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Risk and time preferences have often been viewed as reflecting inherent traits such as impatience and self-control. Here, we offer an alternative perspective, arguing that they are flexible and environmentally informed. In Study 1, we investigated risk and time preferences among children in the United States, India, and Argentina, as well as forager-horticulturalist Shuar children in Amazonian Ecuador. We find striking cross-cultural differences in behavior: children in India, the United States, and Argentina are more risk-seeking and future-oriented, whereas Shuar children are more risk-averse and exhibit more heterogeneous time preferences, on average preferring more today choices. To explore 1 of the socioecological forces that may be shaping these preferences, in Study 2, we compared the behavior of more and less market-integrated Shuar children, finding that those in market-integrated regions are more future-oriented and risk-seeking. These findings indicate that cross-cultural differences in risk and time preferences can be traced into childhood and may be influenced by the local environment. More broadly, our results contribute to a growing understanding of plasticity and variation in the development of behavior.

Keywords: risk preferences, time preferences, cross-cultural, development, market integration

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Given that the future is uncertain but inevitable, many aspects of decision making are influenced by preferences regarding risk and time. Traditionally, these preferences have been seen as inherent traits rather than flexible behaviors, and thought of as a function of self-control (Mischel, Shoda, & Peake, 1988), with risk-seeking and present-oriented behavior frequently seen as undesirable or problematic (Jessor & Jessor, 1977). An alternative perspective is to consider risk and time preferences through the lens of behavioral ecology as developmentally flexible strategies shaped by local environmental pressures. To explore this perspective, here, we consider how risk and time preferences vary across diverse contexts in early life, borrowing from an adaptive developmental plasticity framework (Nettle & Bateson, 2015) in which preferences can be construed as the result of evolved regulatory mechanisms that are sensitive to inputs in early life (Frankenhuis & Fraley, 2017). In line with this perspective, some have argued that

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high rates of future discounting (Frankenhuis & de Weerth, 2013; Frankenhuis & Fraley, 2017; McGuire & Kable, 2013) and increased levels of risk-aversion (Guiso & Paiella, 2008; Haushofer & Fehr, 2014) may be rational strategies shaped by environments in which the costs of uncertainty are high. One integrative perspective, which we refer to as the *uncertainty management framework* for the development of preferences (Amir & Jordan, 2017; Amir, Jordan, & Rand, 2018), may be helpful for understanding how the decision making environment can help shape preferences. In this framework, environments marked by high costs to uncertainty may lead to greater risk-aversion and present-orientation as an effective way to manage the downside costs of uncertainty. In general, this framework suggests that risk[1] and time preferences are likely to exhibit variation across differing ecological contexts, and, more specifically, it suggests that environments marked by lower costs to uncertainty may promote the development of more risk-tolerant and future-oriented behavior.

As previous work on the development of these preferences has focused nearly exclusively on Western samples in industrialized contexts, we know surprisingly little about the extent to which these preferences vary across diverse ecologies. Nor do we have a good understanding of what socioecological forces may be influencing the differential development of risk and time preferences across these contexts. Thus, to gain a more thorough understanding of how these preferences function, it is essential to adopt both a cross-cultural and developmental perspective; the former to capture a diversity of environmental and cultural contexts, and the latter to track how local inputs may be shaping preferences ontogenetically. We do know that these preferences vary across contexts among adults, as a plethora of recent work has documented substantial cross-cultural variation in both time (Falk et al., 2018; Wang, Rieger, & Hens, 2016) and risk preferences (Mata, Josef, & Hertwig, 2016; Rieger, Wang, & Hens, 2015). However, it's important to recognize one limitation of these studies, namely that they provide snapshots of decision-making in adulthood and do not necessarily consider how these individuals reached these end-states, thus precipitating the need for developmental work. Similarly, other recent work with adults has begun to illuminate the ecological and intracultural forces that may be shaping preferences. Typically, within populations, higher income in adulthood has been associated with both greater risk-seeking (Amir et al., 2018; Cancian, 1989; Donkers, Melenberg, & Van Soest, 2001; Haushofer & Fehr, 2014) and greater patience (Green, Myerson, Lichtman, Rosen, & Fry, 1996; Hausman, 1979; Pender & Walker, 1990; Tanaka, Camerer, & Nguyen, 2010; Yesuf & Bluffstone, 2009) consistent with an account in which future-oriented and risk-seeking preferences may be more likely to develop in environments with lower costs to uncertainty (though note the presence of null relationships as well, such as in Gourinchas & Parker, 2002; Ogaki & Atkeson, 1997; Stephens & Krupka, 2006). In addition, longitudinal work suggests a causal relationship between economic downturns and preferences. For instance, individuals who have experienced low stock market returns throughout their lives are less willing to take financial risks (Malmendier & Nagel, 2011), and negative income shocks lead to an increase in temporal discounting (Haushofer, Schunk, & Fehr, 2013).

