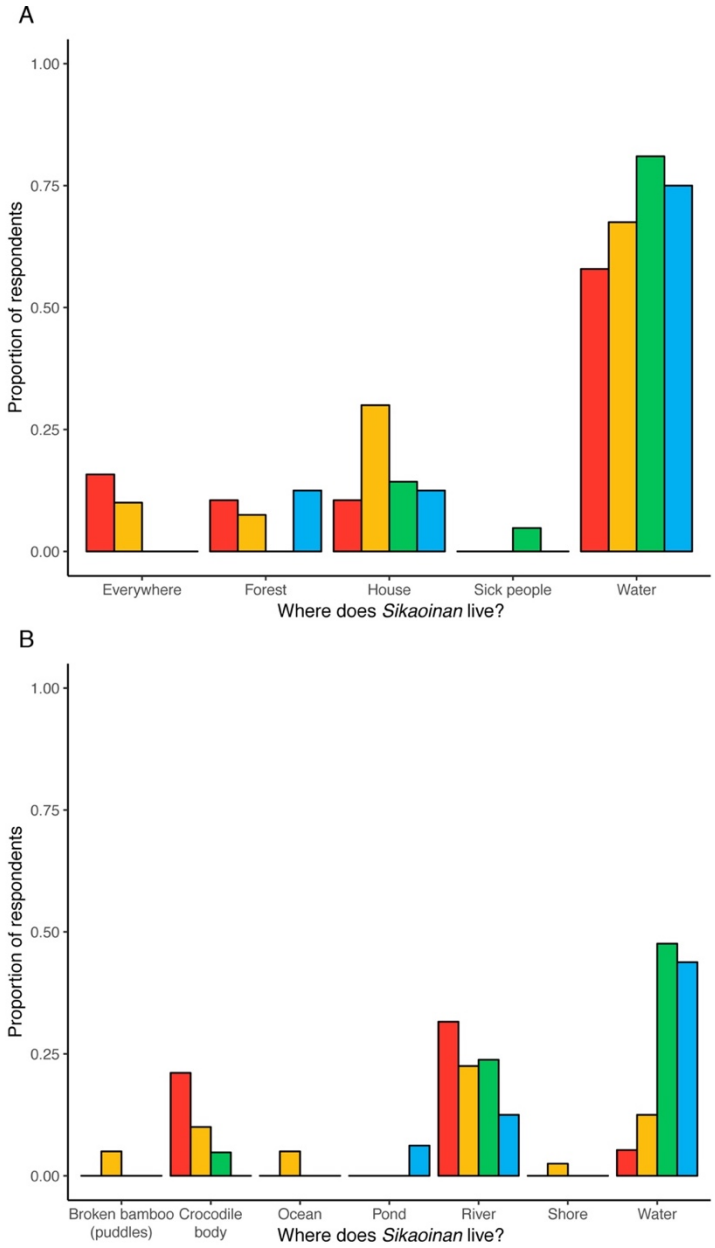

Figure 4. Where *Sikaoinan* lives, according to free responses (N=96). Colors correspond with cultural regions: red = Sabirut; yellow = Sareireket; green = Silaoinan; blue = Taileleu. Panel A shows the proportion of respondents reporting different locations where *Sikaoinan* lives,

aggregating responses about water. Panel B shows the breakdown of different responses about water.

When *Sikaoinan* sees someone refusing to share, it attacks. In one version, it enters the stingy person's house and climbs onto a cross-beam. It radiates its illness-causing energy (*bajou*), scratches its victim, or weighs down on top of them, making it hard to breathe. Alternatively, it might wait for the stingy person or their family members in the river. When its target arrives, *Sikaoinan* attacks them as a crocodile, or it directs a crocodile to attack them, or it pulls them to the bottom and drowns them (see Supplementary Figures S1 and S2 for participants' responses about how *Sikaoinan* attacks and the kinds of illnesses it causes).

