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Kids These Days! Increasing delay of gratification ability over the past 50 years in children

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ABSTRACT

Have children's ability to delay gratification decreased since the past? We analyze the past 50 years of data on the Marshmallow test of delay of gratification; where children must wait to get two preferred treats of their choosing; if they cannot wait, they only get one. Here we provide comprehensive evidence on whether children's ability to delay gratification has truly been decreasing, as theories of technology or a culture of instant gratification have predicted. Before analyzing the data, we polled 260 experts in cognitive development, 84% of who believed children are getting worse or are no different than those of the past. Contrary to this prediction, we show delay of gratification times are increasing over the past 50 years, corresponding to a fifth of a standard deviation increase in ability per decade. This mirrors the magnitude of secular gains in IQ seen over decades.

1. Introduction

A common belief is the children of the present are in decline (Smart, 1767; Freeman, 1907; Kitt, 2013; Protzko & Schooler, 2019; see also Steenvoorden & Van der Meer, 2017 for general societal pessimism); indeed since at least 624bce it has been received as common wisdom that present children are just not as capable as contemporary adults were when they were children (regardless of the veracity of such claims; e.g. Turchin, 2010). In the modern world, one domain that seems especially vulnerable to deficiencies is children's ability to delay gratification or exert self-control (e.g. Bodrova, Germeroth, & Leong, 2013; Kelley, Wagner, & Heatherton, 2015; Louv & Charles, 2011).

A child's ability to delay gratification, to forego an immediate reward for a better future one, is associated with numerous of positive life outcomes. Children who can delay gratification tend to go to school for longer (Ayduk et al., 2000), have healthier bodyweights (Schlam, Wilson, Shoda, Mischel, & Ayduk, 2013), have higher academic achievement and a lower likelihood of engaging in teenage substance use (Wulfert, Block, Santa Ana, Rodriguez, & Colsman, 2002; but also see Watts, Duncan, & Quan, 2018; but then see Michaelson & Munakata, 2020). Any changes in children's abilities should surely merit considerable attention.

Some cognitive domains have indeed shown evidence of declining over time. Abilities such as simple visual and auditory reaction times, color acuity, patterns of vocabulary usage, 3D visuospatial ability, working memory, and per capita rates of macroinnovation and creative genius (Woodley of Menie et al., 2017; see also Dutton & Woodley of Menie, 2018). In Iceland, for example, polygenic scores for educational attainment have been declining over eight decades (Kong et al., 2017). Related abilities such as visual working memory have also shown declines over time (Wongupparaj, Wongupparaj, Kumari, & Morris, 2017). Thus, we may expect to see secular declines in the ability to delay gratification.

Numerous cognitive domains, however, have been *increasing* over time. People's IQ, for example, has been experiencing an increase over generations all over the world (Flynn, 1984). The increase generally runs between 2.3 and 3 points of overall intelligence per decade, corresponding to around 1/5 of a standard deviation (Trahan, Stuebing, Fletcher, & Hiscock, 2014; see also Pietschnig & Voracek, 2015). Across three separate teams, children's ability to delay gratification has also shown an increase of nearly the exact same amount over the past 50 years using the same measure in 840 preschoolers (the 'marshmallow test'; Carlson et al., 2018). Therefore, it is entirely possible that overall there has been an overall increase in children's ability to delay gratification instead of a decrease. The present study provides a larger range of ages across several countries using meta-regression with numerous studies and sample sizes to further investigate the change in children's ability to delay gratification on the 'marshmallow test'.

The paradigmatic measure of delay of gratification in children is the "marshmallow test" (Mischel & Ebbesen, 1970). In this, children are acquainted with an experimenter, and then seated at a table. They are asked their preferred treat among an array of possibilities. This is important as studies usually use children's preferred treat among an array and not just marshmallows. After the child selects their preferred treat,

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they are then told the experimenter has to leave the room. If they wait until the experimenter gets back, they get two treats. Both treats are in front of the child during this time. How long the child can wait before signaling to the experimenter that they submit (usually ringing a bell) or until they eat the treat is the indicator of how well the child can delay gratification.