Recent work with adults has also suggested that within populations, *market integration*—the degree to which one produces for and consumes resources from the market economy, typically proxied through the percentage of calories purchased from markets (Henrich, Ensminger, et al., 2010)—may promote the development of more future-oriented behavior (Salali & Migliano, 2015) and greater risk tolerance (Akay, Martinsson, Medhin, & Trautmann, 2012), though there is mixed evidence (Henrich & McElreath, 2002). More generally, integration can often be a stabilizing force, bolstering food security (Breton, Portugal-Perez, & Régolo, 2014), and increasing access to storable economic resources, both of which play a role in time and risk preferences (Becker, Dohmen, Enke, & Falk, 2014; Holden, Shiferaw, & Wik, 2000; Yesuf & Bluffstone, 2009). It's possible that increasing access to economic and caloric resources may be altering the decision-making environment by reducing the costs of uncertainty; for example, an increase in storable caloric resources means one can better buffer the variance of more unstable food sources, such as wild game. Market integration is also often associated with a shift to wage labor and cash-cropping (Lu, 2007), which leads to a greater temporal disassociation between labor and its payoffs (i.e., individuals must now wait for paychecks, market opportunities, etc.). These forces may therefore support the development of future-oriented time preferences. A recent study in a transitional population suggests this may be the case; among Mbendejele BaYaka hunter-gatherers, increasing market integration was associated with marked increases in patience (Salali & Migliano, 2015). We should note, however, that the relationship between market integration and risk is complicated and most likely nonmonotonic, as integration can also introduce new risks that may offset buffering (Gurven, Jaeggi, von Rueden, Hooper, & Kaplan, 2015), thereby shifting individual risk management portfolios. Despite the importance of these forces in shaping the decision-making environment, however, there is virtually no work on how socioecological shifts may be shaping preferences in development, occluding our understanding of how these differential inputs guide our behavior.

Looking across the developmental literature, a large portion of the work on risk and time preferences has centered on individual differences in preferences, with a focus on age and sex. In general, these studies tend to find higher rates of risk-seeking in children as compared to older individuals (Harbaugh, Krause, & Vesterlund, 2002; Paulsen, Platt, Huettel, & Brannon, 2011, 2012; Rakow & Rahim, 2010), though there is substantial heterogeneity in these patterns, in particular related to choice of paradigm and definition of "risk" (see Boyer, 2006, for a comprehensive review of the literature on the development of risk preferences). Risk preferences also appear to be nonmonotonic across the life span, with studies finding that adolescence is a unique period of time for risk assessment (Boyer, 2006). Other studies have documented gender differences in risk preferences in which boys tend to be more risk-seeking than girls, with this difference emerging in the preteen years (Slovic, 1966). In addition, previous studies suggest that risk-taking in early life increases in the presence of observers

[1] In this account, we define *risk preferences* in the economic sense, as trade-offs between expected value and variance in outcomes (Wärneryd, 1996), and time preferences as how much an individual values present rewards relative to future rewards. Note that this account is primarily concerned with risky choice in an economic sense and not risky behaviors, such as the propensity to engage in behaviors that are potentially damaging or harmful.

(Gardner & Steinberg, 2005). In the domain of time preferences, Mischel and colleagues, in their development of the Marshmallow test, pioneered a large body of work on delay discounting in children (Mischel, 1961), which generally documents increasing levels of patience with age (Bettinger & Slonim, 2007; Green, Fry, & Myerson, 1994; Qu, Shan, Yip, Li, & Zelazo, 2012; Steinberg et al., 2009). In addition, some work finds that boys are more impatient than girls (Castillo, Ferraro, Jordan, & Petrie, 2011; Qu et al., 2012), and that the socioeconomic environment likely influences time preferences, such that those from affluent backgrounds are more likely to delay gratification (Freire, Gormana, & Wessman, 1980), in line with the adult literature.

It is critical to note, however, that the vast majority of this work—and developmental research, more broadly—is conducted among WEIRD populations (those that are Western, Educated, Industrialized, Rich, Democratic; Henrich, Heine, & Norenzayan, 2010; Nielsen, Haun, Kärtner, & Legare, 2017), severely limiting our understanding of the diversity of human development (Kline, Shamsudheen, & Broesch, 2018). This is an especially critical oversight when considering how forces such as market integration may be shaping preferences, as market integration is uniformly high in WEIRD populations. The inclusion of small-scale, subsistence-based societies is important as it allows us to evaluate preferences among individuals living in environments that in some ways more closely resemble (though do not mirror) the socioecological conditions of our ancestors. Save for a handful of recent studies (Apicella, Crittenden, & Tobolsky, 2017; Kirby et al., 2002), little work has examined the development of these preferences in small-scale societies. To the best of our knowledge, this investigation is the first systematic and multicultural investigation of risk and time preferences in early life that incorporates non-WEIRD populations.

Our goal in this investigation was to better understand how risk and time preferences vary across diverse contexts in early life and begin to tease apart some of the ecological and intracultural forces that may lead to variation. In Study 1, we began by examining risk and time preferences among children of four diverse populations, which we now describe. We worked with Shuar children living in the Ecuadorean Amazon. The Shuar are an indigenous, forager-horticulturalist group living largely in the Morona-Santiago region of Ecuador. Their subsistence is largely dependent on foraging, hunting, fishing, and horticulture, with staples such as plantains and yucca. The communities in this sample have relatively low rates of market integration, with market goods comprising roughly 1/3 or less of their calories (Urlacher et al., 2016). The research protocol was in Spanish and children were tested in isolation in local huts and classrooms. We also worked with children from Toba/Qom communities in Argentina. The Toba/Qom are an indigenous population in the Gran Chaco region of Argentina, who were traditionally nomadic hunter-gatherers but are now largely sedentary and live on reservations near major cities. Virtually all of their calories come from market goods and government staples. The research protocol was in Spanish, and children were tested in semiprivacy in their own homes. We also worked with schoolchildren in India at a K–12 school in the city of Vadodara in Gujarat. This school is largely populated by children whose families earned less than $2,000 a year (Srinivasan, Dunham, Hicks, & Barner, 2016). Children were tested in English (the language of instruction) in private classrooms. And lastly, we worked with urban Americans in Connecticut. The research protocol was in English. Children were tested in semiprivate museum settings, private settings in schools, and private settings in-lab at the Social Cognitive Development laboratory at Yale University. These four populations vary across a number of dimensions, but critical for our purposes is market integration: children in Argentina, India, and the United States live in environments of near total market integration, whereas the Shuar participants in this sample (including children) still cultivate, hunt, fish, and forage for the majority of their subsistence (Urlacher et al., 2016).