People sometimes connect others' misfortunes to their stinginess and *Sikaoinan*'s retribution. In 1988, Bakels was told about a crocodile that carried off a small boy (Bakels 1994). The animal's violence was blamed on the boy's mother's stinginess. Similarly, when a boy drowned in August 2017 in a community where M.S. was conducting research, people covertly discussed possible reasons. The leading explanation that developed was that *Sikaoinan* attacked after the boy's parents failed to share their growing wealth. Finally, two men told M.S. about the misfortunes that befall ignorant foreigners. They described two European tourists who, on separate occasions, hoarded food in their backpacks and either ate it in secret or explicitly refused to share. One slipped and died; the other fell in a river and ruined his food. Both incidents were attributed to *Sikaoinan*.

People pay costs for shamans to remove *Sikaoinan* in a dramatic public ritual

All *pabetei* (shamanic healing ceremonies) share common elements, such as fanning the patient with magically potent plants while ringing bells (*pasibibbik)*. But they also vary according to what the *sikerei* and the client suspect is causing the illness (Figure 6 displays examples of common treatments used in *pabetei*).

When it's concluded that a patient's illness is caused by *Sikaoinan*, the *sikerei* conduct a special ceremony to appease the spirit. The *sikerei* assemble in the patient's house or the patient's clan's longhouse, usually with the patient's family and other members of the patient's clan. The *sikerei* put out objects that will attract *Sikaoinan*, such as fabric and a fishing net (Figure 5A). They publicly acknowledge that the patient or their family did not share, but they promise *Sikaoinan* that this was not intentional. The patient and their family members apologize, assuring *Sikaoinan* and any observers that they will share in the future.

The *sikerei* then use special songs to lure *Sikaoinan* into a small basin of water. These songs are considered powerful ways of inviting *Sikaoinan*, and for that reason, people are forbidden from singing them outside of the *Sikaoinan* ceremony. This prohibition even extends to shamans teaching novices the songs required for being a *sikerei*.

Once *Sikaoinan* is captured, the *sikerei* carry it to the river. They hold the basin steady to prevent *Sikaoinan* from tumbling out. They bring the lavish gifts and a small food item, such as smoked meat or piece of chicken (Figure 4B). Finally, they release *Sikaoinan* into the water.

Figure 5. *Sikerei* (Mentawai shamans) conduct ceremonies to remove *Sikaoinan*. (A) A *sikerei* presents items to attract *Sikaoinan*, including a necklace, fabric, and a *luat* (shaman headband) (photo taken in 2019; credit/copyright Rob Henry, Indigenous Education Foundation). (B) *Sikerei* prepare to release *Sikaoinan* into the river (photo taken in 1978; credit/copyright Reimar Schefold).

There are three noteworthy points about this ceremony:

1. The ceremony is costly in two ways. First, the family hosting the ceremony must provide food for the shamans and the other family members in attendance. This means preparing taro, sago, sweetened beverages, and, most importantly, meat.

The consensus is that the "price" of a *Sikaoinan* ceremony is 1 or 2 chickens. Examining the subset of healing ceremonies that included only the *Sikaoinan* ceremony (or the *Sikaoinan* ceremony and a treatment for the spirit-illness *kisei*, which is said to require no additional sacrifice), we found that the number of animals sacrificed varied from no chickens (when a shaman conducted the ceremony privately for his sick child) to a large female pig and 2 chickens (a large female pig is roughly equivalent in value to ten adult chickens) (see Table 1 for the list of ceremonies and their accompanying sacrifices). Although the family also consumes the food, (a) they must share it with a larger group of individuals than they would if they killed it in private, (b) they give up other opportunities to use the animals (such as other household ceremonies or, in the case of pigs, bride prices or penalties for crime), and (c) they give up the best portions of the meat, which are consumed by the shamans.

