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The coexistence of natural and supernatural explanations within and across domains and development

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Abstract

People across highly diverse cultural contexts use both natural and supernatural explanations to explain questions of fundamental concern such as death, illness, and human origins. The present study examines the development of explanatory coexistence within and across domains of existential concern in individuals in Tanna, Vanuatu. We examined three age groups: 7- to 12-year-old children, 13- to 18-year-old adolescents, and 19- to 70-year-old adults ($N = 72$). Within the domain of death, biological and spontaneous explanations were most common across all ages. For illness, children showed the highest rates of explanatory coexistence, while adolescents and adults favoured biological explanations. Within the human origins domain, theistic explanations were most common across the age groups. Overall, these data show that coexistence reasoning in these domains is pervasive across cultures, yet at the same time it is deeply contextually specific, reflecting the nuanced differences in local ecologies and cultural beliefs.

Classic research in developmental psychology proposed that children gradually abandon a belief in supernatural causation and instead acquire a more objective and scientific appreciation of cause and effect (Piaget, 1928). According to the secularization hypothesis, with more widespread access to education and technology, natural explanations will increasingly compete with and displace supernatural explanations (Inglehart & Norris, 2004). In contrast to these hypotheses, there is mounting evidence that individuals across highly diverse cultural contexts use both natural and supernatural explanations to understand the events that occur in their lives (Campbell, 1972; Legare, Evans, Rosengren, & Harris, 2012; Legare & Gelman, 2008; Misztal & Shupe, 1992; Raman & Winer, 2004). We define natural explanations as those that appeal to 'empirically verifiable phenomena of the physical or material world' (Legare *et al.*, 2012, p. 4), and supernatural explanations are those that appeal to phenomena that 'violate, operate outside of, or are distinct from' the natural world (Legare *et al.*, 2012, p. 5).

The objective of the current research was to systematically examine how developmental patterns and cultural ideologies affect the way children (7- to 12-year-olds), adolescents (13- to 18-year-olds), and adults in Tanna, Vanuatu, incorporate natural and supernatural

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explanations within and across the domains of death, illness, and human origins. We begin with a discussion of the domains in which we examine explanatory coexistence (death, illness, and human origins); next, we review the literature on the development of explanatory coexistence, and finally, we discuss how differential framing of the events within these domains might impact explanatory coexistence.

Cultural context of explanatory coexistence

Explanatory coexistence has been studied primarily within three domains of human experience: death, illness, and human origins (Legare *et al.*, 2012). These three domains share a number of properties that make them likely to draw on both natural and supernatural explanations: (1) Each can be attributed to unobservable causal agents, (2) each is associated with strong emotions, and (3) each is embedded in specific cultural scripts (Legare *et al.*, 2012). Based on evidence for explanatory coexistence across highly diverse cultural contexts, we predict that as individuals are confronted with scientific understandings of the world, they will integrate scientific explanations with pre-existing supernatural and other kinds of natural (e.g., folkbiological) explanations (Watson-Jones, Busch, & Legare, 2015).

Understanding the coexistence of natural and supernatural explanations within each of these domains requires situating these explanations within specific cultural contexts (Gelman & Legare, 2011; Harris & Koenig, 2006; Heyman & Legare, 2013; Rosengren *et al.*, 2014). This is particularly important when examining concepts surrounding death, illness, and human origins, all of which are deeply embedded in local beliefs. Cultural input plays a significant role in shaping the types of explanations that are recruited to explain different kinds of life events, even though there may be common patterns associated with the development of explanatory coexistence across cultures. As an example of the role of context in shaping belief systems, consider the Urapmin of Papua New Guinea. For the Urapmin, the body was once regarded as a key component of the social connection between the self and others, whereas the heart and emotions were interior and private. Christian conversion inverted this relationship and required Urapmin to relate to others through ‘shared thoughts and feelings’ (the heart), rather than through the body and kinship (Robbins, Schieffelin, & Vilaca, 2014, p. 584). Examining explanatory coexistence in a culture that still adheres in many ways to indigenous beliefs while integrating and embracing Christian doctrine has the potential to provide insight into how cultural scripts can influence the use of different kinds of explanations.

Vanuatu is a Melanesian island nation in the South Pacific that consists of 65 different islands, each with villages that maintain distinct cultural traditions. Tanna Island has approximately 30,000 inhabitants. The population of Tanna, Vanuatu, has relatively recently experienced Christian conversion, has only recently adopted Western schooling practices, and still relies heavily on interactions with nature. These factors have interesting implications for how individuals reason about natural and supernatural causes for events. Christianity offers a relatively new (within the last 100 years) way of understanding the supernatural, and formal schooling offers a new way of understanding the natural for a society that relies heavily on nature for resources.