In addition to a between-culture analysis of preferences, we next wanted to examine whether similar patterns arose when looking within cultures. Therefore, in Study 2, we conducted a within-culture investigation in two Shuar communities, recruiting age-matched children living in more integrated, peri-urban communities—in what we refer to as the *Upano Valley* region—to compare to the behavior of children in more remote, less-integrated communities—in what we refer to as the *cross-Cutucú* region. There are a number of important differences between these two subpopulations, as documented by the larger Shuar Health and Life History Project. Most Upano Valley Shuar live within walking distance of roads, reside in larger and more market-integrated communities, and have typically divided land into individually owned plots (Liebert et al., 2013; Lu, 2007; Madimenos et al., 2011). In general, Shuar in the Upano Valley have relatively higher caloric access and intake, as evidenced through higher body mass indexes, and higher levels of circulating HDL cholesterol and total cholesterol (Liebert et al., 2013).The Upano Valley Shuar are within a 2-hr drive of the cities of Macas and Sucúa. In these communities, most Shuar can purchase a range of market items and participate in market-oriented agro-pastoralism or wage labor (Liebert et al., 2013). The infrastructure in the Upano Valley region is also more advanced, with some villages offering water-lines, electricity, and regular access to small stores (Liebert et al., 2013). Further, the Upano Valley Shuar tend to have, on average, a lower prevalence of soil-transmitted helminths (Cepon-Robins et al., 2014). Overall growth patterns suggest that increases in market integration lead to increases in body size and nutritional status in Shuar communities (Urlacher et al., 2016). Although it should be noted that differences in market integration also exist within each of these regions (Urlacher et al., 2016), a comparison at the community level still allows us to more directly assess the impact of socioecological changes among individuals who share a recent cultural and genetic history, including many other aspects of their culture and ecology. A summary of the participants in this study can be found in Table 1.

In line with the frameworks outlined earlier, we had two key predictions. The first is that we expected that participants in communities marked by higher certainty—proxied through high market integration (the United States, India, and Argentina)—would display more risk-seeking and future-oriented behavior, whereas participants from cross-Cutucú Ecuador would display more risk-aversion and present-oriented behavior. As such a pattern could also arise because of the many other differences present across sites, in the within-culture analysis, we expected the same pattern of results such that more market integration would be associated with greater risk-seeking and future-orientation.

Table 1
Descriptive Summary of the Full Sample of Participants

Country	Population	Economy	Market integration	Risk: *N* (males)	Time: *N* (males)	Mean age (range)
Argentina	Toba/Qom	Wage labor	High	66 (29 male)	70 (32 male)	10.7 (4–18)
Ecuador	Cross-Cutucú Shuar	Horticulture, fishing, hunting, gathering, limited agropastoralism and sporadic wage labor	Low	63 (33 male)	66 (34 male)	10 (4–17)
Ecuador	Upano Valley Shuar	Horticulture, fishing, hunting, gathering, limited agropastoralism and sporadic wage labor	Medium	78 (39 male)	89 (44 male)	10.3 (5–17)
India	Vadodara	Professional, trade/service, labor	High	85 (43 male)	86 (43 male)	9.7 (6–14)
USA	New Haven	Professional, trade/service, labor	High	86 (38 male)	58 (25 male)	8.4 (4–15)
	Combined across populations			378 (182 male)	369 (178 male)	9.9 (4–18)

Method

Study Protocol

In the time preference task, children were offered a choice between one candy today and a variable number of candies tomorrow. The opening round was a choice between one candy today or one candy tomorrow, after which the amount they could receive for tomorrow increased, always ascending, up to five. In the risk preference task, children were presented with two bags of marbles: a safe bag that always paid out one candy, and a risky bag that offered a one in six chance of one to five candies, in ascending order. (See the online supplemental material for a more detailed protocol, and Figure 1 for a diagram of the tasks). In the risk preference task, all five responses were elicited prior to enactment of choices to reduce updating based on the outcome of the previous round. The research protocol, recruitment methodology, and consent protocol were all approved by community leaders, the Federación Interprovincial de Centros Shuar, and the Yale Human Subjects Committee.

Statistical Methods

We built several generalized linear mixed models (GLMMs) to predict whether participants picked the today/tomorrow option

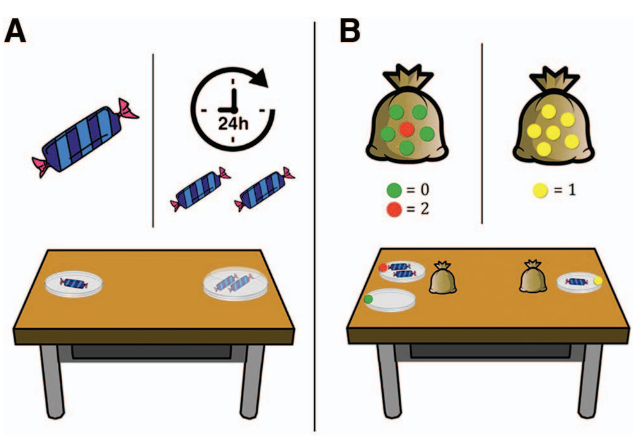

Figure 1. General setup for the (A) time preference and (B) risk preference task. Reward sizes varied across trials. See the online article for the color version of this figure.