The question becomes, what should we expect in terms of children's ability to delay gratification when looked at using the same test (the 'Marshmallow test) over the past 50 years? Three possibilities are: 1) There may be numerous influences on children's delay of gratification ability, for the worse. Multiple aspects of modern life have been negatively associated with self-regulatory behaviors (reviewed below); as such, we may expect decreases in children's ability to delay gratification. 2) Similar to the secular increases in IQ, children's ability to delay gratification may be on the rise. 3) The ability to delay gratification represents a stable developmental trait that is relatively impervious to environmental moderation; thus children may show no change in their ability to delay gratification over the past 50 years.

1.1. Predicting decreases

The largest reason to believe in decreases in children's ability to delay gratification are the widespread use and availability of technology. The mass proliferation of at-home tablets, phones, and computers being used by infants and children continues to grow (Vandewater et al., 2007). Media use by young children has been associated with lowered executive functioning (Barr, Lauricella, Zack, & Calvert, 2010; Lillard & Peterson, 2011), increased obesity (Krebs et al., 2007), showing developmental impairments in social-emotional skills such as theory of mind (Nathanson, Sharp, Aladé, Rasmussen, & Christy, 2013), attentional problems (Baumgartner, Weeda, van der Heijden, & Huizinga, 2014; Ralph, Thomson, Cheyne, & Smilek, 2014). Children being increasingly exposed to more and more screentime, even owning their own personal electronics before the age of four (Kabali et al., 2015), could lead to changes in children's ability to delay gratification. Furthermore, the lack of children engaging in activities purportedly shown to facilitate executive control (Berman, Jonides, & Kaplan, 2008; Louv & Charles, 2011) may be contributing to secular declines.

1.2. Predicting increases

One could expect children to be better than in the past at delaying gratification. There is a voluminous and widely cited literature on secular increases in IQ (see Flynn, 1984, 1987; Pietschnig & Voracek, 2015). The large focus of this literature has been on not only understanding when, where, and under what conditions there has been increases in IQ, but the mechanisms of such increases (which we describe later). This is germane to the question of delay of gratification as increases in (certain aspects) of IQ may reflect increases in certain environmental factors which might have joint effects on diverse specialized aspects of cognitive functioning, even if their effect is not at the level of the positive manifold of general intelligence (te Nijenhuis & van der Flier, 2013; Wicherts et al., 2004).

1.3. Predicting no change

A third possibility is there has been no significant change in children's ability to delay gratification since the 1960s. Two predominant reasons would underpin this pattern of results: No effects on the stable trait, or conflicting forces pushing the ability both up and down. Delay of gratification is an ability within the family of self-regulation and executive functioning; both showing high developmental stability and heritabilities (e.g. Engelhardt, Briley, Mann, Harden, & Tucker-Drob, 2015; Friedman et al., 2008; Isen, Sparks, & Iacono, 2014; Kindlon, Mezzacappa, & Earls, 1995; Niv, Tuvblad, Raine, Wang, & Baker, 2012; Orsini, 1994; Shoda, Mischel, & Peake, 1990).[1] Furthermore, secular increases for tasks such as working memory may not have changed appreciably in 85 years, suggesting some abilities are not changing (Wicherts et al., 2004; Gignac, 2015; but see Woodley of Menie & Fernandes, 2015). Another reason there may be no change is both forces moving abilities upwards and forces moving abilities downwards may be operating simultaneously. Thus, the cancelling out of secular increases plus pernicious environmental abilities or dysgenic effects may lead to the appearance of no change and stability. A lack of changes can also be because environmental forces are just not strong enough to have altered delay of gratification ability in the short (evolutionarily speaking) timespan of a few decades. The multiple traits and processes that may underlie ability to delay gratification may simply not be altered by cultural changes.

Overall, as it was unclear when pursuing this project how the data would look, we make no pre-commitments to explaining changes, if any occur, in children's ability to delay gratification. All three possibilities appeared equally likely. Thus, to answer the question of have children's ability to delay gratification changed over the past 50 years, we took a neutral approach to predicting the pattern of data. Until now, there has been no meta-analytic review of secular changes in young children's' ability to delay gratification. To remedy this, we collected all of the data we could from both published and unpublished studies over the past 50 years.