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Much of the population was converted to Presbyterianism between 1910 and 1930. Despite the influence of Presbyterianism on the island, many villages have maintained *kastom* (custom), or 'ancestrally enjoined rules for life' (Keesing, 1982, p. 360). Whereas nearly 100% of our sample identified as Presbyterian, other denominations are present such as Baha'i and Catholicism. In a recent survey about national identity in Vanuatu, maintaining kastom as well as being Christian were considered two of the most important aspects of what it means to be from Vanuatu (Clarke, Leach, & Scambary, 2013). Adopting a literal interpretation of Biblical scripture is common in Vanuatu (Watson-Jones, Busch, Harris, & Legare, 2016), which may make it more likely that people in Tanna offer exclusively supernatural explanations for human origins while explanations for death and illness may be more likely to invite mixed explanations.

Development of explanatory coexistence

Previous research has examined the development of explanatory coexistence in individual domains. For instance, cross-cultural research on the development of explanatory coexistence has shown that children begin to understand the biology of death early in childhood and they consolidate their biological understanding of organs and of death across middle childhood (Slaughter & Lyons, 2003). Other developmental work, however, has found that adults are less likely than children to insist on the irreversibility of death (Brent & Speece, 1993), and when primed with a supernatural narrative about death, children endorse the continuation of bodily and mental processes following death (Harris & Gimenez, 2005; Watson-Jones *et al.*, 2016). Within the domain of illness, previous research has shown that while biological explanations are the most frequently endorsed causes of illness across age groups, children and adults more often recruit supernatural explanations alongside natural explanations. This may be because adolescents are in the midst of education about biology whereas children have yet to be fully entrenched in this education and adults are further removed from it (Legare & Gelman, 2008; Nguyen & Rosengren, 2004; Raman & Gelman, 2004). The domain of human origins also invites developmental changes in explanatory coexistence – even in fundamentalist Christian populations. There is evidence that older children and adults are more likely to endorse some form of change of species over time than young children. Indeed, theistic evolution, in which God guides evolution, has become a common belief for many Christians (Evans, 2008).

Formal, Western-style education is a relatively recent institution in Vanuatu and has an important impact on the development of explanatory coexistence. In Tanna, there has been no standard schooling curriculum until the last three decades when British and French run schools began providing primary and secondary education (Peck & Gregory, 2005). Education is not mandatory on Tanna. Approximately 86% of children attend primary school in Vanuatu, but only about 35% of children attend secondary school (Hughes, 2004; Ministry of Education and Training, 2015). A Western scientific epistemology has only recently become accessible for use in explaining events. Thus, adolescents and children may be most likely to offer natural explanations to the exclusion of supernatural explanations within the domain of illness because germ theory and methods of illness prevention are reinforced in school. The World Health Organization (WHO) has nearly eradicated malaria on Tanna through educational programmes on disease prevention (Atkinson *et al.*, 2010).

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Priming effects on explanatory coexistence

To examine explanatory coexistence across domains and age in Tanna, we presented children, adolescents, and adults with a variety of vignettes dealing with death, illness, and human origins. We also manipulated the way these vignettes were framed to examine flexibility in explanatory coexistence over very short time periods. Half of the vignettes were framed in a supernatural context and half were framed in a natural context. Previous researchsuggests that context plays a key role in determining how individuals incorporate natural and supernatural explanations. When primed with supernatural narratives, individuals are more likely to incorporate both natural and supernatural explanations for events (Astuti & Harris, 2008; Harris & Giménez, 2005; Legare & Gelman, 2008). The supernatural vignettes included elements that primed ideas related to kastom traditions, such as belief in spirits, taboos associated with farming practices and social hierarchies, folkbiological medical practices, and traditions, which take place within a sacred meeting place known as a nakamal. The natural vignettes included information about going to a hospital, being bitten by a mosquito, etc. This was done to examine how context may affect endorsements across development (Astuti & Harris, 2008; Harris & Giménez, 2005).

The recent influx of Christianity and formal education, as well as low levels of industrialization and reliance on subsistence practices, makes Tanna an ideal location to examine the development of explanatory coexistence. We hypothesized that overall, participants would incorporate both natural and supernatural explanations within each domain. We predicted that within the domain of death participants would be most likely to endorse theistic explanations in response to a supernatural prime and most likely to endorse a biological explanation in response to a natural prime. We also predicted that because adolescents have the most experience with formal education, they would show the least explanatory coexistence of the age groups we examined, and be most likely to strictly endorse biological explanations for death. In the domain of illness, we expected to find more biological explanations. We also expected to find more endorsement of local supernatural explanations for illness, particularly following the supernatural prime, due to the Tannese emphasis on maintaining kastom. In the domain of human origins, we predicted predominantly theistic endorsements regardless of contextual prime(natural or supernatural) due to the religiosity of the sample.

