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Adolescents' Cognitive Capacity Reaches Adult Levels Prior to Their Psychosocial Maturity: Evidence for a "Maturity Gap" in a Multinational, Cross-Sectional Sample

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Abstract

All countries distinguish between minors and adults for various legal purposes. Recent U.S. Supreme Court cases concerning the legal status of juveniles have consulted psychological science to decide where to draw these boundaries. However, little is known about the robustness of the relevant research, because it has been conducted largely in the U.S. and other Western countries. To the extent that lawmakers look to research to guide their decisions, it is important to know how generalizable the scientific conclusions are. The present study examines two psychological phenomena relevant to legal questions about adolescent maturity: cognitive capacity, which undergirds logical thinking, and psychosocial maturity, which comprises individuals’ ability to restrain themselves in the face of emotional, exciting, or risky stimuli. Age patterns of these constructs were assessed in 5,227 individuals (50.7% female), ages 10–30 (M = 17.05, SD = 5.91) from eleven countries. Importantly, whereas cognitive capacity reached adult levels around age 16, psychosocial maturity reached adult levels beyond age 18, creating a “maturity gap” between cognitive and psychosocial development. Juveniles may be capable of deliberative decision making by age 16, but even young adults may demonstrate “immature” decision making in arousing situations. We argue it is therefore reasonable to have different age boundaries for different legal purposes: one for matters in which cognitive capacity predominates, and a later one for matters in which psychosocial maturity plays a substantial role.

Keywords

adolescence; maturity; law; age of majority; cross-national

All developed societies draw chronological age boundaries between minors and adults for legal purposes, among them, determining who is permitted to vote, drive, purchase alcohol, and make autonomous medical decisions and, if arrested, who is tried as an adult. In many countries, age 18 is used for most purposes with some exceptions (e.g., consent to research

or medical treatment; World Health Organization, 2014). In others, such as the United States, different ages are used for different matters. For example, although the presumptive age of majority in the U.S. is 18, eligibility for driver's licensing is generally granted at a younger age, whereas the minimum legal purchase age for alcohol is 21.

The idea that young people lack certain capacities or abilities necessary to assume the responsibilities or enjoy the privileges of adulthood is undoubtedly part of the logic behind differentiating between adults and minors in the law (Woolard & Scott, 2009). For example, the infancy doctrine, which allows minors who enter into contracts to void them at their discretion, was fashioned to protect minors from their immature judgment as well as adults who might capitalize on youths' lack of understanding of the consequences of the contract (Preston & Crowther, 2012). In the early 20th century, legislators established a separate justice system in the U.S. for juveniles (Scott & Steinberg, 2008) based on similar logic, namely, that children differ from adults in ways that require special protection in criminal matters: children suffer from deficient decision-making abilities, which makes them less responsible for their bad acts; children are more amenable to rehabilitation, so they should be reformed, not punished (Davis, Scott, Wadlington, & Whitebread, 2009; Woolard & Scott, 2009).

The delineation of a specific age-boundary that separates children from adults has often resulted from practical considerations, without reference to relevant empirical and theoretical foundations (Scott, 2000). For example, initially there were no age restrictions for driving. As traffic safety became a concern, states began setting a minimum driving age, typically 18 (Mayhew, Fields, & Simpson, 2000). In the 1920s and 1930s, many states lowered the driving age from 18 to 16 to allow minors to work in occupations requiring a vehicle. As teen driving fatalities increased, many states adopted "graduated driver-licensing" in the 1990s, which lets 16-year-olds drive, but only under certain circumstances (e.g., no other teen passengers in the car; Williams, 1999).

In other instances, political considerations led legislators to draw or change legal boundaries. At the height of the Vietnam War, when the military draft age was 18, the voting age was 21. Many politicians argued that it was unfair to send 18-year-olds into battle but prohibit them from voting, and Congress amended the Constitution in 1971 to lower the voting age to 18. In response, some states lowered their legal drinking age from 21 to 18 or 19 (Cook & Tauchen, 1984). Because not all states did this, young people living in places with higher drinking ages would drive across state lines to purchase and consume alcoholic beverages—and then drive back home intoxicated. In 1984, under pressure from the federal government, all states raised the minimum legal drinking age back to 21.

Until recently, developmental psychology has not been an explicit force in determining specific legal age boundaries—when legislators lowered the driving age or raised the drinking age, no one asked whether research on psychological development supported either change. However, developmental science has gradually become more influential (Steinberg, 2017). In both legal and non-legal venues, experts have weighed in on whether, and at what age, the law should distinguish between adolescents and adults. But considerable

controversy has arisen because scientists have answered this question in different ways, depending on the legal issue involved.

In 2005, when the American Psychological Association (APA) submitted an amicus brief in *Roper v. Simmons*, the U.S. Supreme Court case that abolished the juvenile death penalty for 16- and 17-year-olds, the APA argued that people younger than 18 lacked the psychological maturity necessary to be held fully responsible for their crimes and, therefore, that they should not be eligible for capital punishment (APA, 2004). Justice Antonin Scalia, in his dissenting opinion, criticized the APA, because in an earlier case its experts had opined that teenagers should have the right to make decisions about abortion without involving their parents, on the grounds that their decision-making abilities were just as mature as adults' (APA, 1989).

A group of psychologists argued that this apparent logical inconsistency was actually in keeping with developmental science (Steinberg, Cauffman, Woolard, Graham, & Banich, 2009). They contended that because different abilities mature along different timetables, adolescents of a given age could be adult-like in some respects but not others. Based on analyses of data from over 900 individuals between the ages of 10 and 30, they noted that cognitive capacity—the basic cognitive processes supporting the ability to reason logically—matures by 16, whereas psychosocial maturity—the capacity to exercise self-restraint, especially in emotionally-arousing contexts—does not fully mature until several years later. Steinberg et al. (2009) argued that these patterns justify having a lower age boundary for legal decisions that allow deliberation and a higher age boundary for matters pertaining to acts typically made under emotionally arousing circumstances (Scott & Steinberg, 2008).

One way to think about the difference between these capacities and abilities is to distinguish between "cold" cognition and "hot" cognition. Cold cognition refers to mental processes (such as working memory or response inhibition) employed in situations calling for deliberation in the absence of high levels of emotion (e.g., Figner, Mackinlay, Wilkening, & Weber, 2009). Hot cognition involves mental processes in affectively charged situations where deliberation is unlikely or difficult. Recent research has borne out this distinction, showing that on response inhibition tasks, young adults (aged 18–21) perform comparably to somewhat older individuals when tested under emotionally neutral conditions but more poorly—and similarly to younger teenagers—when tested under arousing ones (Cohen et al., 2016).

Legal issues pertaining to cold cognition include voting, granting consent for research participation, and making autonomous medical decisions, where the presence of adult consultants and the absence of time pressure impose sufficient external control to minimize the dangers of impulsive decision making (Grisso et al., 2003; Hein et al., 2015). Issues related to hot cognition include driving, consuming alcohol, and criminal behavior; it is easy to make impulsive choices when emotions are aroused, such as when behind the wheel, intoxicated, or committing a crime, behaviors that often occur in the presence of peers during adolescence (Albert & Steinberg, 2011).

Importantly, the developmental trajectories of cold and hot cognition differ. In studies using cold cognitive tasks, performance increases dramatically from childhood to early- or mid-adolescence and then plateaus. This pattern is demonstrated on tasks of response inhibition (e.g., Huizinga, Dolan, & van der Molen, 2006; Luna, Garver, Urban, Lazar, & Sweeney, 2004), cognitive flexibility (e.g., Crone, Ridderinkhof, Worm, Somsen, & van der Molen, 2004), and working memory (e.g., Huizinga et al., 2006; Luna et al., 2004; Prencipe et al., 2011). A similar developmental pattern appears in the psycholegal literature as well. For example, younger juveniles (11–15 years) are impaired at significantly higher rates than older adolescents (16–17) on measures of understanding and appreciation of Miranda rights and on other measures of adjudicative competence (Viljoen, Zapf, & Roesch, 2007). But by the time they are 16–17 years old, adolescents and adults score comparably on abilities relevant to competence to stand trial, (Grisso et al., 2003; Redlich & Shteynberg, 2016).

In contrast, facets of hot cognition, including sensation seeking (or lack thereof), impulse control, future orientation, and resistance to peer influence, follow a protracted development into adulthood. Sensation seeking, which peaks during adolescence (Steinberg et al., 2008), decreases into the early- to mid-twenties (Harden & Tucker-Drob, 2011; Shulman, Harden, Chein, & Steinberg, 2014). On the other hand, impulse control, future orientation, and resistance to peer influence improve into adulthood in studies employing either self-report assessments (e.g., Harden & Tucker-Drob, 2011; Romer, Duckworth, Sznitman, & Park, 2010; Steinberg et al., 2009c; Steinberg & Monahan, 2007) or behavioral tasks (e.g., Chein, Albert, O'Brien, Uckert, & Steinberg, 2011; Cohen et al., 2016; Steinberg et al., 2009c). Similarly, relative to adults, adolescents demonstrate impaired decision making in emotionally arousing contexts, such as when being interrogated by police (e.g., Malloy, Shulman, & Cauffman, 2014). To the extent that these legal contexts become emotionally arousing as a consequence of external pressures—by friends, family, police, or the adolescent's own lawyer—adolescents' decision making lags behind adults'. Thus, if our laws were more closely aligned with developmental science, age boundaries for matters involving cold cognition might be lower than those involving hot cognition, because effective hot cognition requires both cognitive capacity and psychosocial maturity (e.g., self-restraint).