2. Materials and methods

2.1. Delay of gratification meta-analysis

2.1.1. Inclusion criteria

The standard version of the delay of gratification task we chose was what we believed would be most familiar to people: children in a room alone with both rewards present. The first study to administer this procedure was used as our earliest study (Mischel & Ebbesen, 1970). We then conducted a forward search of every study citing the first delay of gratification paradigm which also included the words "participants" and "marshmallow". This left us with 165 studies which were scanned first to determine if they were empirical articles meeting our inclusion criteria. Our inclusion criteria was the following: All children used were under the age of ten; this was because as delay times increase with age (e.g. Hongwanishkul, Happaney, Lee, & Zelazo, 2005; Melikian, 1959; Mischel & Metzner, 1962; Toner & Smith, 1977; Yates, Lippett, & Yates, 1981) the task at older ages becomes nearly impractical to use in the general population (as delay times can be 30 min or higher). Furthermore, as a single treat may not represent the same level of temptation to 'tweens', the test may not be measuring the same underlying phenomena at older ages. All studies administered the marshmallow test with both rewards present and minimal to no changes in administration (following the original administration of the task). The average amount of time waited in the study was our metric, so wait times had to either be reported, calculated from the materials presented, or the authors when contacted would be able to provide the wait times.

In addition, on September 26, 2016 we posted an email to the email listserv of the Cognitive Development Society asking for unpublished data using our inclusion criteria. This resulted in a total of three additional studies that met our inclusion criteria, totaling thirty studies spanning 50 years of administration of the 'marshmallow task' (see Fig. 1 for flow of study inclusion and exclusion).

[1] We find it important to point out that the authors do not share the assumptions that high developmental stability and heritability *necessarily* mean low ability for environmental modulation. The argument is simply presented here as a reason others may have for predicting no changes in children's ability to delay gratification.

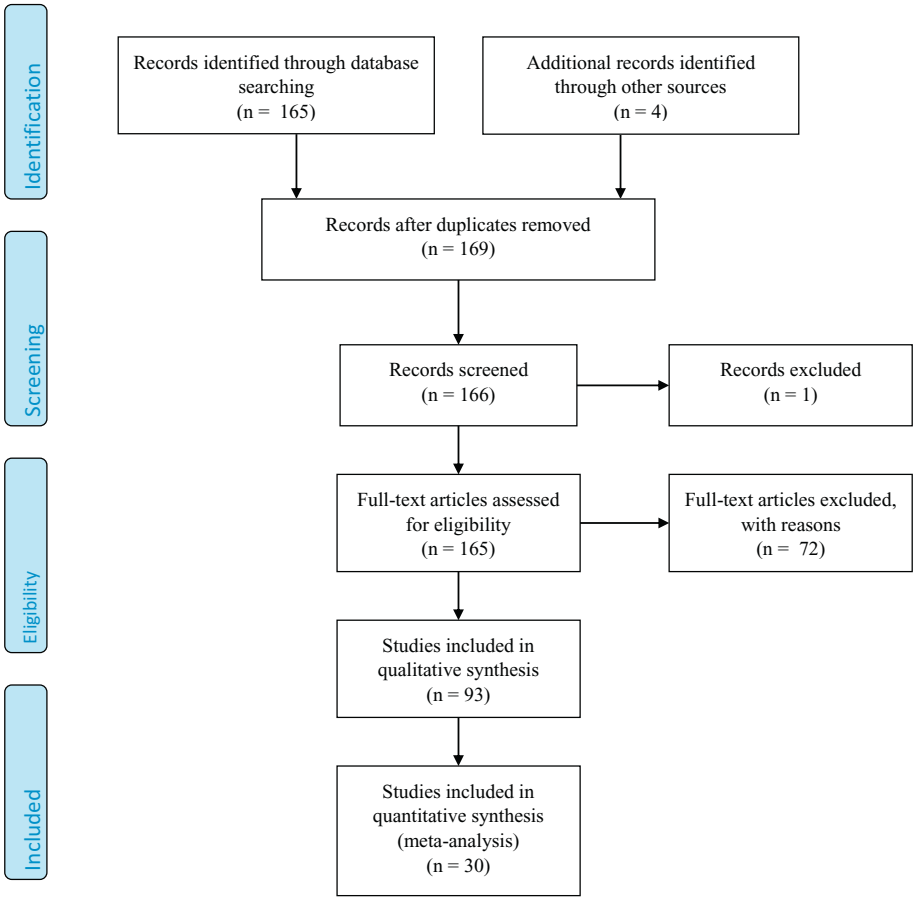

Fig. 1. Flow Diagram of study inclusion and exclusion in the following meta-analysis.