Method

Participants

Participants in Vanuatu were divided into three age categories: child (7- to 12-year-olds), adolescent (13- to 18-year-olds), and adult (19- to 70-year-olds). A total of $N = 72$ individuals participated in the study (twenty-four 7- to 12-year-olds, twenty-nine 13- to 18-year-olds, and nineteen adults). To give a better sense of the breadth of the adult age range, it can be broken down further into six 19- to 23-year-olds, five 27- to 34-year-olds, and eight 42- to 65-year-olds. Children and adolescents were recruited from two primary and secondary schools in the city of Lenakel on the island of Tanna and completed the study

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in an unused classroom on the school grounds away from their classmates. Adults were recruited in the markets and neighbourhoods in the city of Lenakel.

Materials and procedure

All participants were read a series of vignettes (12 total) that primed either natural or supernatural conceptions of death (two natural; two supernatural), illness (two natural; two supernatural), and origins (two natural; two supernatural) using two scripts with the vignette orders randomized (see Table 1).

Endorsement options—After being read each vignette, participants were presented with a series of four options to choose from to explain why the event described in the vignette occurred (response types were randomized for each vignette and each script): (1) local supernatural: an explanation related to *kastom* supernatural beliefs; (2) biological: an explanation related to purely natural causes; (3) spontaneous: an explanation related to unpredictability and events happening for no particular reason; and (4) theistic: an explanation related to the workings of the Christian God. Participants could endorse as many or as few explanations as they liked (see Table 2).

All participants completed the study one-on-one with a trained research assistant who was native to Tanna and fluent in Bislama, one of the official languages of Vanuatu. All participants were video recorded.

Coding

Participants provided ‘yes’ or ‘no’ responses to each of the four possibilities following each vignette. ‘Yes’ was coded as 1, and ‘no’ was coded as 0. To compare explanation types by each type of vignette, summary scores out of 2 were created for vignette type (death, illness, human origins) and prime type (natural, supernatural) across participants.

Results

First, we present the analyses conducted to examine explanatory coexistence within the three different domains. Next, we present the analyses to examine differences in the frequency of different explanation types across domains and development.

Within domain analyses

Three repeated-measures ANOVAs were conducted to examine explanatory coexistence within each domain with explanation type and priming as the within-subjects variables and age group as the between-subjects variable. Within each domain, all participants were asked to endorse or reject explanations in response to two vignettes with a naturalistic prime and two with a supernatural prime. Therefore, each explanation could be endorsed a maximum of two times within each domain for each prime.

Death domain—A repeated-measures ANOVA was conducted on the number of times participants endorsed each explanation type within the death domain with explanation type (four: local supernatural, biological, theistic, and spontaneous), prime (two: natural and

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supernatural) as the within-subjects variables, and age group (three: child, adolescent, and adult) as the between-subjects variable. This analysis revealed no main effect of prime. There was a main effect of explanation type, F(3, 207) = 11.40, $p < .001$, $\eta^2_p = .142$, and a main effect of age group, $F(2, 69) = 12.86$, $p < .001$, $\eta^2_p = .272$. There were no significant interactions (see Table 3).

Pairwise comparisons on explanation type reveal that the most commonly endorsed explanation type, spontaneous explanations ($M = 1.19$, $SE = 0.08$), were statistically more common than theistic explanations ($M = 0.84$, $SE = 0.09$), $p = .001$, and local supernatural explanations ($M = 0.76$, $SE = 0.08$), $p < .001$. Biological explanations ($M = 1.18$, $SE = 0.09$) were also statistically more commonly endorsed for death than theistic explanations, $p = .002$, and local supernatural explanations, $p < .001$. There was no significant difference in the endorsement of spontaneous explanations and biological explanations. There was also no statistical difference between endorsement of theistic explanations and local supernatural explanations.

Pairwise comparisons on age reveal that adolescents ($M = 0.59$, $SE = 0.10$) were statistically less likely than children ($M = 1.26$, $SE = 0.10$), $p < .001$, and adults ($M = 1.13$, $SE = 0.12$), $p = .001$, to endorse any of the explanation types. There was no statistical difference between children and adults in the frequency of endorsement of the explanations for death.

Illness domain—A repeated-measures ANOVA was conducted on the number of times participants endorsed each explanation type within the illness domain using the same factors as the analysis within the death domain. This analysis revealed no main effect of prime. There was a main effect of explanation type, $F(3, 204) = 49.74$, $p < .001$, $\eta^2_p = .422$, and a main effect of age group, $F(2, 68) = 8.67$, $p < .001$, $\eta^2_p = .203$. These main effects, however, should be interpreted in the light of a significant interaction between explanation type and age group, $F(6, 204) = 9.86$, $p < .001$, $\eta^2_p = .225$ (see Table 4).

Examining the data across both priming types, the data reveal that there were no statistically significant differences in the explanation types for children. Children endorsed biological explanations ($M = 1.28$, $SE = 0.14$) just as frequently as local supernatural explanations ($M = 1.13$, $SE = 0.14$), which were just as common as spontaneous explanations ($M = 1.13$, $SE = 0.13$), which were just as common as theistic explanations ($M = 1.11$, $SE = 0.14$).