The second important way in which the ceremony is costly is that it redirects resources from other treatments. Of the 62 bouts of illness treated in the studied healing ceremonies, 63% (39/62) were also treated with herbal or magical remedies. For 50% of those illnesses (31/62), the patient or their family also sought healthcare at a village health post (*Poskesdes*) or community health center (*Puskesmas*). Obtaining herbal remedies and healthcare at a clinic incurs costs, including the time involved in collecting herbs or the price of the medicine. Patients also visit alternative health providers, such as Muslim or Christian healers; these visits also consume time and resources. By spending half a day organizing and paying for a *Sikaoinan* ceremony, families lose the opportunity to pursue other treatment options. People's willingness to pay for *Sikaoinan* ceremonies, especially considering the opportunity costs, demonstrates that representations of supernatural punishment encourage them to engage in costly behavior.

Table 1. Prices of twelve healing ceremonies that either only included the *Sikaoinan* ritual (S) or included the *Sikaoinan* ritual and a treatment for *kisei* (K), which is said to require no additional sacrifices. The PBID refers to the identifier in the data-set, available online. The estimated value is listed in thousands of Indonesian Rupiah (IDR); as of 5 September 2019, 1000 IDR is equivalent to about 0.071 USD. Note that not all chickens are equivalent in value. For PB03, the patient reported two sets of responses on two different occasions; both are reported in the table.

PBID	Animals sacrificed	Estimated value (thousands of IDR)	Interventions
PB30	1 large female pig and 2 chickens	1010	S
PB42	1 medium-sized pig and 2 chickens	660	S
PB66	1 medium-sized pig and 4 chickens	700	S
PB03	2 chickens // 1 rooster	160 // 100	S // S, K
PB39	2 chickens	160	S, K
PB40	2 small pigs	350	S, K
PB41	2 chickens	160	S, K
PB51	0 *[shaman healed his sick child]*	0	S, K
PB57	1 small pig, 1 chicken, and 1 duck	330	S, K
PB60	1 medium-sized pig	500	S, K
PB63	2 chickens and 1 duck	235	S, K
PB73	1 chicken	80	S, K

2. *Elements of the ceremony reinforce belief.* Two aspects of the *Sikaoinan* ceremony seem to reinforce beliefs that *Sikaoinan* is responsible for illness. First, hosting a healing ceremony exhibits the features of what Henrich called CRedibility-Enhancing Displays (CREDS) (Henrich 2009). It is a behavior that would only be sensible if a person held a given belief. In this case, the ceremony is sufficiently costly that someone should host it only if they believe that *Sikaoinan* may have caused illness. The ceremony thus provides a reliable indication of belief, increasing the likelihood that others will adopt similar representations about *Sikaoinan.*

The second element of the *Sikaoinan* ceremony that should reinforce others' beliefs is that it features prestigious individuals speaking to the spirit. *Sikerei* are said to be uniquely capable of seeing spirits, including *Sikaoinan*. They are also trusted for their expertise, especially in Mentawai religious practice (see Supplementary Study 1 and Supplementary Figure S3), and are frequently called to intervene in conflicts, evidencing their status and people's trust in their decisions. The *Sikaoinan* ceremony features these reputable men speaking to the spirit, apologizing to it, coaxing it into a container, and then carefully releasing it into the water. This public performance may further reinforce for spectators that *Sikaoinan* is real and to be taken seriously.

3. The natural course of recovery reinforces belief. Eventually, most people recover from their illness. The timing of their recovery influences their theories about which treatments were effective and, in turn, what originally caused the illness. For example, a patient who recovers soon after shamans remove *Sikaoinan* from their house might attribute their improvement to the ritual and thus their illness to *Sikaoinan*'s attack. This seems to happen in Mentawai. Of families

that paid for a *Sikaoinan* ritual, 11% later reported that *Sikaoinan* was a reason the patient became ill.

People infer features of *Sikaoinan* from ceremonies

Sikaoinan ceremonies occur often. In our sample of 66 healing ceremonies, nearly all of which occurred in a single year, 46 included a *Sikaoinan* ceremony – more than any other special intervention (Figure 6). Although it remains uncertain how often individuals attend the *Sikaoinan* ceremony, we counted 19 *Sikaoinan* ceremonies in a community of 262 individuals. Assuming that each ceremony draws 20 observers, we estimate that an individual has a 78% chance of attending a *Sikaoinan* ceremony in a given year.