There is no universally agreed-upon way to measure cognitive capacities or psychosocial maturity. Steinberg et al. (2009) measured cognitive capacity using tests of short-term memory, working memory, and verbal fluency. These measures of executive functioning undergird goal-directed behavior and higher-order logical reasoning (Diamond, 2013). Their measure of psychosocial maturity was based on self-reports of traits such as impulse control, sensation seeking, future orientation, and resistance to peer influence. These measures tap individuals' ability to restrain themselves in the face of temptations to pursue rewarding, immediately gratifying, socially encouraged, or risky activities. These measures capture some, but not *all*, important aspects of cognitive and psychosocial functioning that are relevant to decision making (e.g., neither measure included an index of morality or perspective taking; see Fischer, Stein, & Heikkinen, [2009] and Steinberg, Cauffman, Woolard, Graham, & Banich [2009b] for a response). It is notable that Steinberg and colleagues' (2009) measure of cognitive capacity comprised all behavioral tasks, whereas their measure of psychosocial maturity comprised all self-report measures. These limitations

notwithstanding, both constructs include measures that are essential to decision making competence in legal contexts—executive functions facilitate flexible, optimized decision making (Diamond, 2013) whereas elements of psychosocial maturity are strongly tied to what some writers have referred to as "judgment" (e.g., Scott, Reppucci & Woolard, 1995; Steinberg & Cauffman, 1996).

Overview and Rationale of Present Study

The present study replicates Steinberg et al. (2009) in a large international sample. Such a replication is warranted for several reasons. First, because most of the relevant research has been conducted in Western countries, it is not known to what degree conclusions drawn from these countries extend to non-Western societies. Further, of the few cross-national studies of cognitive capacity or psychosocial development that do exist, most suffer at least one major limitation. Studies typically examine only a single developmental period (e.g., middle adolescence, excluding the transition into adulthood). Furthermore, these studies often examine mean differences between cultures and not age trends (e.g., Thorell, Veleiro, Siu, & Mohammadi, 2013). In addition, apart from a few studies (e.g., Matsumoto et al., 2008; Vazsonyi & Ksinan, 2017), most cross-cultural work examines only a few countries or cultures at a time. Although some studies have collected data from a large number of participants from many countries (e.g., Rossier et al., 2007), such studies are limited to adult samples and rely on self-report measures, which typically do not assess executive functions. To our knowledge, no cross-cultural study has measured multiple elements of both cognitive and psychosocial development within a single, multi-age sample. To the extent that lawmakers look to science to guide their decisions, it is important to know how robust the scientific conclusions are. This is especially important with respect to laws within the U.S., with its ever-growing population of immigrants (Migration Policy Institute, 2018).

Despite the limitations of most of the published cross-cultural research, some studies have examined age patterns of legally-relevant psychological phenomenon. For example, cognitive capacity improves with age across childhood and into adolescence in Kenya (Alcock, Holding, Mung'ala-Odera, & Newton, 2008), Japan (Imada, Carlson, & Itakura, 2013), and Hong Kong (Wang, Devine, Wong, & Hughes, 2016). Using self-report indices of facets of psychosocial maturity, Rossier and colleagues (2007) found that sensation seeking decreased with age during young adulthood (from age 18 to 25) in China, Germany, Italy, Spain, and Switzerland, though impulsivity did not.

The paucity of cross-cultural work in this area is regrettable because there is reason to expect cultural variation in development, particularly with respect to psychosocial maturity. Cross-cultural studies of self-regulation focus on the socialization of appropriate behaviors (i.e., emotional displays), especially in social interactions. That is, to the extent that emotions motivate or precipitate behavior (e.g., feeling anger may lead to an act of aggression), emotion regulation is necessary to comply with the behavioral norms of a culture (LeCuyer & Zhang, 2014; Matsumoto et al., 2008). In this view, parents and peers shape self-regulation by encouraging culturally appropriate behaviors and discouraging inappropriate behaviors (Chen & French, 2008). Cultures valuing individuality (typically Western

cultures) encourage autonomy and self-assertion, whereas more collectivistic cultures stress the importance of suppressing one's desires to benefit the group (Chen & French, 2008).

Cultural variations in self-regulation also extend to the management of positive emotions. Americans, for example, are less likely to dampen positive emotions than are people from East Asian countries (Ma, Tamir, & Miyamoto, 2018; Miyamoto & Ma, 2011). This cultural difference has particular implications for sensation seeking, which often involves a lack of regulation of positive affect (e.g., the thrill or excitement of doing something fun, but dangerous, with friends). Indeed, according to Hofstede (2011), cultures vary considerably along a dimension of "indulgence-restraint," the degree to which societal norms encourage hedonic satisfaction rather than the strict regulation of impulses. In summary, in East Asian and collectivistic cultures, children must learn to suppress (regulate) undesirable behaviors (LeCuyer & Zhang, 2014). Thus, self-regulation may develop earlier in these contexts than in Western/individualistic societies for both positive and negative affect (Lamm et al., 2017). Comparative cross-cultural research on the development of self-regulation is limited and equivocal. Some studies indicate similar developmental patterns cross-culturally, but other research examining the socialization of self-regulation suggests divergent developmental trajectories.

A second reason for the present replication concerns the measurement of psychosocial maturity. Steinberg and colleagues (2009) employed behavioral tasks to assess cognitive capacity and self-report measures to assess psychosocial maturity. One outstanding question is whether previously documented differences in age patterns of cognitive capacity and psychosocial maturity are an artifact of differences in methodology. For example, whereas self-report measures tap the individual's subjective assessment of their behavior, behavioral tasks provide a brief snapshot of behavior while controlling for context, an important consideration in cross-national studies. In the present study, we employ a measure of psychosocial maturity that is based mainly on behavioral assessments, which allows us to more directly compare its growth to a measure of cognitive capacity that is also based on behavioral assessments.

Finally, since its 2005 decision on the juvenile death penalty, the Supreme Court has heard several other cases in which developmental science was applied. During the past decade, the Court has decided cases on the constitutionality of sentencing juveniles to life without the possibility of parole (Graham v. Florida, 2010; Miller v. Alabama, 2012) and on the admissibility of the results of interrogations of adolescents in situations in which they may be inadvertently encouraged to confess to crimes (JDB v. North Carolina, 2011). And, in light of new evidence that brain maturation continues into adulthood (Casey, 2015), a number of experts have asked whether these findings support raising the age of majority under criminal law and processing young adult offenders in the juvenile justice system (Schiraldi, Western, & Bradner, 2015). Importantly, the relevant research on psychological development in young adulthood—especially comparing young adults to people in their mid- and late twenties—is very limited (Scott, Bonnie, & Steinberg, 2016).

In the present study, we compare two facets of development relevant to the treatment of young people under the law—cognitive capacity (the predominant influence on cold

cognition) and psychosocial maturity (the predominant influence on hot cognition)—using some of the same tasks as Steinberg and colleagues (2009), but in an 11-country sample of more than 5,200 individuals between the ages of 10 and 30. Countries vary in how they socialize youth (Chen & French, 2008; Matsumoto et al., 2008), but the question of where to draw a boundary between adolescence and adulthood is one that all societies face. Accordingly, we examine the second two decades of life to determine whether and in what ways age differences in cognitive capacity and psychosocial maturity are evinced in a diverse group of countries. The countries in this sample—China, Colombia, Cyprus, Jordan, Kenya, India, Italy, the Philippines, Sweden, Thailand, and the U.S.—are diverse geographically, economically, and culturally, including on dimensions of individualism/collectivism and indulgence/restraint (Hofstede, 2011). For example, Columbia and China rank as some of the world's most collectivistic cultures, whereas Italy and the U.S. are some of the most individualistic. Likewise, China and India greatly value restraint, whereas Sweden and Columbia are highly indulgent (see Table 1 for details on country-level attributes and the supplemental materials for details on legal age boundaries by country).