For adolescents, the most commonly endorsed explanation for illness was biological ($M = 1.57$, $SE = 0.10$), which was significantly more common than spontaneous explanations ($M = 0.60$, $SE = 0.11$), $p < .001$, theistic explanations ($M = 0.22$, $SE = 0.09$), $p < .001$, and local supernatural explanations ($M = 0.19$, $SE = 0.08$), $p < .001$. Spontaneous explanations were also endorsed significantly more often than theistic explanations, $p = .01$, and local supernatural explanations $p = .001$. There was no statistically significant difference in the frequency of endorsement of theistic and local supernatural explanations for illness.

Adults, like adolescents, most commonly endorsed biological explanations for illness. Biological explanations ($M = 1.74$, $SE = 0.09$) were endorsed significantly more than spontaneous explanations ($M = 1.18$, $SE = 0.16$), $p = .004$, theistic explanations ($M = 0.79$,

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SE = 0.20), $p < .001$, and local supernatural explanations (*M* = 0.68, *SE* = 0.20), $p < .001$. Spontaneous explanations were endorsed significantly more than both theistic explanations, $p = .02$, and local supernatural explanations, $p = .01$. There was no statistically significant difference in the frequency of endorsement for theistic and local supernatural explanations for illness.

The data within the domain of illness also show there was a significant interaction between explanation type and prime, $F(3, 204) = 3.88$, $p = .01$, $\eta^2_p = .054$. In response to the natural prime, participants gave significantly more biological explanations (*M* = 1.58, *SE* = 0.07) than theistic (*M* = 0.66, *SE* = 0.09), local supernatural (*M* = 0.61, *SE* = 0.09), or spontaneous explanations (*M* = 0.83, *SE* = 0.10), $p < .001$. Spontaneous explanations were also endorsed significantly more often than local supernatural explanations following the natural prime for illness. There was no statistical difference in the rates of endorsement between theistic and local supernatural explanations or between theistic explanations and spontaneous explanations.

In response to the supernatural prime, biological explanations were again the most common (*M* = 1.46, *SE* = 0.08) and endorsed significantly more often than spontaneous explanations (*M* = 1.10, *SE* = 0.09), $p = .001$, theistic explanations (*M* = 0.74, *SE* = 0.10), $p < .001$, and local supernatural explanations (*M* = 0.71, *SE* = 0.09), $p < .001$. Spontaneous explanations were statistically more common than both theistic explanations, $p = .004$, and local supernatural explanations, $p < .001$. There was no statistical difference in the frequency of endorsement of theistic explanations and local supernatural explanations.

Origins domain—The same repeated-measures ANOVA was conducted on the number of times participants endorsed each explanation type within the origins domain. This analysis revealed no main effect of prime. There was a main effect of explanation type, $F(3, 207) = 76.46$, $p < .001$, $\eta^2_p = .526$,as well as a main effect of age group, $F(2, 69) = 14.38$,$p < .001$,$\eta^2_p = .294$. These main effects, however, should be interpreted in the light of a significant interaction between explanation type and age group, $F(6,207) = 9.25$,$p < .001$,$\eta^2_p = .212$.As there was no effect of prime, all subsequent analyses were collapsed across prime type (see Table 5).

For children, the most frequently endorsed explanation type was theistic (*M* = 1.56, *SE* = 0.10), which was significantly more common than local supernatural explanations (*M* = 1.00, *SE* = 0.15), $p = .003$. The second most commonly endorsed explanation type for origins among children was spontaneous explanations (*M* = 1.33, *SE* = 0.13), which were also significantly more common than local supernatural explanations, $p = .03$. There was no significant difference between biological explanations (*M* = 1.29, *SE* = 0.14) and any of the other explanation types.

For adolescents, as with children, the most commonly endorsed explanation for origins was theistic explanations (*M* = 1.74, *SE* = 0.08), which were significantly more common than spontaneous explanations (*M* = 0.36, *SE* = 0.12), $p < .001$, biological explanations (*M* = 0.29, *SE* = 0.10), $p < .001$, and local supernatural explanations (*M* = 0.12, *SE* = 0.07), $p < .001$. Local supernatural explanations were also significantly less common than

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both spontaneous explanations, $p = .02$, and biological explanations, $p = .02$. There was no significant difference between the frequency of biological explanation endorsement and spontaneous explanation endorsement.

As with children and adolescents, the most commonly endorsed explanation for origins among adults was theistic explanations. Theistic explanations ($M = 1.87$, $SE = 0.06$) were significantly more common than spontaneous explanations ($M = 0.79$, $SE = 0.21$), $p < .001$, biological explanations ($M = 0.71$, $SE = 0.19$), $p < .001$, and local supernatural explanations ($M = 0.63$, $SE = 0.18$), $p < .001$. There was no significant difference between any of the other explanation.