(binary) or the risky/safe bag (binary). We examined the fixed effects of the following predictors: stake size (continuous), gender (male, female), age (continuous, standardized), and region (factor). Participant ID number was fit as random intercepts due to repeated measures within each participant. The complete model selection and comparison process is outlined in the online supplemental material, along with additional analyses. Our deidentified data, codebook, and annotated R script are available online at http://dx.doi.org/10.17605/osf.io/65qup.

Results

Study 1: Cross-Cultural Variation in Risk and Time Preferences

To examine cross-cultural variation in risk and time preferences, we built GLMMs to predict the likelihood that a participant would pick the tomorrow option over the today option and whether they would choose the risky option over the safe option. In these analyses, we controlled for the following covariates thought to influence preferences: gender, age, and stake size. *Stake size in the risk task* refers to the number of candies associated with the red marble (or the *risky reward*) and ranges sequentially from one to five throughout the five trials. *Stake size in the time task* refers to the number of candies for tomorrow, which ranges sequentially from one to five throughout the five trials The regression output of the final model for risk preferences can be found in Table 2 and time preferences in Table 3.

Our results demonstrate both similarities and differences in preferences across populations. We find main effects of stake size for both risk ($\beta = 0.67$, $SE = 0.05$, $p < .001$) and time preferences ($\beta = 0.41$, $SE = 0.05$, $p < .001$), such that as stakes increased, participants were more likely to choose the risky or tomorrow option, respectively. Using Ecuador (cross-Cutucú Shuar) as the reference region, we also find cross-cultural variation such that children were more risk-seeking in America ($\beta = 1.25$, $SE = 0.27$, $p < .001$), Argentina ($\beta = 1.81$, $SE = 0.28$, $p < .001$), and India ($\beta = 1.16$, $SE = 0.26$, $p < .001$). We also observe greater patience in America ($\beta = 1.41$, $SE = 0.38$, $p < .001$), Argentina ($\beta = 0.94$, $SE = 0.36$, $p = .008$), and (marginally) in India ($\beta = 0.62$, $SE = 0.33$, $p = .06$). In Figure 2, we provide a summary of individual participant behavior, for both risky and tomorrow choices, using density plots (smoothed histograms) for ease of comparison (see

Table 2
Final Models for Time Preferences Across Cultures, With Main Effects and Retained Interactions

Variable	Main effects	Retained interactions
(Intercept)	-1.52^{***} (.32)	$-.91^{*}$ (.43)
Stake size	$.41^{***}$ (.05)	$.21^{*}$ (.11)
Region: United States	1.41^{***} (.38)	.75 (.59)
Region: Argentina	$.94^{**}$ (.36)	−.84 (.58)
Region: India	$.62^{\dagger}$ (.33)	.40 (.53)
Age (standardized)	$.59^{***}$ (.13)	$.61^{***}$ (.14)
Gender: female	.06 (.24)	.06 (.25)
Stake Size × United States		.23 (.15)
Stake Size × Argentina		$.63^{***}$ (.16)
Stake Size × India		.07 (.14)
AIC	1,631.12	1,616.81
BIC	1,673.06	1,674.48
Log likelihood	−807.56	−797.40
Num. obs.	1,398	1,398
Num. groups: pid	280	280
Var: pid (intercept)	2.61	2.79

Note. AIC = Akaike information criterion; BIC = Bayesian information criterion; Num. obs. = number of observations; Var: pid = variance associated with participant id (random intercept term). Baseline region is Ecuador (Cross-Cutucú Shuar). Baseline gender is male.
† $p < .1$. * $p < .05$. ** $p < .01$. *** $p < .001$.

the online supplemental material for raw histograms). As can be visualized, we also note significant variation in the distribution of choices, such that Shuar children exhibit more heterogenous time preferences.

We also find significant interactions between stake size and region in time preferences (Likelihood Ratio Test [LRT], χ^2, $p < .001$). For risk preferences, we find a significant interaction between stake size and age (LRT, χ^2, $p < .01$), and stake size and region. (LRT, χ^2, $p < .01$). These interactions are explored in more detail in the full sample in the the online supplemental material and in the *Age Trends in Risk and Time Preferences Across Full Sample* section.

Overall, in Study 1, we find variation across cultures in both the risk and time preference tasks. We find that cross-Cutucú Shuar children are on average more risk-averse and more present-oriented than children in India, the United States, and Argentina. Although we believe that degree of market integration may be related to these differences, there are undoubtedly a large number of other factors that vary across these cultures. Therefore, in Study 2 below, we explore these patterns further within Ecuador.

Study 2: Within-Culture Variation in Risk and Time Preferences

After documenting between-culture differences in preferences, we wanted to further investigate the role of market integration in shaping preferences within cultures. Therefore, we conducted an intracultural investigation in two Shuar communities, comparing the behavior of Shuar children in more remote communities (cross-Cutucú) in Study 1 to those in more market-integrated, peri-urban communities (Upano Valley). The Shuar communities in this rural region largely share the cultural characteristics of their counterparts in the cross-Cutucú region but have experienced a recent increase in market integration as a result of expanded road systems (Liebert et al., 2013), now living much closer to small urban centers.

To examine behavioral differences between children across these two regions, we built GLMMs to predict the likelihood that participants would pick the tomorrow option and the likelihood that they would pick the risky option. As in the models above, we included age, gender, and stake size as covariates. The regression output of the final model for risk preferences can be found in Table 4, and time preferences in Table 5.