Consistent with Steinberg and colleagues (2009), we examine age differences using composite measures of psychosocial maturity and cognitive capacity. These composite variables allow us to capture multiple facets of an overarching construct (executive functions in the case of cognitive capacity and self-restraint in the case of psychosocial maturity). However, unlike Steinberg et al. (2009), we rely largely on behavioral measures of psychosocial maturity. Like the original measure of psychosocial maturity, these behavioral tasks tap various manifestations of self-restraint. Here, we include behavioral measures of sensation seeking (using the "Stoplight Game"), future orientation (using a delay discounting task), and impulse control (using the Tower of London task). We also measure cost sensitivity, or one's ability to learn from negative outcomes, using a modified version of the Iowa Gambling Task (IGT). This measure has not been used before as an indicator of psychosocial maturity, but it can be used to assess self-restraint. Specifically, successful performance on the IGT requires that one learn to resist potential rewards that also carry high costs. Lastly, because a behavioral measure was unavailable, we rely on a self-report measure of resistance to peer influence. In its opinion in Roper v. Simmons (2005), the Supreme Court explicitly cited teens' greater susceptibility to others as a mitigating factor for their bad behavior. Thus, given its important place in questions of maturity, self-reported resistance to peer influence was retained in the current study.

Hypotheses

We hypothesized that cognitive capacity would reach adult levels *prior* to age 18 and plateau in mid-adolescence, but that psychosocial maturity would not reach adult levels until after 18, into the 20s. These hypotheses are consistent with the idea that deliberative, "cold" decision making matures prior to "hot" decision making. Given the substantial cultural variation in expectations for self-regulation (which likely influences each component of self-restraint within the psychosocial maturity composite), we anticipated that patterns of age differences in psychosocial maturity would vary notably across countries (Chen & French, 2008; Matsumoto et al., 2008). In contrast, we expected the pattern of age differences in cognitive capacity to generally be more consistent across countries.

Methods

Participants

We recruited nine of the eleven countries of the present sample from an ongoing longitudinal study of parenting across cultures (PAC; Lansford & Bornstein, 2011), which has been described elsewhere (Steinberg et al., 2017). The PAC study originally selected these nine countries because they differ in how children are parented and disciplined, which is the focus of that study. In particular, these nine countries differ on several levels: (1) individualism versus collectivism, (2) religious affiliation, and (3) laws governing parenting behaviors (e.g., the one-child policy in China that was in effect at the time of data collection) (Lansford & Bornstein, 2011). The current study has a different focus, but collaborating with the PAC group allowed us to build on their cross-national infrastructure. In addition to the PAC countries, the current study included Cyprus and India. Cyprus participated in the current study, but not the PAC project, because PAC data collection had already begun prior to Cyprus' involvement. India was unable to join the PAC group because the Indian Council of Medical Research did not approve the PAC study given that the sample was not nationally representative of India. Because the National Institutes of Health, which funds the PAC study, required this approval to fund data collection, India could not participate in the PAC study. However, because the Jacobs Foundation funded the current study, such approval was not required, thus allowing India to participate.

The sample (N = 5,404) comprises individuals between 10 and 30 years in eleven countries: China (n = 493), Colombia (n = 513), Cyprus (n = 407), India (n = 425), Italy (n = 561), Jordan (n = 506), Kenya (n = 488), the Philippines (n = 512), Sweden (n = 425), Thailand (n = 504), and the U.S. (n = 570) (see Table S2 for a breakdown of participants by age in each country). We balanced the proportion of males and females in the full sample (50.8% female, n = 2,746), within each country (ranging between 48.9–53.8% female) and across age group (ranging between 48.7–52.0% female). Each site recruited participants from urban centers in each participating country using flyers posted in neighborhoods, advertisements in newspapers, and word of mouth. All sites attempted to recruit a minimum of 60 participants (50% female) for each of seven age groups: 10–11 years, 12–13 years, 14–15 years, 16–17 years, 18–21 years, 22–25 years, and 26–30 years. (Because the 10–11 year-old group comprised PAC participants, within PAC countries, the number of participants in this group generally exceeded those in other age groups.) Participants came from households with similar levels of parental education (average = "some college") and reflected the majority ethnicity of the country (except in the U.S., where we tried to recruit equal numbers of Black, Latino, and White participants, and in Kenya, where participants were of the Luo ethnic group).

Procedure

At each data collection site, research staff received identical training for administering the test battery. Measures were administered in the predominant language at each site, following forward- and back-translation and a process of cultural adaptation (Erkut, 2010). Translators were fluent in both English and the target language, and identified any items that translated poorly, were culturally insensitive or inappropriate, or may have multiple meanings. Site

coordinators and translators then modified items as appropriate. During data collection, investigators from each site attended an annual in-person meeting to resolve any questions, concerns, or obstacles, and to review study procedures. In addition, sites regularly used e-mail and Skype calls to resolve ongoing questions or issues. A central coordinating center received and checked all incoming data each week.

Participants completed a session that lasted two hours. Staff members tested participants individually in their homes, schools, or other locations designated by the participants. Parental consent and adolescent assent were obtained at all sites for all youth under 18 except Sweden, where parental consent is not required for participants over 15. Participants completed computerized versions of all measures including self-report measures, behavioral tasks, an intelligence assessment, and a demographic questionnaire.

In order to maintain participants' interest and motivation, they were told they would receive a base payment ($30 in the U.S.) for participating in the study, but that they could earn a bonus (equal to 50% of the base payment) based on their performance on the computer tasks. In actuality, all participants received this bonus. Research staff debriefed participants regarding this deception in countries where local Institutional Review Boards (IRBs) deemed such disclosure necessary. Local investigators set base payments so as not to be coercive; the participating university in Sweden prohibits paying research participants, so these participants received a base payment of two movie tickets and a bonus of one additional ticket. Local IRBs approved all procedures.

Measures

Analyses focused on a demographic questionnaire, a measure of intellectual ability, three measures of cognitive capacity, and five measures of psychosocial maturity.

Demographics.—Participants reported their age, sex, and the level of education of each of their parents, as a proxy for socioeconomic status. Owing to small but significant differences among age groups, we added average parental education as a covariate in all analyses.

Intellectual ability.—We used the Matrix Reasoning subtest of the *Wechsler Abbreviated Scale of Intelligence* (WASI) (Psychological Corporation, 1999), administered on a laptop, to estimate *nonverbal intellectual ability*. (Verbal subscales of the WASI were excluded due to the variability in language across sites in the sample.) The WASI has been normed for individuals between the ages of 6 and 89 years; an age-normed score (i.e., *t*-score) was computed for each participant (see Icenogle et al. (2016) for more details about this measure). We included intellectual ability, which may influence task performance, as a covariate in all analyses to control for small but significant age differences in intellectual functioning in some of the countries.

Cognitive capacity.—We computed a measure of cognitive capacity by averaging within-country standardized scores from Digit Span, working memory, and verbal fluency tasks.

Digit Span.: Participants recalled strings of digits beginning with two digits and increasing to eight. The outcome of interest is the highest number of digits recalled in reverse order

(DSB). DSB taps working memory because it requires individuals to hold and manipulate information held in memory (Diamond, 2013).

Working memory.: Participants saw four probe letters on the screen, followed by a target letter (Thompson-Schill et al., 2002). Participants indicated whether the target letter was among the four probes. On difficult trials, two of the four probes had appeared on the previous trial; on easy trials, none of the four probes had appeared in the two previous trials. Participants completed two blocks of thirty-two trials. The outcome of interest is average accuracy across all trials.

Verbal fluency.: Participants generated as many words as possible belonging to a given category in one minute. Three categories were used: fruits, vegetables, and animals. The number of valid words (i.e., those that were not proper nouns, repeats, or different forms of the same word) generated within each category were averaged to create an overall fluency score. Kenyan participants scored notably lower than any other country (e.g., 2/3 of the sample did not produce one example of a fruit). A discussion with the principal investigator in Kenya revealed that these low scores may be the result of low exposure to a variety of fruits, vegetables, and animals, or to performance-related anxiety. Further, Kenyans who have attended school are often multilingual, and a language mix-up could have contributed to poor performance. Accordingly, the cognitive capacity variable for Kenyan participants excluded verbal fluency.

Psychosocial maturity.—We computed a composite measure of psychosocial maturity by averaging within-country standardized scores from five measures: self-reported resistance to peer influence, the Stoplight task, delay discounting, the modified Iowa Gambling Task, and the Tower of London task. Although Steinberg and colleagues (2009) also included a measure of risk perception, this measure was excluded from the current analyses (although it was administered). Unlike the other psychosocial measures, the risk perception questionnaire asks about specific risky behaviors (e.g., riding in a car with a drunk driver), perceptions of which may differ across countries simply because the behavior is more or less normative or common (e.g., sanctions against alcohol use in Jordan give intoxicated driving a different meaning than in the United States).

These specific measures were chosen both because they tap aspects of development frequently cited in legal debates, and because they are behavioral, not self-report, assessments. By using behavioral measures of both psychosocial maturity and cognitive capacity, we are able to determine whether previously-reported divergent age patterns of the two are merely a reflection of measurement type. Although our measures, like those used by Steinberg and colleagues (2009), reflect multiple domains of psychosocial functioning, we create an aggregate for two main reasons. Conceptually, these measures are related; each is undergirded by self-restraint (which manifests in different ways). Second, it is important to produce scientific research that meaningfully guides the legal field. Practically speaking, the courts and policymakers require simple explanations to complicated questions (Steinberg et al., 2009b). Thus, we consolidate across measures to make our study more directly applicable to legal settings.