Across domain analyses

Next, we present analyses examining differences in explanation frequency across domains. As the first set of analyses revealed that the effects of priming were minimal, we collapsed the natural and supernatural prime for the subsequent analyses. Within each domain, participants were asked to endorse or reject explanations in response to two vignettes with a naturalistic prime and two with a supernatural prime. As naturalistic and supernatural prime vignettes were collapsed for these analyses, each explanation could be endorsed a maximum of four times within each domain. Four repeated-measures ANOVAs were conducted using domain as the within-subjects variable and age as the between-subjects variable.

Local supernatural explanations—A repeated-measures ANOVA was conducted on the number of times participants endorsed local supernatural explanations using domain type (three: death, illness, and human origins) as the within-subjects variable, and age group (three: child, adolescent, and adult) as the between-subjects variable. This analysis revealed a main effect of age group, $F(2, 69) = 16.32$, $p < .001$, $\eta^2_p = .321$. There was no significant effect of domain, $F(2, 138) = 2.51$, $p = .085$, and no significant interaction between domain and age. Pairwise comparisons reveal that children endorsed significantly more local supernatural explanations than adolescents, $p < .001$, and adults, $p = .03$. Adults endorsed significantly more local supernatural explanations than adolescents, $p = .004$ (see Table 6).

Biological explanations—A repeated-measures ANOVA was conducted on the number of times participants endorsed biological explanation using the same factors as the analysis for local supernatural explanations. This analysis revealed a main effect of domain, $F(2, 138) = 39.10$, $p < .001$, $\eta^2_p = .345$, as well as a main effect of age group, $F(2, 69) = 2.90$, $p = .003$, $\eta^2_p = .158$. These main effects, however, should be interpreted in the light of a significant interaction between domain and age group, $F(4, 138) = 13.30$, $p < .001$, $\eta^2_p = .278$ (see Table 7).

The frequency of children's biological explanations was not affected by domain, $F(2, 46) = .09$, $p = .91$. For adolescents, the frequency of biological explanations was affected by domain, $F(2, 56) = 47.35$, $p < .001$, $\eta^2_p = .628$. Pairwise comparisons reveal that biological explanations were significantly more common for the illness domain than for death or human origins, $p < .001$. Biological explanations were also significantly more common for death than for human origins, $p < .001$. For adults, the frequency of biological explanations

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was significantly affected by domain, $F(2, 36) = 26.25$, $p < .001$, $\eta^2_p = .593$. Pairwise comparisons show that for adults, biological explanations were significantly more common in the illness domain than in the domain of death, $p = .046$, and the domain of human origins, $p < .001$. Biological explanations were also significantly more common within the domain of death than human origins, $p < .001$.

Spontaneous explanations—The same repeated-measures ANOVA was conducted on the number of times participants endorsed spontaneous explanations. This analysis revealed a main effect of domain, $F(2, 136) = 11.30$, $p < .001$, $\eta^2_p = .143$, as well as a main effect of age group, $F(2, 68) = 11.53$, $p < .001$, $\eta^2_p = .253$. These main effects, however, should be interpreted in the light of a significant interaction between domain and age group, $F(4, 136) = 3.01$, $p = .02$, $\eta^2_p = .081$ (see Table 8).

Children's endorsement of spontaneous explanations was not affected by domain, $F(2, 44) = 2.39$, $p = .10$. For adolescents, the frequency of spontaneous explanations was affected by domain, $F(2, 56) = 5.60$, $p = .006$, $\eta^2_p = .167$. Pairwise comparisons show that spontaneous explanations are significantly less common in the human origins domain than the domains of death, $p = .007$, and illness, $p = .032$. There was no statistical difference between the domains of death and illness in endorsement of spontaneous explanations for adolescents. For adults, there was a significant difference in the endorsement of spontaneous explanations across domains, $F(2, 36) = 7.50$, $p = .002$, $\eta^2_p = .294$. Pairwise comparisons show that for the domain of death, spontaneous explanations are significantly more common than in the domain of illness, $p = .047$, and human origins, $p = .002$. There was no statistical difference in spontaneous explanations between the illness domain and the human origins domain for adults.

Theistic explanations—Finally, the same repeated-measures ANOVA was conducted on the number of times participants endorsed theistic explanations. This analysis revealed a main effect of domain, $F(2, 138) = 76.86$, $p < .001$, $\eta^2_p = .527$, as well as a main effect of age group, $F(2, 69) = 7.58$, $p = .001$, $\eta^2_p = .180$. These main effects, however, should be interpreted in the light of a significant interaction between domain and age group, $F(4, 138) = 7.70$, $p < .001$, $\eta^2_p = .182$ (see Table 9).