In comparing the behavior of Shuar participants in these two regions, we find that children in the more market-integrated Upano Valley sample are both more risk-seeking (β = 1.66, SE = 0.50, $p < .001$) and marginally more future-oriented (β = 1.109, SE = 0.564, p = .05) than those in the cross-Cutucú sample, suggesting that market integration may be related to the development of risk-seeking and future-oriented preferences. The distributions of choices are plotted in the density plots of Figure 3 (see the online supplemental material for raw histograms).

Age Trends in Risk and Time Preferences Across Full Sample

To better understand how risk and time preferences are shaped throughout development, we next pooled data from both studies to explore how increasing age is related to patterns of behavior across all children in this investigation. Given the variability in how these preferences develop across age in the literature, and the lack of data on their development in non-WEIRD populations, we did not have strong predictions for these patterns and see these as exploratory analyses. Further, there are a number of reasons to interpret these age trends carefully. First, as recruitment and logistical constraints varied across sites, participants were not evenly dis-

Table 3
Final Model for Risk Preferences Across Cultures, With Main Effects and Retained Interactions

Variable	Main effects	Retained interactions
(Intercept)	-3.21^{***} (.29)	-1.98^{***} (.40)
Stake size	$.67^{***}$ (.05)	$.29^{**}$ (.10)
Region: United States	1.25^{***} (.27)	−.14 (.50)
Region: Argentina	1.81^{***} (.28)	.38 (.51)
Region: India	1.16^{***} (.26)	−.51 (.50)
Age (standardized)	−.10 (.09)	$-.50^{**}$ (.18)
Gender: female	.08 (.18)	.09 (.18)
Stake Size × United States		$.43^{**}$ (.14)
Stake Size × Argentina		$.46^{**}$ (.15)
Stake Size × India		$.52^{***}$ (.14)
Stake Size × Age		$.14^{**}$ (.05)
AIC	1,771.56	1,757.92
BIC	1,814.06	1,821.67
Log likelihood	−877.78	−866.96
Num. obs.	1,499	1,499
Num. groups: pid	300	300
Var: pid (intercept)	1.10	1.10

Note. AIC = Akaike information criterion; BIC = Bayesian information criterion; Num. obs. = number of observations; Var: pid = variance associated with participant id (random intercept term). Baseline region is Ecuador (Cross-Cutucú Shuar). Baseline gender is male.
* $p < .05$. ** $p < .01$. *** $p < .001$.

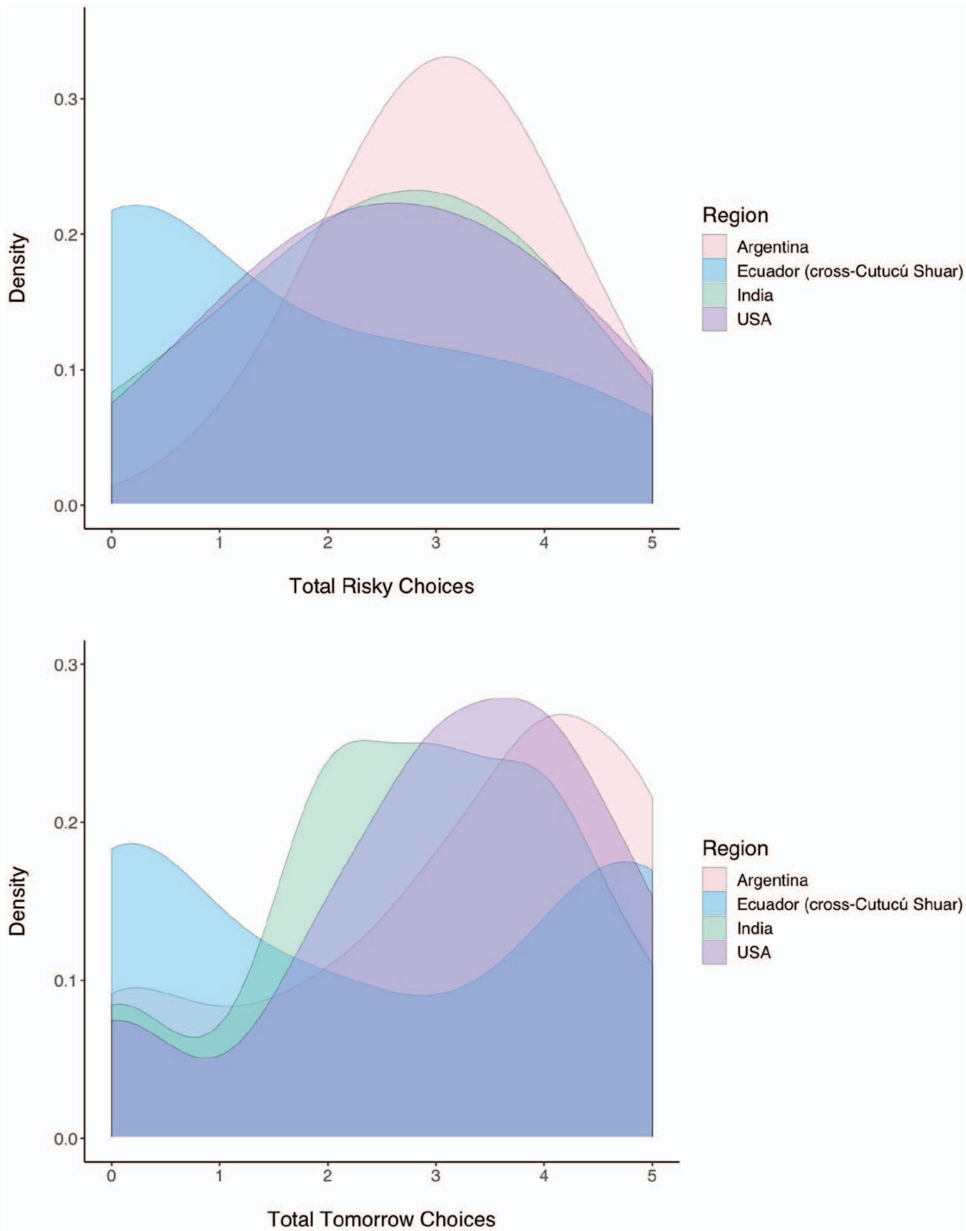

Figure 2. Density plots showing the total number of risky choices (out of five; top) and total number of tomorrow choices (out of five; bottom) in each region. See the online article for the color version of this figure.