Resistance to peer influence.: We used the Resistance to Peer Influence scale (RPI; Steinberg & Monahan, 2007), a ten-item questionnaire that uses a two-stage response format (see supplemental materials for an example and full scale). Participants first indicated which of two opposing statements best described them (e.g., "For some people, it's pretty easy for their friends to get them to change their mind BUT for other people, it's pretty hard for their friends to get them to change their mind"). Then, participants rated whether this statement is "really true" or "sort of true," yielding a four-point scale. Because, in our sample, confirmatory factor analyses (CFAs) indicated poor model fit using the four-point scale in all countries, we used dichotomized responses (i.e., which of the two statements was selected) —which yield better model fit indices—to compute scales scores. Further, psychometric properties of the RPI (based on fit indices from CFA) were improved when using only seven of the original ten items. Thus, we used only dichotomized responses from these seven items. (See the supplemental materials for details of this procedure.) Reliabilities ranged from $\alpha = .43$ (Philippines) to .79 (India) (see supplemental materials for reliabilities in each country and the full 10-item scale).

The Stoplight task.: To obtain a behavioral index of sensation seeking, participants completed a computerized driving task called the "Stoplight task" (Steinberg et al., 2008). In this task, participants approached a series of twenty intersections at which they decided whether to run a stoplight as it turned yellow, or to stop safely. If the participant chose to stop, he or she must wait three seconds before restarting. If the participant ran the light, he or she either passed through successfully (resulting in no loss of time) or crashed into another car (resulting in a loss of six seconds). Performance on this task is associated with self-reported sensation seeking (Chein et al., 2011; Steinberg et al., 2008). We defined sensation seeking as the proportion of lights run (regardless of whether the participant passed safely through the intersection). Z-scores for this measure were reversed so that higher values indicate greater restraint (i.e., less sensation seeking).

Delay discounting.: We employed a computerized delay discounting task to assess individuals' future orientation (see Steinberg et al., 2009 for details). In this task, participants made hypothetical decisions between an immediate but smaller reward and a delayed but larger reward. The value of the delayed reward was held constant at 1,000 units of local currency. The starting value of the immediate reward was randomly determined for each participant to be 200, 500, or 800 units of currency. Our version of the task uses six delay periods: 1 day, 1 week, 1 month, 3 months, 6 months, and 1 year (e.g., "Would you rather have 200 euros today or 1,000 euros in six months?"). The size of the immediate reward was adjusted after each offer to converge at a value reflecting the subjective value of the delayed reward if it were offered immediately, referred to as the "indifference point" (Ohmura, Takahashi, Kitamura, & Wehr, 2006). As the delay period lengthens, one must have a stronger sense of future orientation to forgo the immediate reward. That is, when waiting only one day or one week to receive a reward, it is relatively easy to forgo the immediate option. Longer delays, then, may better inform our understanding of future orientation because they require projection into the extended future. Accordingly, indifference points for the three longest delay intervals (3 months, 6 months, and 1 year) were averaged and used as a measure of future orientation. A higher value indicates a

stronger willingness to forgo an immediate smaller reward for a more valuable reward in the future (i.e., greater future orientation).

Many researchers report that on delay discounting measures, there often are a small number of participants who fail to vary their responses across delay periods (i.e., they always choose the immediate reward regardless of the delay, or they always choose the delayed reward regardless of the delay). Because these responses show an absence of discounting behavior (indicating that participants either do not take the task seriously, or do not understand the task), we recoded them as missing for these participants.

Modified Iowa Gambling Task.: We measured cost sensitivity with a modified IGT (Cauffman et al., 2010). Participants played from four decks of cards to earn money. Two of the decks resulted in a monetary gain over repeated play (advantageous decks), whereas the other two resulted in a net loss over repeated play (disadvantageous decks). In this modified version of the IGT, one deck was highlighted with an arrow, and participants were given four seconds to decide to play or pass on that card (see Cauffman et al., 2010 for details). This "play or pass" modification allowed us to independently track avoidance of disadvantageous decks (Peters & Slovic, 2000). The task was administered in six blocks of twenty trials. A running total of each participant's earnings remained on the screen throughout the task. Cost sensitivity was operationalized as the change in proportion of cards played on disadvantageous decks from the first block to the last block. The more individuals resist the disadvantageous decks over the course of the task, the better they are at learning to avoid harmful decks despite their potential for reward. So that higher values indicated greater cost sensitivity and restraint, scores were *z*-scored and reversed.

Tower of London task.: We measured impulse control using a computerized version of the Tower of London task (Shallice, 1982; Steinberg et al., 2008). Participants saw pictures of two sets of three colored balls distributed across three rods, one of which can hold three balls, one can hold two balls, and the last, only one ball. The first picture showed the starting positioning of the three balls and the second picture depicted the goal position. The purpose of the task is for participants to match the goal arrangement in as few moves as possible by moving the balls from peg to peg. Participants saw twenty trials, beginning with trials that can be solved in three moves and progressing to those that require a minimum of seven moves.

One capacity assessed by this task is whether one can inhibit acting before a plan is fully formed (i.e., impulse control). Impulse control was measured by the latency to the first move (in milliseconds) on difficult problems (those requiring six or seven moves to complete). To prevent extreme outliers form influencing the results, we recoded as missing responses from any participants with latencies greater than sixty seconds ($n = 18$). As is often the case with response time data, latencies were markedly skewed. A log transformation was applied to these data, which improved the distribution.

Data analyses

We excluded a relatively small number of participants (172; 3.18%) based on interviewer feedback (e.g., the participant did not appear to understand tasks or did not evince adequate

effort during the assessment). We also excluded three participants who failed to report their age or whose age exceeded the specified age range for the study. Of the remaining 5,227 participants, 78 (1.50%) did not provide information on parental education, 83 (1.59%) lacked Tower of London data, and 165 (3.16%) lacked data from the Stoplight task (mostly due to technical difficulties with the program). Forty-one participants were missing delay discounting, and an additional 171 failed to vary their responses (either always choosing the immediate option or always choosing the delay option) and were recoded as missing. In total, 212 (4.06%) of participants lacked delay discounting data. Less than 1% of the sample were missing data on any other covariate or measure. Analyses were completed with Mplus statistical software (Version 7.31; Muthén & Muthén, 1998–2010) using full-information maximum likelihood to handle missing data.

We tested for linear, quadratic, and cubic age patterns of the cognitive capacity and psychosocial maturity composites in the sample as a whole and separately within each country. All analyses controlled for parental education and intellectual ability. To produce meaningful decimals and avoid rounding errors, we multiplied composite values by 100. Age was centered at 10 years, and both parental education and intellectual functioning were centered at their respective means.

Results

Zero-order correlations among all variables and descriptive statistics for each measure by age group are reported in Table 2 and Table 3, respectively. For all regression analyses, we report only coefficients from the model with the highest-order significant age trend. Lower-order age trends are reported in the supplemental materials. Results of age patterns of individual components can be found in the supplemental materials.

Measurement Invariance

To ensure that self-reported resistance to peer influence was suitable for use in our sample, we examined measurement invariance in all eleven countries. We fit CFAs for this measure within each country to test for unidimensionality and identify problematic items. We used the alignment technique to explore measurement invariance (Muthén & Asparouhov, 2014), which also provided information about the non-invariance of each item in each country. CFAs indicated that the RPI evinced acceptable model fit when three problematic items (based on visual inspection and alignment analyses) were dropped. Muthén and Asparouhov (2014) suggest that approximate measurement invariance is attained if less than 20–25% of parameters register as non-invariant. Tests of measurement invariance indicated very few non-invariant items (less than 7%) for the RPI. More details of this process and results can be found in the supplemental materials.

Full Sample Age Trends

Cognitive capacity followed a significant cubic age trend in the full sample (b_{Age} = 22.82, SE = 1.07, 95% CI [20.68, 24.90], p < .001; b_{Age}^2 = −1.95, SE = 0.14, 95% CI [−2.22, −1.66], p <.001; b_{Age}^3 = 0.05, SE = 0.01, 95% CI [0.04, 0.06], p <.001; R^2 = .92, p <.001). Improvements in cognitive capacity were most striking from childhood into adolescence,

with little change after age 16. Psychosocial maturity, in contrast, followed a significant linear trend (b_{Age} = 1.86, SE = 0.12, 95% CIs [1.62, 2.07], p <.001; R^2 = .09, p <.001). Figure 1 displays age patterns of both composites.