For children, there was a significant effect of domain on endorsement of theistic explanations, $F(2, 46) = 4.41$, $p = .018$, $\eta^2_p = .161$. Pairwise comparisons show that children endorse significantly more theistic explanations in the human origins domain than in the illness domain, $p = .005$. There was no statistical difference in theistic explanation endorsement between the origins domain and the domain of death. Nor was there any statistical difference between the domain of death and the domain of illness. For adolescents, there was a significant effect of domain on the number of theistic explanations endorsed, $F(2, 56) = 81.93$, $p < .001$, $\eta^2_p = .745$. Pairwise comparisons reveal that they endorsed more theistic explanations in the human origins domain than in the domains of death and illness, $p < .001$. Adolescents also endorsed more theistic explanations in the domain of death than in the domain of illness, $p = .043$. For adults, there was a significant effect of domain on the number of theistic explanations, $F(2, 36) = 26.75$, $p < .001$, $\eta^2_p = .598$. Pairwise comparisons reveal that adults endorsed significantly more theistic explanations for human

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origins than for the domains of death or illness, $p < .001$. There was no statistical difference in the number of theistic explanations between the death and illness domains for adults.

Discussion

Our data demonstrate that although explanatory coexistence is prevalent across the domains of death, illness, and origins in Tanna, there are nuanced and interesting age and domain differences. Below, we highlight how priming and development influence the way individuals in Tanna invoke both natural and supernatural explanations within and across these core domains.

In the domain of death, our prediction that participants would endorse theistic explanations in response to the supernatural prime and biological explanations in response to the natural prime was only partially supported. Across age groups and prime, participants commonly endorsed both spontaneous and biological explanations for death, indicating high levels of coexistence thinking. Both biological and spontaneous explanations for death were more common than theistic or local supernatural explanations. Recent research has shown that priming supernatural conceptions about death in Vanuatu increases ideas about the continuation of both the body and mind after death (Watson-Jones *et al.*, 2016). It may have been that the response options presented in the present study did not give participants the option to express these beliefs in response to the supernatural prime. Adolescents were less likely than adults and children to endorse any of the explanation types for death. Again, this could be because the forced choice paradigm employed in the present study did not accurately reflect the beliefs adolescents held about death. Looking across domains reveals that spontaneous explanations were more common in the death domain than any other domain for the adult sample. This may suggest that, similar to adolescents, the closed-ended response options for death did not match adults' beliefs and they therefore endorsed a spontaneous explanation. Future research employing an openended response paradigm could bring further clarity to the development of death concepts in Tanna.

In the domain of illness, our prediction that we would find high levels of biological explanation endorsement following the natural prime and local supernatural explanations following the supernatural prime for illness was partially supported. We found that biological explanations were the most frequent for illness among our adolescent and adult sample regardless of prime. The data also show an interaction between prime and explanation type, which revealed that in response to the supernatural prime, endorsement of spontaneous explanations became more common than theistic or local supernatural explanations. This could be because the supernatural prime primed participants to believe that something other than purely biological processes were taking place. Participants may not have been willing to attribute the cause to the supernatural and instead increased their endorsement of spontaneous explanations. This would be consistent with previous research, which shows that explanatory coexistence is more common for very serious illnesses (Legare & Gelman, 2008). The illnesses examined in the present study, malaria and tuberculosis, may not have been viewed as serious enough to invoke high levels of explanatory coexistence. Recent efforts on Tanna by the WHO have almost completely eradicated malaria, and 89% of Tannese people believe tuberculosis is easily cured by

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Western medicine (Atkinson *et al.*, 2010; Viney *et al.*, 2014). Unlike adults and adolescents, children engaged in higher levels of explanatory coexistence. Children frequently endorsed all four explanation types, and no explanation type was statistically more common than any other. We propose that children may adopt a broader explanatory framework for the cause of illness than adolescents and adults. This is consistent with past research, which shows that children believe that illness can be caused by germs, poor nutrition, or behaving badly (Inagaki & Hatano, 2004). As children accumulate additional knowledge about the causes of illness through formal education, health campaigns, and experience with illness more generally, they may pare down the number of causal pathways they believe can leadto illness and thereby engage in lower levels of explanatory coexistence. Examining explanations across domains also reveals that biological explanations were more common for illness than any other domain for the adolescent and adult samples. Theistic explanations were also less common for illness than they were for human origins across all ages.

For the domain of origins, we predicted that theistic explanations would be the most common and results support this prediction. Across all ages, participants strongly favoured theistic explanations, a finding consistent with previous research (Watson-Jones *et al.*, 2015). The domain of human origins elicited low levels of explanatory coexistence across age groups. Adolescents and adults specifically endorsed theistic explanations statistically more often than all other explanation types, and children endorsed theistic explanations more than all explanation types except spontaneous. We propose that the lower level of coexistence reasoning in the domain of human origins is partly because of minimal exposure to any alternative explanations, such as evolution. This proposal is supported by examining the frequency of explanations across domains, which reveals that biological explanations were endorsed significantly less frequently for human origins than in the death and illness vignettes for adolescents and adults. With increasing exposure to evolutionary explanations through the advancement of Western schooling on the island, explicit attempts to integrate evolutionary and biblical accounts will likely become more prevalent and may lead to higher levels of explanatory coexistence within the domain of human origins, a possibility that should be examined through continued research. It might be especially fruitful to examine whether differences in explanatory coexistence for human origins exist between individuals who grew up attending Westernstyle schooling where evolutionary accounts of humans origins are prominent, and older adults who did not attend school. A study of this kind has the potential to document the emergence of explanatory coexistence in a unique cultural ecology.