tributed across age classes (see the online supplemental material). Second, as the environmental changes occurring in Shuar communities are happening rapidly, these cross-sectional age samples may not reflect clear or normative developmental trajectories. As such, we suggest that interpretations of the following results be made cautiously.

To assess general age trends across the full sample, we built GLMMs to predict the likelihood that participants would pick the tomorrow option and the likelihood that they would pick the risky option. As in the models above, we included age, gender, region, and stake size as covariates. The model selection process, regression outputs, and visualizations of interactions can be found in the online supplemental material. In the time preference task, we find a main effect of age such that children get more patient across age ($\beta = 0.38$, $SE = 0.09$, $p < .001$); however, this is qualified by a significant two-way interaction between region and age (LRT, χ^2, $p < .001$), such that as compared to children in the cross-Cutucú region, Shuar children in the Upano Valley region get less patient with increasing age ($\beta = -0.89$, $SE = 0.26$, $p < .001$). In the risk preference task, we do not find a main effect of age ($\beta = -0.12$, $SE = 0.08$, $p > .1$) but do find a trending interaction between region and age (LRT, $\chi2$, $p = .05$), such that kids in the United States ($\beta = -0.59$, $SE = 0.27$, $p = .03$), India ($\beta = -0.58$, $SE = 0.29$, $p = .05$), and the Upano Valley Shuar ($\beta = -0.73$, $SE =$

Table 4
Final Model for Risk Preferences Within Ecuador, With Main Effects and Retained Interactions

Variable	Main effects	Retained interactions
(Intercept)	-3.86^{***} (.58)	-3.91^{***} (.58)
Stake size	$.61^{***}$ (.09)	$.61^{***}$ (.09)
Region: Upano Valley	1.66^{***} (.50)	1.84^{***} (.51)
Age (standardized)	−.15 (.26)	.45 (.38)
Gender: Male	.72 (.48)	.64 (.48)
Region (Upano Valley) × Age		-1.09^{*} (.53)
AIC	741.83	739.38
BIC	769.14	771.24
Log likelihood	−364.92	−362.69
Num. obs.	700	700
Num. groups: pid	140	140
Var: pid (intercept)	5.57	5.43

Note. AIC = Akaike information criterion; BIC = Bayesian information criterion; Num. obs. = number of observations; Var: pid = variance associated with participant id (random intercept term). Baseline region is Ecuador (Cross-Cutucú Shuar). Baseline gender is male.
$^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$.

0.27, $p = .007$) get more risk-averse with age as compared to the cross-Cutucú region who appear get less risk averse with age (see the online supplemental material for visualizations).

Discussion

Our study is among the first to highlight cross-cultural variability in the development of risk and time preferences among diverse populations, suggesting that these preferences are both culturally tethered and developmentally flexible. As the majority of previous work on the development of risk and time preferences was conducted virtually exclusively in industrialized populations, we have not previously had a thorough understanding of how differing ecologies contribute to differing preferences or even the extent to which these preferences may vary across cultures. Our results suggest that these preferences are more malleable than previously documented and exhibit ontogenetic variation that was formerly occluded by a sampling bias that favored Western participants (Nielsen et al., 2017).

We observe a number of similarities across populations, most prominently that all children are sensitive to stakes in both tasks, choosing the tomorrow and risky options as stake sizes increased. We also observe a number of striking differences between populations. First, in line with our predictions, cross-Cutucú Shuar children appear to be more risk averse than children from the other populations, including age-matched Shuar children in the Upano Valley. In line with the uncertainty management framework, we suggest that this greater risk-aversion may represent a useful behavioral heuristic in an environment marked by higher costs to uncertainty. Looking across the full sample, we also see that, as compared to the cross-Cutucú children, children in the Upano Valley, the United States, and India display more risk-seeking behavior at younger ages and more risk-aversion at older ages. The cross-Cutucú children display the opposite pattern, such that the youngest kids are the most risk-averse and this risk tolerance increases with age. Keeping in mind the limitations of these exploratory age analyses, these results nonetheless suggest greater variation in the development of risk preferences than previously documented. The pattern observed in American children, in which children become more risk-averse across age, is not found in Argentina, where risk preferences are relatively flat and high across age, and similarly not found among the cross-Cutucú Shuar, who exhibit the opposite pattern.

Second, we observe cross-cultural differences in time preferences, such that cross-Cutucú Shuar children are, on average, more present-oriented than children in United States, India, and Argentina, and still more present-oriented when compared to more market-integrated Shuar children. This greater present-orientation is consistent with the *uncertainty management framework*, which predicts greater future discounting in environments with higher costs to uncertainty. However, time preferences are complex, as a breakdown of individual behavior demonstrates that cross-Cutucú Shuar children exhibit a more heterogenous pattern in time preferences, with some preferring all rewards today and others preferring all rewards tomorrow. This pattern can be better contextualized by taking age into consideration, as the all-today preferences are more common among younger children, whereas all-tomorrow preferences are more common among older children. Though it is not fully clear why we observe this pattern, it may be reflecting a larger shift in age-related subsistence activity; ethnographic observations of similar Amazonian groups suggest that younger children primarily target immediate-return foods, whereas older children target more delayed-return foods (Sugiyama & Chacon, 2005). These exploratory age analyses should be interpreted with caution, but, in general, the age trends across the full sample of regions appear to share some common features. In four out of five regions, there is a strong trend such that children are more patient with increasing age. However, there appears to be an exception to this pattern among the Upano Valley Shuar such that children become more present-oriented with age. Although it's unclear why this pattern exists, this too implies that the behavior of American children cannot automatically stand in for the behavior of children in other populations and suggests that our understanding of how preferences develop could benefit from the inclusion of diverse populations.