Age Trends in Cognitive Capacity by Country

Cognitive capacity followed a significant age pattern in all eleven countries (see Table 4 for regression results). Nine of these countries evinced a cubic pattern, and two (Sweden and Cyprus) followed a curvilinear pattern. Figure 2 depicts the estimated regression lines for all countries. Except in Jordan, cognitive capacity increased steeply from age 10 to around age 16, when it plateaued. In a subset of countries with cubic age patterns (China, Colombia, India, and Thailand), cognitive capacity increased during childhood and again, albeit modestly, at the end of the age range. Jordan followed a cubic trend, but the pattern departed notably from other countries and from theory-based predictions.

Age Trends in Psychosocial Maturity by Country

Psychosocial maturity evinced a significant age pattern in all countries except Jordan and Kenya (see Table 5). Notably, there was far more diversity in patterns of psychosocial maturity than in patterns of cognitive capacity (see Figure 3). Significant linear age patterns for psychosocial maturity were found in China, Cyprus, India, Italy, the Philippines, Sweden, and Thailand. The US evinced a curvilinear age pattern, increasing throughout the teen years before leveling-off in the 20s. Lastly, Colombia followed a cubic pattern where psychosocial maturity improved until the mid-20s, after which it declined.

Sensitivity analysis.—In the current study, the self-report measure of resistance to peer influence, which was the only non-behavioral measure used in the present analyses, evinced low reliability in some countries. To ensure that including this variable did not fundamentally change the observed age patterns, we computed the psychosocial maturity composite without the RPI scale, and reran all analyses. By and large, the results of these analyses mirrored the original findings. One exception was in Thailand, where the age pattern of psychosocial maturity without the RPI scale followed a cubic trend rather than the linear trend seen in the original analysis. However, visual inspection of the estimated marginal means of both versions of the psychosocial maturity composite indicates very similar age patterns; in both cases, psychosocial maturity increases with age, but also peaks around 16–17 years. Nevertheless, caution is needed when interpreting age patterns of psychosocial maturity in Thailand.

Post-hoc analyses of unusual age patterns.—In most of the countries, interpretation of the age patterns was straightforward. In Colombia and the U.S, however, both cognitive capacity and psychosocial maturity follow non-linear age patterns, making it more challenging to test the hypothesis that the former reaches adult levels earlier than the latter. Visual inspection of age patterns in these two countries suggests that cognitive capacity reaches adult levels prior to psychosocial maturity. To statistically determine which construct reaches a plateau first, we examined the instantaneous rate of change in each variable, which is equal to the slope of a tangent line drawn at a given point along the curve of a line. With this technique, we are able to determine the magnitude and significance of a tangent line

drawn at each discrete age. Accordingly, the age at which this tangent slope is no longer significantly different from zero indicates the beginning of a plateau in the estimated regression line. Consistent with visual inspection, cognitive capacity reaches a plateau prior to psychosocial maturity in both Colombia (where cognitive capacity peaks at 18 and psychosocial maturity at 24) and the U.S. (where cognitive capacity peaks at 19 and psychosocial maturity at 22).

In China and Colombia, cognitive capacity appears to increase near the end of the age range. To determine whether these increases are significant, we identified the age at which cognitive capacity reaches a peak according to the instantaneous rate of change in all eleven countries, and re-assessed age patterns from this peak through age 30. According to these analyses, there is no growth in cognitive capacity after the beginning of the plateau in any country except China, where cognitive capacity increases linearly from age 20 to age 30 (b = 5.16, SE = 1.37, p <.001), and in the Philippines, cognitive capacity increases during early and middle adolescence, but decreases between 19 and 30 (b = −3.19, SE = 1.04, p = .002). Results for all analyses of the instantaneous rate of change are listed in Table S12.

Lastly, it is important to caution the reader that the instantaneous rate of change approach, while useful to compare the *relative* age patterns between psychosocial maturity and cognitive capacity, does not tell us absolute age at which these constructs reaches adult levels because this test is highly sensitive to very small changes in slopes. Thus, we caution the reader not to over-interpret the implications of these analyses.

Discussion

The age of majority, when citizens become legal adults, is set at 18 in most countries, but this boundary is an imperfect divider separating mature from immature individuals. Rather, research suggests that some aspects of psychological development reaches adult levels prior to 18, whereas others reach adult levels later. Findings from the present study are consistent with previous reports that cognitive capacity (cold cognition), the ability of an individual to reason and consider alternative courses of action—undergirded by executive functions—reaches adult levels during the mid-teen years, whereas other elements of maturity, specifically those indexing aspects of psychosocial functioning (hot cognition), such as self-restraint, tend to reach adult levels into adulthood. That these constructs reach adult levels on different timetables suggests a “maturity gap” between these elements of psychological development. To our knowledge, this is the first study to measure both cognitive capacity and psychosocial maturity within a single sample with a sufficiently wide age range (10–30) across so many diverse countries.

The age patterns of cognitive capacity and psychosocial maturity evinced in the international sample in the aggregate strongly resemble those reported by Steinberg and colleagues (2009) in their exclusively U.S. study. Specifically, post-hoc analyses indicate that in nine of eleven countries, cognitive capacity does not change during adulthood. This age pattern is also consistent with previous studies of working memory, inhibition, and verbal fluency, where adult-like performance is generally reached around age 15 or 16 (e.g., Linares, Bajo, & Pelegrina, 2016; Huizinga et al., 2006). Further, consistent with Steinberg et al. (2009), who

reported that adults in their late 20s evince higher psychosocial maturity than young adults (ages 18–21), we note the same pattern in eight of the eleven countries studied (the exceptions are Colombia, Jordan, and Kenya). It is notable that the age pattern of psychosocial maturity using primarily behavioral assessments replicates the age pattern reported by Steinberg and colleagues (2009) using self-report measures. Our results are also consistent with Rossier and colleagues (2007), who reported that sensation seeking (an aspect of immaturity) decreased between 18 and 25 years in a sample drawn from China, Germany, Italy, Spain, Switzerland, and the U.S. However, these investigators found that impulsivity did not change during this same age period (Rossier et al., 2007). The age pattern of psychosocial maturity found in the current study is also consistent with studies (largely conducted in Western countries) documenting improvements during adulthood with respect to declines in sensation seeking (Quinn & Harden, 2013) and increases in impulse control (Shulman et al., 2014), future orientation (Steinberg et al., 2009c), and resistance to peer influence (Chein et al., 2011). Our results also align with neuroscientific evidence indicating that the brain continues to develop during the early 20s, especially with regard to connectivity among brain regions in ways that improve self-regulation (Casey, 2015). The relative immaturity in functional connectivity in late adolescence, compared to the mid-20s, is reflected in part in the findings on psychosocial maturity, of which self-restraint is a part.

Although many of our findings are consistent with our hypotheses—specifically, that cognitive capacity would reach adult levels prior to age 18, but psychosocial maturity not until the 20s—there were several unanticipated results. First, a few countries exhibited either no age differences in psychosocial maturity or a pattern inconsistent with developmental theories. Neither Jordan nor Kenya evinced significant age patterns. There is no obvious factor distinguishing countries that did and did not show the expected increase in psychosocial functioning into the adult years. The countries in which psychosocial maturity evinced age differences into adulthood are diverse (e.g., a mix of Western and Asian, and individualistic and collectivistic countries), as is the group in which this pattern was not seen. Thus, although cultural norms likely influence the development and expression of self-regulation (Chen & French, 2008; Matsumoto et al. 2008), in our sample they did not do so in an easily interpretable way. Furthermore, given the relative absence of prior studies using these measures in many non-Western countries, we do not know whether cross-cultural differences in participants' responses to elements of the test battery account for differences in their performance on various tasks.

Second, although we anticipated few changes in cognitive capacity during the adult years, we found continued improvement during the late 20s in China and a modest decline during the late 20s in the Philippines. Nevertheless, even in these countries the majority of growth in cognitive capacity occurred prior to adulthood, consistent with past research (Linares et al., 2016; Huizinga et al., 2006), followed by modest changes thereafter. There is no obvious reason why cognitive capacity increases in adulthood only in China and decreases in adulthood only in the Philippines. Further cross-cultural research on age differences in executive function would be useful in determining whether these patterns are robust or idiosyncratic to the present study. In the absence of more research, we caution against generating post-hoc explanations for these patterns.

Third, contrary to our hypothesis, we did not find more consistency in age patterns of cognitive capacity compared to psychosocial maturity across countries. Eight countries followed qualitatively similar patterns of cognitive capacity (i.e., increasing from childhood to adolescence, then plateauing), while seven countries followed qualitatively similar patterns of psychosocial maturity (i.e., increasing linearly with age). Thus, it does not appear that age patterns are more similar in one domain than the other, at least with respect to the measures employed in this study.