Across highly diverse populations, domains of fundamental concern to humans often motivate coexistence thinking. Yet explanatory coexistence is dependent on contextual factors and is heavily influenced by local ecologies and the content of cultural belief systems, as well as the availability of different kinds of explanatory frameworks. This research from Tanna provides unique insight into how diverse epistemological perspectives, kastom, Christian, and scientific, can be seamlessly integrated into a causal understanding of the world that merges the natural and the supernatural.

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Statement of contribution

What is already known on this subject?

- Individuals across highly diverse cultural contexts use both natural and supernatural explanations to understand the events that occur in their lives.
- Context and cultural input play a large role in determining when and how individuals incorporate natural and supernatural explanations.
- The development of explanatory coexistence has primarily studied explanations for isolated domains.

What does this study add?

- We examined explanatory coexistence in a culture with recent conversion to Christianity and formal education.
- The current research examines how individuals reason within and across the domains of human origins, illness, and death.
- Developmental differences associated with explanatory coexistence are examined.

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Table 1.

Vignettes by prime and domain

Instructions: 'I am going to ask you some questions. There are no right or wrong answers to these questions, just different ideas. We are interested in knowing all that you think about these things. Please choose from the following answers. You can endorse as many of the answers as you like, you can reject all of the answers if you like, and you can endorse some and reject others'			
	Death	**Illness**	**Origins**
Natural	1. Mary's friend slipped and fell down a hillside and was severely injured. Mary took her friend to a hospital to help her get better but her injuries were too bad and they could not make her better. A few days later Mary's friend died. Why did Mary's friend die?	1. I know a person named Simon. A few days ago, Simon played with his cousin who was coughing and whose head was warm. Today, Simon is feeling sick. He has a cough and a fever. He doesn't feel like eating and feels tired all the time. Simon has TB. Why did Simon get TB?	1. Humans have lived on the Earth for a very long time just like other animals and plants and many people wonder why the first humans got here on Earth. Why did the first humans get here on Earth?
	2. Denise's grandmother was very sick. Denise asked a doctor to help her grandmother get better. Denise's grandmother was too sick and the doctor could not make her better. A few days later, Denise's grandmother died. Why did Denise's grandmother die?	2. I know a person named Samuel. A few days ago Samuel got bitten by a mosquito. Today, Samuel is feeling sick. He has chills and a fever. He feels nauseous and tired all the time. Samuel has malaria. Why did Samuel get malaria?	2. Animals have lived on the Earth for a very long time just like other animals and plants and many people wonder why the first animal got here on Earth. Why did the first animals get here on Earth?
Supernatural	1. Anna's friend fell out of a tree after disobeying an order of the chief and was severely injured. Anna took her friend to a traditional healer to help her get better but her injuries were too bad and they could not make her better. A few days later Anna's friend died. Why did Anna's friend die?	1. I know a person named David. A few days ago David made someone very angry when he walked through their garden of freshly planted seeds. Today, David is feeling sick He has a cough and a fever. He doesn't feel like eating and feels tired all the time. David has tuberculosis. Why did David get tuberculosis?	1. Humans have lived on the Earth for a very longtime and many people ask the elders at the nakamal[a] why the very first humans got here on Earth. Why did the first humans get here on Earth?
	2. Margaret's grandfather was very sick. Margaret asked the spirits to help her grandfather get better. There were many people in the village who were angry with him and felt he did not treat them fairly. A few days later Margaret's grandfather died. Why did Margaret's grandfather die?	2. I know a person named Carol. A few days ago Carol broke a taboo and walked by a nakamal[a] during kava time. Today, Carol is feeling sick She has chills and a fever. She feels nauseous and tired all the time. Carol has malaria. Why did Carol get malaria?	2. Animals have lived on the Earth for a very long time and many people ask the elders at the nakamal[a] why the very first animal got here on Earth. Why did the first animals get here on Earth?

Note.

[a]In Vanuatu, a nakamal is a place that men gather to drink kava and discuss issues (women are not allowed in nakamals).

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Table 2.