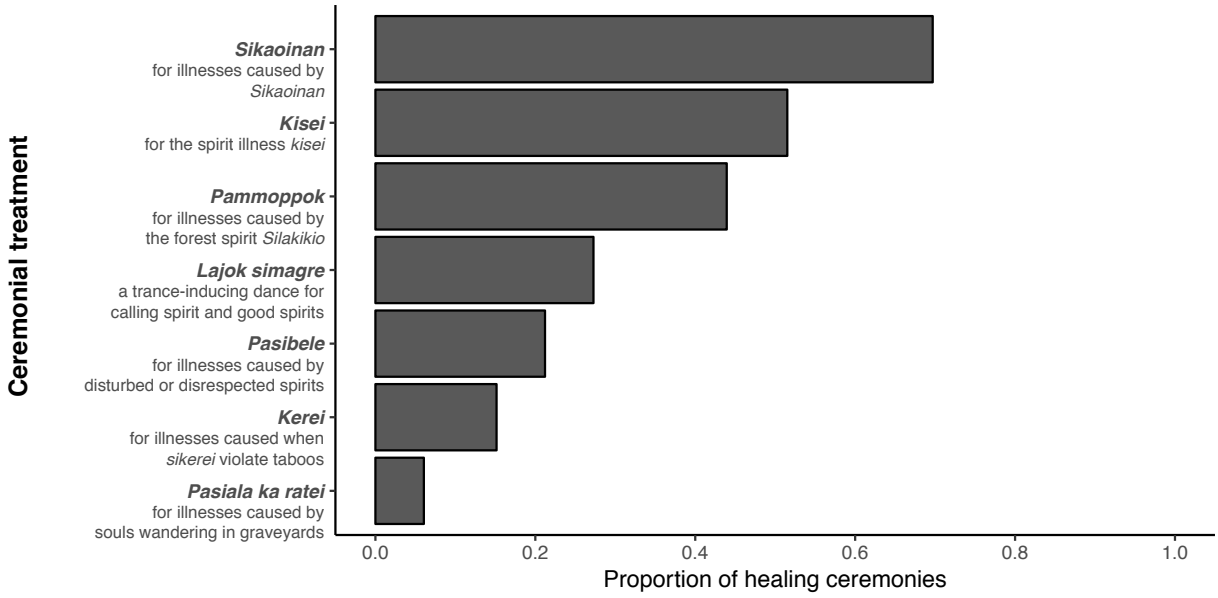

Figure 6. The proportion of healing ceremonies featuring different treatments. Treatments used infrequently (>0.05) have been removed.

At least two lines of evidence suggest that these frequent ceremonies serve as important vehicles to transmit beliefs about *Sikaoinan*.

First, in explaining or thinking through their answers, respondents explicitly drew inferences from the *Sikaoinan* ceremony. These inferences included that *Sikaoinan* lives in water because shamans place it in water, that it lives near the ceiling because shamans look there during ceremonies, and that it is female because shamans refer to it (her) as "aunt".

Second, of those features of *Sikaoinan* we systematically studied, all of the most widely shared beliefs are represented in the ritual or can be readily inferred. As Figure 7 shows, participants agreed most on why *Sikaoinan* attacks people (not sharing), followed by the number of *Sikaoinan* (one) and the objects used to appease it in ritual (fabric, fishing net, and necklaces). By contrast, elements of *Sikaoinan* that are not present in the ritual (how it attacks people and the kinds of illnesses it causes) showed large variation, both within and across cultural regions.