Limitations and Future Directions

The current study has a few limitations, some of which limit its utility as a guide for the law. First, our measures do not assess real-world behaviors or explicitly test decision-making capacities (e.g., by using decision-making vignettes), and therefore do not assess actual decision-making competence. However, Steinberg and colleagues (2009) found that cognitive capacity (as assessed in this study) and performance on a standardized assessment of competence to stand trial develop nearly in lockstep. Thus, our assessment of cognitive capacity may speak to decision-making competency, albeit indirectly. Second, not all countries evinced the expected age pattern of psychosocial maturity, and other relevant aspects of psychosocial maturity not captured by our measure likely do develop with age in these societies. Third, the reliability of self-reported resistance to peer influence was low in some countries. Although sensitivity analyses indicate the results with respect to age patterns in psychosocial maturity are largely unchanged when this measure is excluded, caution is needed when interpreting our analyses, especially in Thailand. More generally, the reliability and validity of some of our measures in non-Western societies are not known. For example, although some of our measures have been used cross-culturally (e.g., executive functioning measures in Kenya; Alcock et al., 2008), others have not (e.g., the Stoplight task). Lastly, despite our wide age range, this study relies on cross-sectional data, which limits our ability to draw conclusions about developmental changes. That is, we are able to study age differences, but cannot directly study development and maturity.

With these caveats in mind, we can draw several conclusions from our findings. In agreement with Steinberg and colleagues (2009), the clear answer to the question, “When do individuals become mature?”, is that it depends on the component of maturity in question. Our findings provide evidence that basic cognitive processes undergirding higher-order, goal-directed behavior (cold cognition) reach adult levels relatively early—around age 16. To the extent that a situation lends itself to deliberation, 16 might be a reasonable age of majority. Voting (Steinberg, 2014), making decisions in medical contexts (Weithorn & Campbell, 1982), consenting to participate in research (Hein et al., 2015), and participating in legal proceedings (Grisso et al. 2003) constitute situations in which adolescents may be competent. Although all 16-year-olds would not necessarily make “good” decisions in the voting booth or doctor’s office, their decisions in these contexts, on average, would be as logical as adults’ decisions.

Decision making in these contexts is not purely cognitive, of course. Being a defendant in a legal proceeding or deciding whether to undergo a medical procedure may instill concern or fear. However, given that knowledgeable adults (e.g., doctors and lawyers) typically

surround adolescents in these situations, there is opportunity to diminish the emotional intensity of the decision in favor of reflection. For example, pressure to decide quickly intensifies the affective arousal of a situation (Hein et al., 2015), so one easy point of intervention is to ask clinicians and legal professionals to mitigate arousal and facilitate reflection by giving their patients and clients time to consider their options (and be available to discuss them). Such efforts may be especially important during plea negotiations. Ideally, individuals considering a plea bargain have time to contemplate their choices, consult with their attorney about the offer, and deliberate on what is in their best interest. In reality, the context may be considerably less favorable. For instance, the plea bargain may be a one-time offer, and a decision whether to accept may need to be immediate (or nearly so) (Malloy et al., 2014; Zottoli, Daftary-Kapur, Winters, & Hogan, 2016). Furthermore, a minor may experience external pressure from his own attorney, parents, or friends to take the deal (Daftary-Kapur & Zottoli, 2014). Thus, depending on the unique situation of the adolescent, the plea bargain context straddles the line between a hot and cold context, which complicates discussions around appropriate age boundaries.

That the age at which psychosocial reaches adult levels is beyond age 18 (and to a striking degree in some countries) suggests that adolescents *and* young adults are still developing in ways that should influence their culpability in criminal proceedings and, perhaps, some of the privileges we extend to them. Young adults—like adolescents—are more likely than somewhat older adults to be impulsive, sensation seeking, and sensitive to peer influence in ways that influence their criminal conduct (Scott et al., 2016). This does not mean that no one under 18 is mature enough to drink responsibly or premeditate a serious crime; nor is it to say that all adults are capable of mature self-restraint. It is to posit that *on average*, teens—and young adults—are relatively less likely to have the self-restraint necessary to deserve the privileges and penalties we reserve for people we judge to be fully responsible for their behavior.

The idea that young adults may be worthy of special consideration in criminal cases has circulated for years (e.g., Council of Europe, 2003; Woolard & Scott, 2009), but there is a dearth of research exploring differences between young adults and older adults (e.g., studies often combine all adults 18 and older into a single group). However, recent commentaries have sparked discussions about the differential treatment of young adults in the legal system in the U.S. (Schiraldi et al., 2015). Other countries have implemented policies that extend to young adults some aspects of leniency and protection given to minors (e.g., the Netherlands, Germany, and Sweden), informed partly by evidence of continued brain maturation beyond 18, and because the acquisition of adult roles has been increasingly delayed in many parts of the world (Dünkel, 2014; Scott et al., 2016) leading to a developmental period some writers call “emerging adulthood” (Arnett, 2000).

Conclusions

The present study reaffirms the complexity of defining “maturity” or “adulthood” based on psychological grounds alone. Developmental science ought to inform, but not dictate, where the law sets age boundaries. Having different ages of majority, depending on the legal issue in question, is truer to the science than having a single age for all legal matters. Therefore,

we advocate two different boundaries: one that applies to situations in which time pressure, emotional arousal, and coercive influence are not likely to inhibit decision-making capacities —which might be designated at age 16—and a second that applies to situations in which psychosocial immaturity may compromise judgment—which might be designated at 18 or older.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Public Significance Statement

Cognitive capacity—the basic cognitive functions that serve as the foundation for higher-level, complex thinking processes—reaches adult levels during adolescence (around 16). In contrast, psychosocial maturity—one's ability to exercise self-restraint in emotional situations—reaches adult levels during the 20s. Importantly, in a study of over 5,200 participants, these distinct age patterns emerge across eleven diverse countries around the world. Thus, having two legal age boundaries that distinguish adolescence and adulthood —one for decisions typically made with deliberation and another for decisions typically made in emotionally-charged situations—may be more sensible than having just one.

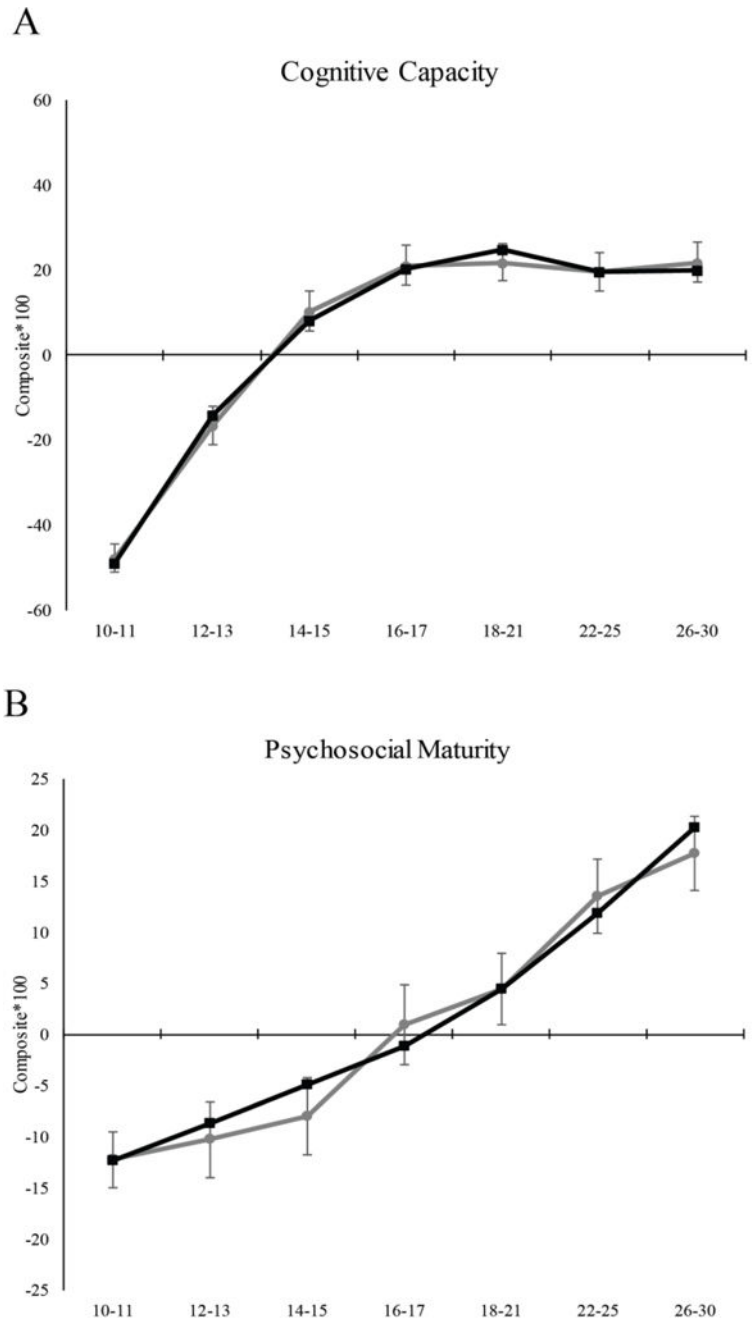

Figure 1.