Endorsement options by domain

	Local supernatural	Biological	Spontaneous	Theistic
Death	She went to be with her ancestors, that is why she died. Yes or no?	Her heart stopped beating and her mind stopped working, that is why she died. Yes or no?	She just died, sometimes people just die, that is why she died. Yes or no?	She went to be with God, that is why she died. Yes or no?
Illness	David did something that made the spirits angry, that is why David got TB. Yes or no?	David shared a drink with someone whose sick saliva was still on the cup, that is why David got TB. Yes or no?	There is no reason that David got TB, people just get sick sometimes, that is why David got TB. Yes or no?	David did something that made God angry, that is why David got TB. Yes or no?
Origins	Majihjiki created them and put them on the Earth, that is why the first animal got here. Yes or no?	They changed from a different kind of animal that was better at finding food, avoiding predators and having babies, that is why the first animal got here. Yes or no?	They just appeared. They came out of the ground, that is why the first animal got here. Yes or no?	God made them and put them on the earth, that is why the first animal got here. Yes or no?

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Table 3.

Mean number of explanations endorsed by explanation type by age group and prime within the death domain

	Child		Adolescent		Adult	
Explanation	**Natural**	**Supernatural**	**Natural**	**Supernatural**	**Natural**	**Supernatural**
Local S. Nat.	1.13 (0.85)	1.13 (0.80)	0.31 (0.60)	0.41 (0.63)	0.68 (0.89)	0.89 (0.88)
Biological	1.46 (0.83)	1.13 (0.85)	0.76 (0.83)	0.72 (0.84)	1.53 (0.70)	1.47 (0.70)
Theistic	1.21 (0.88)	1.25 (0.90)	0.52 (0.74)	0.48 (0.74)	0.79 (0.86)	0.79 (0.86)
Spontaneous	1.46 (0.72)	1.29 (0.81)	0.76 (0.87)	0.72 (0.80)	1.53 (0.70)	1.37 (0.76)

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Table 4.

Mean number of explanations endorsed by explanation type by age group and prime within the illness domain

	Child		Adolescent		Adult	
Explanation	**Natural**	**Supernatural**	**Natural**	**Supernatural**	**Natural**	**Supernatural**
Local S. Nat.	1.13 (0.82)	1.13 (0.76)	0.17 (0.47)	0.21 (0.56)	0.58 (0.90)	0.79 (0.92)
Biological	1.43 (0.73)	1.13 (0.76)	1.62 (0.56)	1.52 (0.57)	1.74 (0.45)	1.74 (0.56)
Theistic	1.17 (0.78)	1.04 (0.83)	0.10 (0.41)	0.34 (0.72)	0.74 (0.93)	0.84 (0.90)
Spontaneous	1.04 (0.93)	1.22(0.74)	0.45 (0.63)	0.76 (0.83)	1.05 (0.85)	1.32 (0.75)

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Table 5.

Mean number of explanations endorsed by explanation type by age group and prime within the origins domain

	Child		Adolescent		Adult	
Explanation	**Natural**	**Supernatural**	**Natural**	**Supernatural**	**Natural**	**Supernatural**
Local S. Nat.	1.08 (0.83)	0.92 (0.78)	0.10 (0.41)	0.14 (0.44)	0.74 (0.93)	0.53 (0.77)
Biological	1.33 (0.76)	1.25 (0.85)	0.21 (0.49)	0.38 (0.68)	0.79 (0.92)	0.63 (0.83)
Theistic	1.50 (0.51)	1.62 (0.65)	1.76 (0.51)	1.72 (0.46)	1.84 (0.38)	1.89 (0.32)
Spontaneous	1.42 (0.78)	1.25 (0.74)	0.31 (0.66)	0.41 (0.73)	0.79 (0.98)	0.79 (0.92)

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Table 6.

Mean number of local supernatural explanations endorsed in each domain by age group

Domain	Child	Adolescent	Adult
Death	2.25 (1.26)	0.72 (1.13)	1.58 (1.71)
Illness	2.17 (1.40)	0.38 (0.90)	1.37 (1.77)
Origins	2.00 (1.47)	0.24 (0.79)	1.26 (1.56)

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Table 7.

Mean number of biological explanations endorsed in each domain by age group

Domain	Child	Adolescent	Adult
Death	2.58 (1.53)	1.48 (1.43)	3.00 (1.29)
Illness	2.46 (1.41)	3.14 (1.06)	3.47 (0.77)
Origins	2.58 (1.38)	0.59 (1.02)	1.42 (1.61)

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Table 8.

Mean number of spontaneous explanations endorsed by domain and age group

Domain	Child	Adolescent	Adult
Death	2.83 (1.27)	1.48 (1.43)	2.89 (1.37)
Illness	2.26 (1.29)	1.21 (1.21)	2.37 (1.42)
Origins	2.65 (1.34)	0.72 (1.31)	1.58 (1.81)

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Table 9.

Mean number of theistic explanations endorsed by domain and age group

Domain	Child	Adolescent	Adult
Death	2.46 (1.41)	1.00 (1.36)	1.58 (1.64)
Illness	2.12 (1.39)	0.45 (0.95)	1.58 (1.77)
Origins	3.13 (0.99)	3.48 (0.83)	3.74 (0.56)