Table 5
Final Model for Time Preferences Within Ecuador, With Main Effects and Retained Interactions

Variable	Main effects	Retained interactions
(Intercept)	-1.32^{*} (.54)	-1.20^{*} (.59)
Stake size	$.23^{**}$ (.07)	$.24^{**}$ (.08)
Region: Upano Valley	$1.07^{\dagger}$ (.56)	1.03 (.59)
Age (standardized)	−.01 (.29)	.77 (.45)
Gender: Female	.62 (.55)	.49 (.58)
Region (Upano Valley) × Age		-1.46^{*} (.62)
AIC	761.27	757.39
BIC	788.95	789.67
Log likelihood	−374.64	−371.70
Num. obs.	744	744
Num. groups: pid	149	149
Var: pid (intercept)	9.04	8.88

Note. AIC = Akaike information criterion; BIC = Bayesian information criterion; Num. obs. = number of observations; Var: pid = variance associated with participant id (random intercept term). Baseline region is Ecuador (Cross-Cutucú Shuar). Baseline gender is male.
$^{\dagger}p < .1$. $^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$.

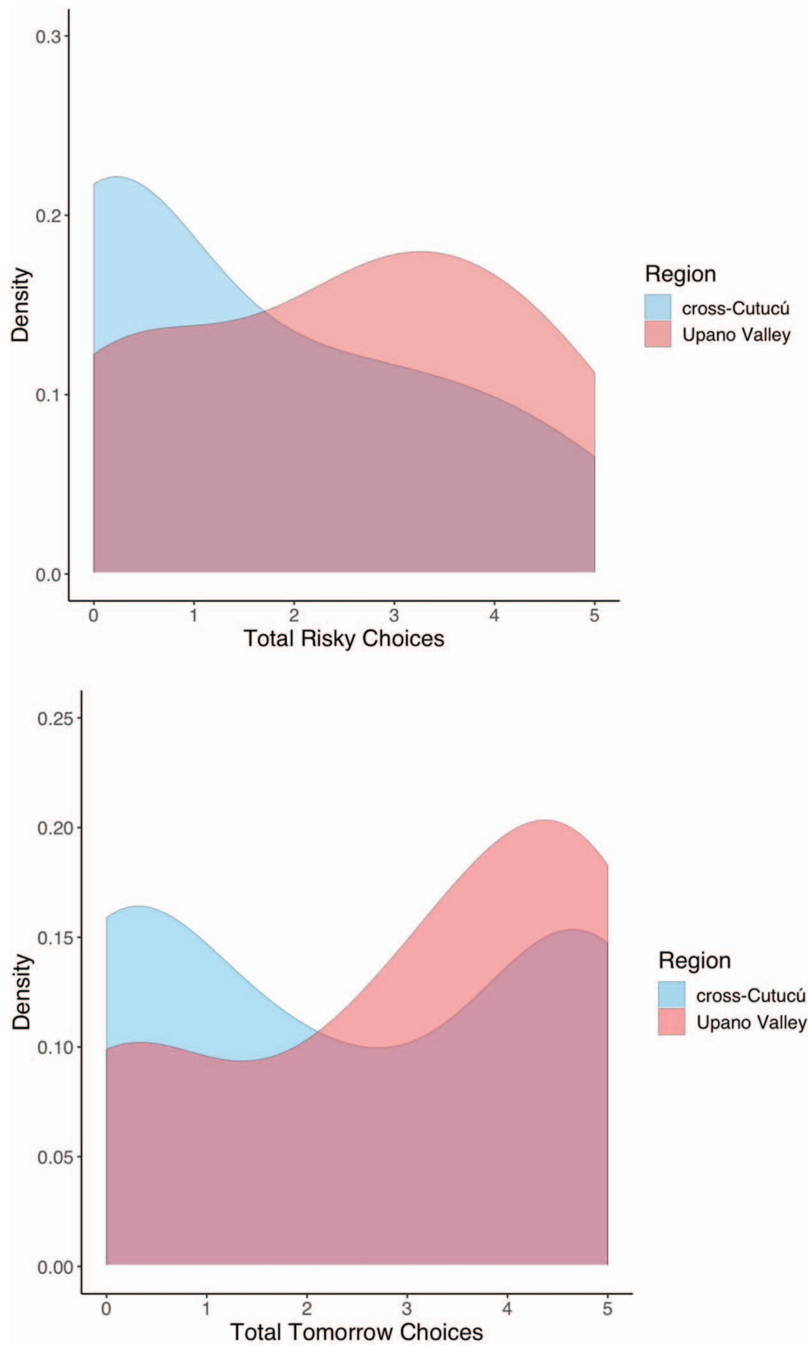

Figure 3. Density plots showing the total number of (top) risky choices (out of five) and (bottom) tomorrow choices (out of five) in each region of Ecuador. See the online article for the color version of this figure.