Age patterns in cognitive capacity (top) and psychosocial maturity (bottom) in the aggregated sample. Values of these composites were multiplied by 100. Grey lines denote estimated marginal means for each age group (error bars indicate 95% confidence intervals). Black lines denote estimated regression value.

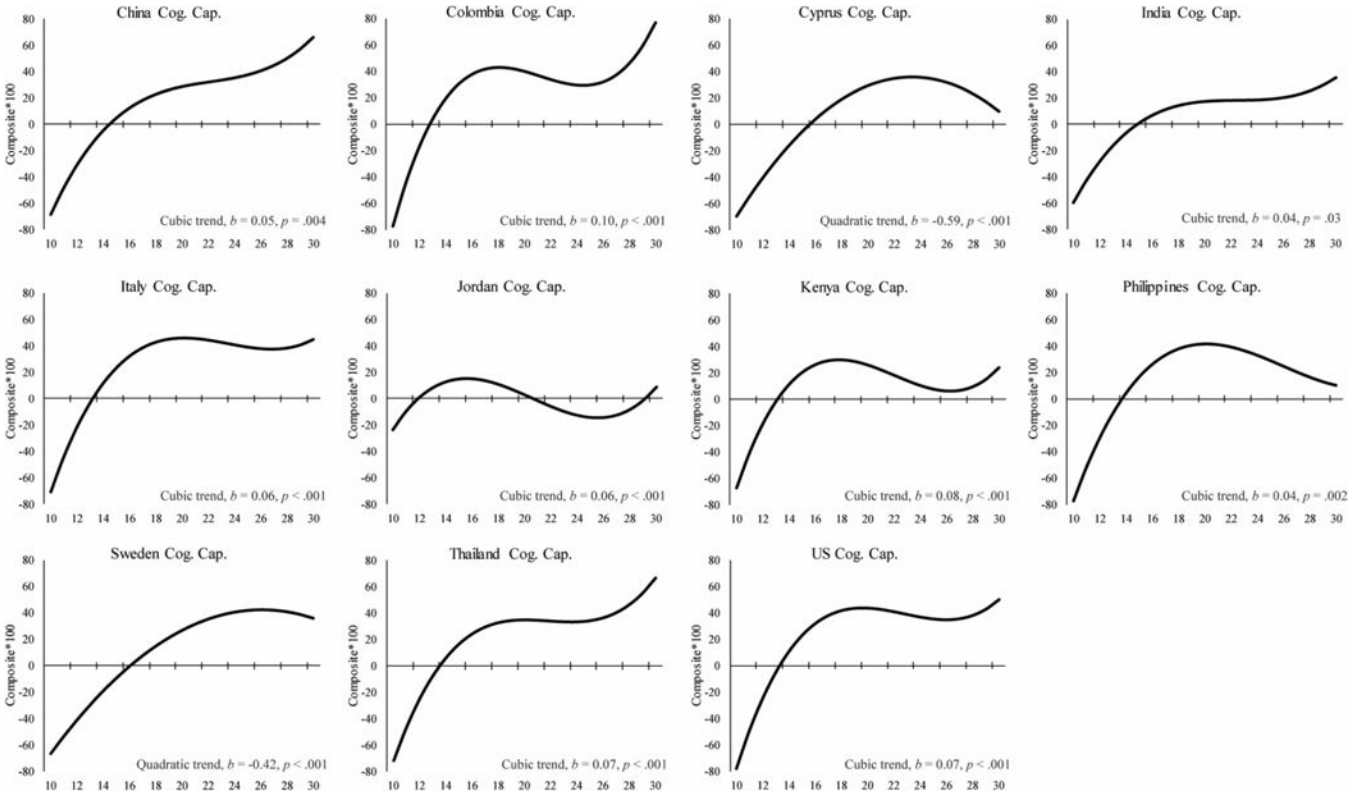

Figure 2.

Age patterns in cognitive capacity for each country. Values of the composite were multiplied by 100. Coefficients indicate the highest-order significant age term.

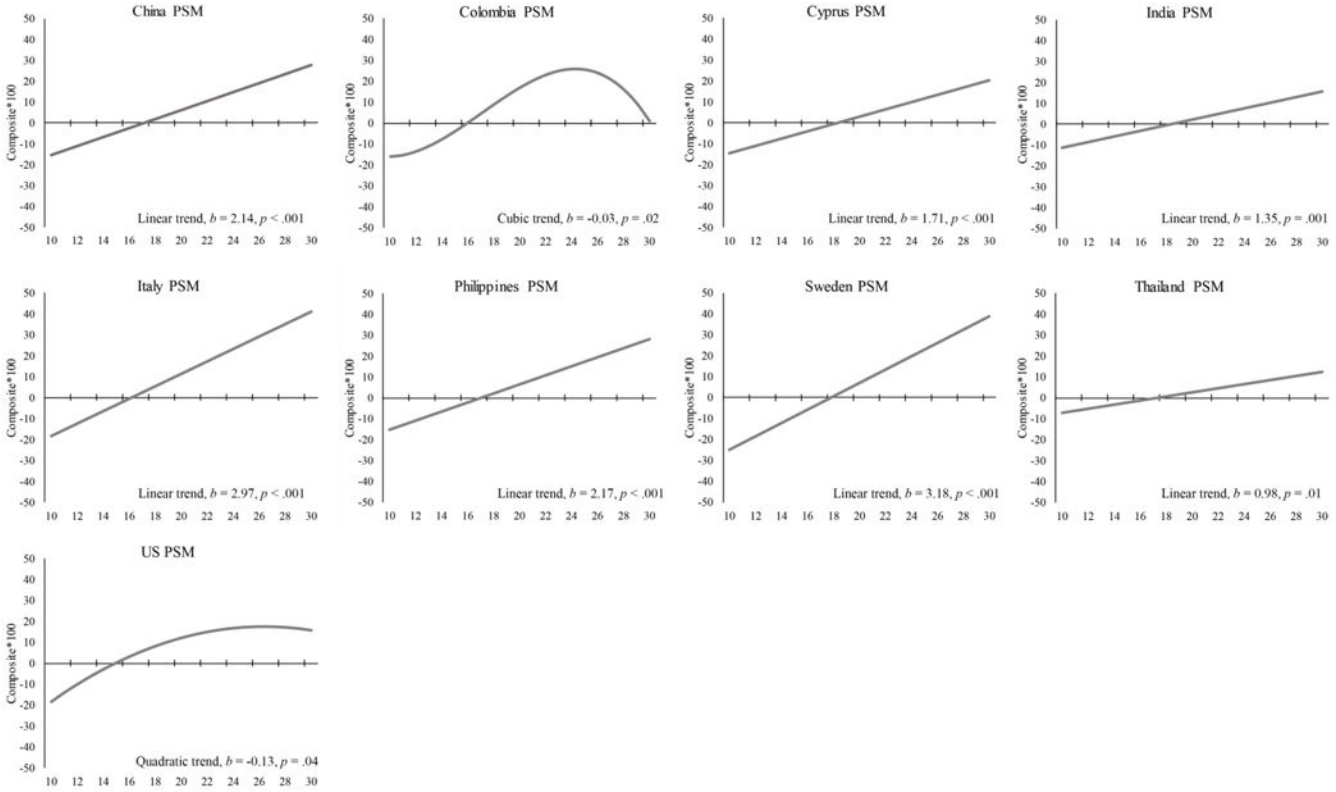

Figure 3.

Age patterns in psychosocial maturity for each country. Values of the composite were multiplied by 100. Coefficients indicate the highest-order significant age term. Only significant age patterns are shown.

Table 1

Country-level Attributes

Country	Individualism/ Collectivism	Indulgence/ Restraint	GDP per capita (PPP) 2014 (USD)
China	20	24	13,200
Columbia	13	83	13,500
Cyprus	-	70	30,900
India	48	26	5,800
Italy	76	30	35,100
Jordan	30	43	12,000
Kenya	25	-	3,100
Philippines	32	42	7,000
Sweden	71	78	46,200
Thailand	20	45	15,600
U.S.	91	68	54,400

Note. The Individualism/Collectivism scale and the Indulgence/Restraint scale range from 0–100 (Hofstede, 2011). GDP per capita is given in U.S. dollars (Central Intelligence Agency, 2018).

Table 2

Zero-order Correlations Among Variables

	Par. Ed.	WASI	RPI	Stoplight	DD	IGT	ToL	WM	VF	DSB
Age	−.07***	.15***	.15***	−.03*	.06***	−.16***	.18***	.29***	.26***	.20***
Par. Ed.	-	.20***	.05**	.004	.09***	−.08***	.04**	.10***	−.03*	.09***
WASI		-	.10***	.06***	.13***	−.15***	.21***	.36***	.30***	.36***
RPI			-	−.05***	.07***	−.07***	.06***	.15***	.04*	.06***
Stoplight				-	−.03	.04**	.02	.09***	.09***	.07***
DD					-	−.12***	.09***	−.01	.09***	.05**
IGT						-	−.14***	−.13***	−.10***	−.10***
ToL							-	.16***	.08***	.23***
WM								-	.26***	.37***
VF									-	.27***

Note. Par. Ed. = Parental education; WASI = WASI *t*-score; RPI = Resistance to peer influence; DD = Delay discounting, average indifference point for longest delays; IGT = Iowa Gambling Task, corresponding to the proportion decrease in plays on disadvantageous decks; ToL = Tower of London, latency to first move; WM = Working memory; VF = Verbal fluency; DSB = Digit Span backward.