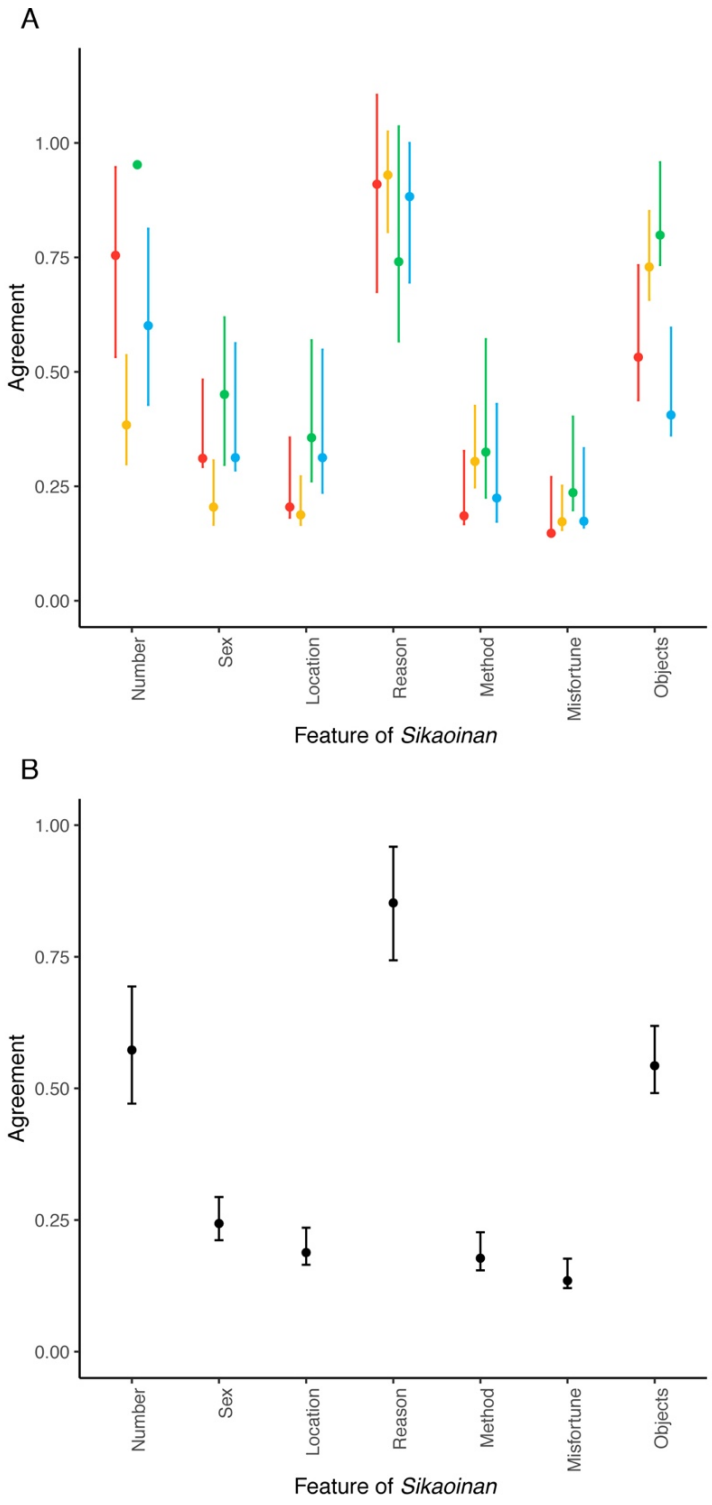

Figure 7. Agreement among participants about different features of *Sikaoinan*. Error bars are bootstrapped 95% confidence intervals (10,000 samples). Colors correspond with cultural regions: red = Sabirut; yellow = Sareireket; green = Silaoinan; blue = Taileleu. Panel A shows

agreement among respondents living in the same cultural region; Panel B shows agreement among respondents pooling across cultural regions.

By this logic, we should expect higher agreement about *Sikaoinan*'s location (water) and, possibly, its sex (female). What explains the lower values? For responses about *Sikaoinan*'s location, the lower agreement is a result of people's diverse responses. Still, the majority of responses referred to the water (e.g., river, ocean, puddles inside broken bamboo), a belief again reinforced in ritual (see Figure 4). For sex, the lower agreement is partly the high frequency with which participants responded that they didn't know (Supplementary Figure S4). Moreover, the participants who did respond usually replied that *Sikaoinan* is either female (29%) or both sexes (23%) with only 4% of respondents claiming that *Sikaoinan* is male. The bias towards *Sikaoinan* being female is what we expect on the basis of *Sikaoinan*'s polite name (aunt) and the objects used to appease it (especially the fishing net, which women typically use).