Although there are undoubtedly many other sources of variation between these populations, the combination of between- and within-cultural differences suggests that market integration may be related to the development of more future-oriented and risk-tolerant preferences. Our preferred explanation for these patterns, stemming from the uncertainty management framework, suggests that integration may help to reduce the downside costs of uncertainty by increasing access to resources that may buffer costs, such as storable economic or caloric goods. Interestingly, the within-culture analyses suggest that this shift in preferences can happen quickly, as the integration of the Upano Valley region is relatively recent. An important open question is the nature of causality in these relationships, as natural experiments are fundamentally correlational. Given that preferences such as risk preferences exhibit some heritability (Cesarini, Dawes, Johannesson, Lichtenstein, & Wallace, 2009), it is possible that Shuar families who are on average more risk-seeking and future-oriented relocate to the Upano Valley, but our ethnographic observations suggest this is unlikely to fully explain the pattern of results as most families in these regions have been living in the same area for relatively long periods of time. That is, it is more likely that roads came to the Upano Valley families, as opposed to families coming to the roads.

There are a number of limitations to this study. Because of the nature of work with small-scale societies, it is often difficult to recruit a large number of participants across evenly distributed age classes (indeed, in some of cases we tested all available children in the given age range). Interpretations of the developmental trajectories should take this into account. Second, although we attempted to standardize rewards across sites, by using familiar and local candy of approximately the same caloric density, as is standard among these types of cross-cultural studies (Blake et al., 2015), it is possible that the observed differences between populations arise from variables such as food-limitation or novelty of rewards. However, we see these as part of the phenomenon we're exploring, rather than alternative explanations. That is, one direct consequence of low integration (and poverty, more generally) is placing a higher utility on the same value of good. Further, although it is plausible that children across sites are valuing the same rewards differently, there is some evidence from research in social decision-making that suggests this is less influential than assumed (Blake et al., 2015).

In addition, although we observe differences between the behavior of the cross-Cutucú Shuar and the Upano Valley Shuar, and even granting our general hypothesis, it is unclear which features *within* the broader construct of market integration are contributing to these observed behavioral differences. That is, although we frequently measure market integration as calories obtained from markets, this is a proxy measure for a much larger set of changes, including, but not limited to, greater access to health care, more opportunities for education, greater exposure to Western media, habitation of admixed communities, lower caloric restriction, and many others. An increased focus on *within-population* differences in the development of preferences is thus necessary to weigh these contributing factors against one another and we hope future work will continue to examine the within-cultural forces shaping behavior through the collection of even more fine-grained data. It is also possible that trust in the experimenter is playing a role in these studies, as it has in other studies with children (Kidd, Palmeri, & Aslin, 2013). It may be the case that children trust the researchers more as they have more experience with them in their communities, though younger children report the same levels of trust despite behaving differently in the tasks (see the online supplemental material). In addition, children in the Shuar communities have more experience with the experimenter than children of other communities, as the researcher typically stays in a hut in their village and can be tracked down. And lastly, although we find evidence for variation in early life, it's unclear what these patterns look like in adulthood. This is an important piece to the puzzle as it will help us tease apart the roles of early experience with markets, social and cultural norms, and cohort effects in preferences and we hope future work can elucidate these patterns across the full life span. Further, as the environments the Shuar live in are changing rapidly, these cross-sectional age patterns may be reflecting cohort effects more clearly than they are reflecting longitudinal trends, and again, should be interpreted carefully.

These findings are important for a number of reasons. First, they challenge the notion that the behavior of children in WEIRD populations is an accurate predictor of how children behave across the world. We show much greater complexity and nuance in the development of preferences than has been documented in the literature thus far. Importantly, the results of this investigation—and particularly of the within-culture comparison—underscore the importance of including non-WEIRD societies when assessing behavioral development. Without the inclusion of the Shuar, for instance, one would observe that children in India, Argentina, and the United States tend to be future-oriented and risk-seeking, and (incorrectly) conclude that these are universal patterns of behavior. These data are particularly important now as these small-scale societies are experiencing rapid cultural changes and we will soon lose the ability to assess the effects of these lifeways on behavior. Second, these results are consistent with the adaptive developmental plasticity hypothesis, which posits that behaviors exhibit flexible calibration to features of the local environment across development. Third, our results are consistent with the uncertainty management framework of preference development, in which heuristics of risk-aversion and present-orientation are predicted to be more common in environments marked by low resource access. Given the role of risk and time preferences in many aspects of our decision making, a better understanding of these preferences may enable us to promote positive decision making and design interventions that focus less on individual decision-makers and more on the larger environmental and ecological contexts that shape behavior.

Context

Given that much of what we know about child development is skewed toward Western populations, our team of psychologists and anthropologists thought it both pertinent and important to investigate how behavior may differ across diverse cultures. Utilizing tools from behavioral economics and developmental psychology, in addition to insights gleaned from other cross-cultural, developmental studies conducted by our team members (e.g. Blake et al., 2015), we designed intuitive, child-friendly economic games to tap into two important preferences at the heart of decision making. The anthropologists in our research team conducted the studies in Argentina, India, and among the Shuar of Amazonian Ecuador, who still maintain a forager-horticulturalist lifeway. Given that the vast majority of the human experience was marked by foraging, we thought it particularly important to include children from these small-scale societies to better assess how the rapid environmental changes leading to industrialization may have shaped child development. Additionally, as these cultures are rapidly changing and becoming more integrated with the industrialized world, we believe these data are particularly timely and valuable. In future work, we are interested in exploring the presence of a *knowledgebehavior* gap in preferences and expanding our investigations to investigate behavior not just in decision-theoretic contexts, but game-theoretic contexts as well.

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