* $p < .05$

** $p < .01$

*** $p < .001$.

Table 3

Descriptive Statistics by Age Group: Mean (SD)

	10–11	12–13	14–15	16–17	18–21	22–25	26–30
Par. Ed.	11.83 (3.00)	12.07 (2.91)	12.12 (2.78)	11.86 (2.88)	12.01 (2.79)	11.78 (3.03)	11.24 (3.24)
WASI	48.33 (11.00)	46.01 (11.07)	46.18 (10.87)	46.97 (10.54)	49.81 (10.41)	51.36 (10.19)	51.42 (11.62)
RPI	.57 (.25)	.60 (.25)	.60 (.25)	.62 (.25)	.62 (.24)	.67 (.23)	.67 (.25)
Stoplight	.42 (.22)	.42 (.21)	.44 (.23)	.42 (.21)	.43 (.23)	.42 (.23)	.39 (.23)
DD	400.85 (301.17)	375.29 (303.76)	384.49 (269.58)	400.23 (295.09)	415.20 (291.62)	443.08 (303.11)	437.20 (311.98)
IGT	−.02 (.24)	−.03 (.24)	−.06 (.25)	−.07 (.27)	−.10 (.28)	−.12 (.29)	−.13 (.32)
ToL	4475.99 (3382.75)	4467.41 (3661.45)	5363.33 (5660.86)	5848.01 (6092.83)	6481.17 (5978.23)	6926.48 (6618.99)	7055.67 (6932.37)
WM	6.11 (1.37)	6.58 (1.26)	6.97 (1.08)	7.15 (1.00)	7.26 (0.95)	7.21 (1.08)	7.17 (1.11)
VF	10.5 (4.44)	11.03 (5.15)	12.72 (5.71)	13.65 (6.52)	13.94 (5.84)	14.46 (6.49)	14.90 (6.48)
DSB	4.02 (1.19)	4.26 (1.20)	4.52 (1.47)	4.61 (1.43)	4.82 (1.49)	4.81 (1.52)	4.79 (1.39)
N	1191	702	667	623	715	670	659
% Female	51.8	48.4	50.7	50.9	49.9	51.3	51.4

Note. Par. Ed. = Parental education. WASI = WASI *t*-score. DD = Delay discounting, average indifference point for longest delays. RPI = Resistance to peer influence (on a 0–1 scale). IGT = Iowa Gambling Task, corresponding to the proportion decrease in plays on disadvantageous decks. ToL = Tower of London, latency to first move (in ms). WM = Working memory, average accuracy (out of 8). VF = Verbal fluency, number of words produced in one minute. DSB = Digit Span backward, longest string of digits correctly recalled in reverse order (with a maximum value of 8).

Table 4

Regression Results for Cognitive Capacity

			95% Confidence Interval				
		***b* (SE)**	**LB**	**UB**	***p*-value**	***R*² *Adjusted***	***p*-value**
China	Age	22.02 (3.48)	15.20	28.84	<.001	.88	<.001
n = 489	Age²	−1.70 (0.45)	−2.59	−0.81	<.001		
	Age³	0.05 (0.02)	0.02	0.08	.003		
Colombia	Age	37.00 (2.76)	31.59	42.41	<.001	.97	<.001
n = 498	Age²	−3.58 (0.40)	−4.36	−2.81	<.001		
	Age³	0.11 (0.02)	0.08	0.13	<.001		
Cyprus	Age	15.11 (1.97)	11.25	18.98	<.001	.80	<.001
n = 364	Age²	−0.56 (0.10)	−0.76	−0.36	<.001		
	Age³	-	-	-	-		
India	Age	19.19 (4.18)	11.00	27.39	<.001	.86	<.001
n = 417	Age²	−1.54 (0.52)	−2.57	−0.53	.003		
	Age³	0.04 (0.02)	0.01	0.08	.02		
Italy	Age	28.76 (3.08)	22.73	34.80	<.001	.95	<.001
n = 547	Age²	−2.27 (0.42)	−3.10	−1.44	<.001		
	Age³	0.06 (0.02)	0.03	0.09	<.001		
Jordan	Age	14.90 (3.65)	7.74	22.06	<.001	.84	<.001
n = 450	Age²	−1.82 (0.47)	−2.75	−0.91	<.001		
	Age³	0.06 (0.02)	0.03	0.09	<.001		
Kenya	Age	27.13 (3.62)	20.03	34.23	<.001	.94	<.001
n = 483	Age²	−2.48 (0.46)	−3.40	−1.57	<.001		
	Age³	0.07 (0.02)	0.04	0.10	<.001		
Philippines	Age	27.80 (2.89)	22.15	33.45	<.001	.95	<.001
n = 505	Age²	−2.01 (0.39)	−2.77	−1.25	<.001		
	Age³	0.04 (0.01)	0.02	0.07	.002		
Sweden	Age	13.61 (1.72)	10.25	16.99	<.001	.75	<.001
n = 416	Age²	−0.42 (0.09)	−0.61	−0.25	<.001		
	Age³	-	-	-	-		
Thailand	Age	28.29 (3.72)	21.00	35.58	<.001	.93	<.001
n = 502	Age²	−2.46 (0.51)	−3.45	−1.47	<.001		
	Age³	0.07 (0.02)	0.03	0.11	<.001		
U.S.	Age	30.94 (3.18)	24.70	37.17	<.001	.95	<.001

			95% Confidence Interval				
		***b* (SE)**	**LB**	**UB**	***p*-value**	***R*^{2} *Adjusted***	***p*-value**
n = 556	Age^2	−2.47 (0.42)	−3.29	−1.64	<.001		
	Age^3	0.06 (0.01)	0.03	0.09	<.001		

Note. Composite values were multiplied by 100. Analyses control for parental education and intellectual functioning (each centered at their mean). Age was centered at 10. Reported coefficients were derived from a single model with the highest-order significant age term.

Table 5

Regression Results for Psychosocial Maturity

			95% Confidence Interval				
		***b* (SE)**	**LB**	**UB**	***p*-value**	***R^2 Adjusted***	***p*-value**
China	Age	2.1 (0.40)	1.34	2.89	<.001	.09	<.001
n = 489	Age^2	-	-	-	-		
	Age^3	-	-	-	-		
Colombia	Age	−0.17 (2.23)	−4.56	4.22	.94	.17	.26
n = 498	Age^2	0.64 (0.32)	0.02	1.28	.04		
	Age^3	−0.03 (0.01)	−0.05	−0.01	.01		
Cyprus	Age	1.64 (0.46)	0.74	2.54	<.001	.11	<.001
n = 364	Age^2	-			-		
	Age^3	-			-		
India	Age	1.29 (0.42)	0.47	2.11	.002	.02	.06
n = 417	Age^2	-	-	-	-		
	Age^3	-	-	-	-		
Italy	Age	2.92 (0.36)	2.21	3.63	<.001	.15	<.001
n = 547	Age^2	-	-	-	-		
	Age^3	-	-	-	-		
Jordan	Age	0.03 (0.44)	−0.82	0.89	.94	.01	.13
n = 450	Age^2	-	-	-	-		
	Age^3	-	-	-	-		
Kenya	Age	0.27 (0.36)	−0.44	0.97	.46	.004	.24
n = 483	Age^2	-	-	-	-		
	Age^3	-	-	-	-		
Philippines	Age	2.17 (0.38)	1.44	2.91	<.001	.12	<.001
n = 505	Age^2	-	-	-	-		
	Age^3	-	-	-	-		
Sweden	Age	3.18 (0.41)	2.38	3.99	<.001	.22	<.001
n = 416	Age^2	-	-	-	-		
	Age^3	-	-	-	-		
Thailand	Age	0.93 (0.37)	0.21	1.66	.01	.02	.05
n = 502	Age^2	-	-	-	-		
	Age^3	-	-	-	-		
U.S.	Age	4.43 (1.21)	2.06	6.80	<.001	.38	.001

			95% Confidence Interval				
		***b* (SE)**	**LB**	**UB**	***p*-value**	***R^2 Adjusted***	***p*-value**
$n = 556$	Age^2	−0.13 (0.07)	−0.26	−0.003	.04		
	Age^3	-	-	-	-		

Note. Composite values were multiplied by 100. Analyses control for parental education and intellectual functioning (each centered at their mean). Age was centered at 10. Reported coefficients were derived from a single model with the highest-order significant age term.