Of course, just how central the ritual is in the transmission of beliefs remains uncertain. But this evidence suggests that the *Sikaoinan* ceremony is a potent mechanism of transmitting cultural information and creating shared beliefs among community members.

Discussion

At the outset of this article, we asked three questions:

1. Are supernatural agents believed to punish non-cooperative behavior in small-scale societies and, if so, how does their jurisdiction differ from that of bigger gods in more complex societies?
2. Do beliefs in these supernatural agents motivate people to incur costs?
3. What is the relationship between belief and ritual?

For the first question, our study found strong evidence that a supernatural agent in a small-scale society is said to punish non-cooperative behavior. But in comparison with the moralizing high gods of world religions, *Sikaoinan*'s scope and domain of interest are much more limited. *Sikaoinan* doesn't care about murder, adultery, or kindness towards strangers — it attacks people who fail to share with fellow clan members. *Sikaoinan* also seems to lack the ability to read minds or see into people's hearts, demonstrated in shamans' assurance to the spirit that the patient's failure to share was inadvertent. *Sikaoinan* is morally concerned about some behaviors but provincial in its scope and limited in its knowledge compared to the all-powerful and omniscient gods of the largest-scale societies.

For the second question, our findings suggest that beliefs in supernatural punishment motivate people to incur costs. Patients and their families pay for shamans to come and remove *Sikaoinan* from their homes, and they do so at the expense of other treatment options, such as visiting a health clinic. Moreover, shamans call other shamans to perform the ceremony, and shamans even perform the ceremony in private.

An alternative explanation for these observations is that people's representations of *Sikaoinan* do not motivate them to incur costs and instead families host the ceremony for reputational benefits, perhaps because it indicates to other people that they fear *Sikaoinan* and can therefore be trusted. Aside from the fact that such a hypothesis still invokes erroneous beliefs – observers would erroneously infer that the family holds *Sikaoinan* beliefs that make them

trustworthy – readers should also be aware that conducting a *Sikaoinan* ceremony is an admission that one violated an important social norm. Future research should more systematically identify the full set of costs and benefits associated with hosting these ceremonies.

For the final question, our study showed that ritual and belief can mutually reinforce each other. People's belief that *Sikaoinan* harmed them or their family motivates them to call shamans to conduct the appropriate ceremony. The costly, optional, and public nature of the ceremony in turn strengthens observers' beliefs about *Sikaoinan*, especially the idea that *Sikaoinan* punishes for not sharing. The patient's recovery, such as through the spontaneous remission of the illness or, possibly, placebo effects stimulated by ritual healing (Kaptchuk 2011), further convinces patients and observers that the ceremony worked and that *Sikaoinan* was the originating cause of the illness. The belief-producing effects of ritual manifest in population-level variation in beliefs. Those beliefs that vary the least across individuals are represented in ritual, while those beliefs not represented exhibit the least agreement. Belief motivates ritual; ritual reproduces belief.

In closing, we hope our study demonstrates the capacity for primary ethnographic research to provide rich descriptions of behavior in diverse societies and address targeted research questions. This point is important, because, as with all sciences, the naturalistic study religion is undergoing a methodological revolution. Researchers increasingly draw on massive online experiments, cross-cultural studies, and analyses of large-scale databases to test the behavioral and historical predictions of existing theories(Slingerland and Sullivan 2017; Watts, Sheehan, et al. 2015; Purzycki et al. 2016). These methods open up novel research programs, but they have limitations. First, analyses of large-scale databases must usually leverage existing descriptions, and despite the richness of the ethnographic and historical record, many observers failed to document behaviors and beliefs that are most relevant for existing questions, such as whether beliefs in small punishing gods motivate people to incur costs. Ethnographic research that balances behavioral data, survey responses, and qualitative description allows scholars to ask theoretically-relevant questions about social and cultural behavior. Second, experiments conducted online or in field settings increase statistical power and allow researchers to examine a greater diversity of human psychology. But they sacrifice investigations of the social and cultural factors that reinforce particular behaviors, such as how recurrent rituals reinforce beliefs about supernatural punishment. A comprehensive understanding of human behavior requires leveraging a diverse toolkit, integrating targeted ethnographic investigations with large-scale, comparative projects.

Methods

The Harvard University Committee on the Use of Human Subjects approved this research project. All participants provided verbal informed consent before the study.

***Sikaoinan* interviews.** M.S. and a research assistant interviewed participants about *Sikaoinan* in 2017 as part of a larger cross-regional study of cultural beliefs in southern Siberut. Interviews were conducted in the villages of Buttui and Ugai (Sarereiket), Muntei and Maileppet (Sabirut), Salappa (Silaoinan), and Taileleu (Taileleu). We aimed to interview those participants living in the same village in as few days as possible and visited different sections of each village on different days. We selected participants opportunistically and made efforts to both (1) interview

participants privately and out of earshot (such as in the participant's house or a small building to which participants were invited) and (2) prevent participants who had completed the interview from discussing it with other individuals (such as by having a research assistant sit with participants as they waited to be interviewed).

Interviews were conducted in Mentawai. They consisted of demographic variables (name, age, patrilineal clan, village of residence, village of origin, spouse's clan, religion, and years of schooling), as well as surveys on shaman taboos and *Sikaoinan*. With the exception of eight participants in Sarereiket, all participants were asked the seven questions about *Sikaoinan* in the same order: (1) number of *Sikaoinan*; (2) sex; (3) location; (4) reason for attack; (5) method of attack; (6) injury/illness resulting from attack; (7) objects used in ritual.

Responses to these questions were recorded during the interviews. We later translated answers into English, cleaned them, and binned them. All analyses were conducted in R 3.4.3 (R Foundation).

We calculated the agreement about a given question (represented here with *a*) according to the formula

$$a = \frac{\sum_{i=1}^{s} p_i n_i}{n} * \frac{n}{\sum_{i=1}^{s} n}$$

where n_i is the number of respondents who gave the *i*th answer, p_i is the proportion of respondents who gave the *i*th answer, *s* is the total number of types of answers, and *n* is the total number of respondents. The formula measures the extent to which respondents gave similar answers (term on the left), taking into account that respondents can give more than one answer (term on the right). The formula simplifies to the following:

$$a = \frac{\sum_{i=1}^{s} {n_i}^2}{n \sum_{i}^{s} n_i}$$

Healing ceremonies. M.S. and a research assistant interviewed patients of healing ceremonies (or their families) in 2017. All interviews were conducted along the Rereiket River with most occurring in Ugai, Buttui, and the surrounding hamlets.

Interviews were conducted in Mentawai. Respondents were asked about the treatments in the healing ceremony, the number of pigs and chickens sacrificed, the length of the ceremony, and which shamans provided care. Participants were also asked about the illness, such as what the ailment was, its duration, whether they had hosted a healing ceremony for it before, why they believed it to have occurred, which other treatments they had pursued, and whether the ceremony had worked.

When possible, participants' responses were verified in one or more of the following ways: (a) M.S. attended the healing ceremony; (b) M.S. verified details with other community members, preferably one of the shamans said to administer the ceremony; (c) M.S. reinterviewed the participant or another family member. In total, 90 interviews were conducted about 77 healing ceremonies and 75 bouts of illness (some healing ceremonies targeted several bouts of illness, such as when siblings or spouses were healed, while some illness bouts were healed in several successive ceremonies). Eleven healing ceremonies were removed from analyses because

no ceremony was actually conducted (n = 1); other observers denied that a ceremony was conducted (n = 4); or the information was unreliable, such as because the participant admitted to not remembering clearly (n = 3), there were substantial discrepancies when the participant was interviewed again (n = 2), or other parties disagreed about noteworthy details (n = 1).

Responses to the questions were recorded during the interviews. All analyses were conducted in R 3.4.3 (R Foundation).

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