2.1.2. Reasons for exclusion

Studies coding the marshmallow test in ways other than time to delay were excluded: e.g. waited full time yes/no (Callaway, Lutes, & Schlatter, 2007; Carlson, 2005; Da Silva, Moreira, & Da Costa Jr, 2014; Paulsen & Johnson, 1980; Van Reet, 2014); Likert-scale-type coding (Kreitler & Zigler, 1990; Merz et al., 2016; Putnam, Spritz, & Stifter, 2002; Weber, 2015); self-estimates of elapsed time (Miller & Karniol, 1976); number ratings (e.g. 0–10 scale) instead of wait time (Atance & Jackson, 2009).

Studies testing whether children wanted one reward now or two later (choice delay) were also excluded (e.g. Bandura & Mischel, 1965; Herzberger & Dweck, 1978; Hongwanishkul et al., 2005; Imuta, Hayne, & Scarf, 2014; Labuschagne, Cox, Brown, & Scarf, 2017; Mischel, 1958; Mischel, 1961; Mischel & Grusec, 1967; Mischel & Metzner, 1962; Nisan, 1976; Prencipe & Zelazo, 2005; Schwarz, Schrager, & Lyons, 1983; Seeman & Schwarz, 1974; Staub, 1972; Thompson, Barresi, & Moore, 1997; Tynan, 2014; Yu, Kam, & Lee, 2016).

Children who were over the age of ten were not considered for this meta-analysis (e.g. Avci, 2013; Ayduk et al., 2000; Bruce et al., 2011; Corvi, 2010; Corvi, Juergensen, Weaver, & Demaree, 2012; Duckworth, Tsukayama, & Kirby, 2013; Funder & Block, 1989; Herndon, 2011; Kirby & Maraković, 1996; Meade, 2012; Rachlin, Raineri, & Cross, 1991; Rodriguez, Mischel, & Shoda, 1989; Trommsdorff & Schmidt-Rinke, 1980; Waclawik, 2014; Watson & Milfont, 2016; Wulfert et al., 2002; Zytkoskee, Strickland, & Watson, 1971).

Studies using the similar gift delay task were also excluded. In the gift delay, a gift is loudly wrapped and children are told not to touch the gift until they get back. As the gift delay task has only one reward present (the gift), we a priori chose not to include it in this investigation. Studies that were eliminated due to this inclusion include (but not limited to: Crivello et al., 2016; Cuskelly, Jobling, Gilmore, & Glenn, 2006; Joyce et al., 2016; Mulder, Hoofs, Verhagen, van der Veen, & Leseman, 2014; Olson, Schilling, & Bates, 1999; Vaughn, Kopp, & Krakow, 1984; Vaughn, Kopp, Krakow, Johnson, & Schwartz, 1986).

An alternate version of the delay of gratification task involves the alternate reward not being two of the preferred treat, but instead an increasing accumulation of treats, one at a time, periodically until the child breaks (e.g. 2 treats at 1 min, 3 at 2 min, 4 and 3 min…). Again, to allow for accurate estimation across ages, we exclude these studies as times are consistently lower than the marshmallow task. Studies excluded for this reasons included: (Hrabic, 2015; Lomranz, Shmotkin, & Katznelson, 1983; Ritchie & Toner, 1984; Toner, 1981; Toner, Holstein, & Hetherington, 1977; Toner, Lewis, & Gribble, 1979; Toner, Moore, & Emmons, 1980; Toner & Smith, 1977).

Studies that altered the marshmallow task substantially in an experimental or other context and no standard-instructions control group available were also excluded (e.g. Corfield, Al-Issa, & Johnson, 1976; Kanfer, Stifter, & Morris, 1981; Kidd, Palmeri, & Aslin, 2013; Kochanska, Murray, & Harlan, 2000; Leonard, Berkowitz, & Shusterman, 2014; Maccoby, Dowley, Hagen, & Degerman, 1965; Michaelson & Munakata, 2016; Mischel & Moore, 1980; Mischel & Underwood, 1974; Yates et al., 1981). One study was excluded for dropping all children who waited the full time (Joseph, 2015). One study was excluded for running the marshmallow test in an fmri scanner (Luersson et al., 2015).

2.1.3. Coding of studies

Each study was then coded for delay time in minutes, sample size, average age, socioeconomic status (SES; if available), and year of data collection. For year of data collection we used the following rule: If the

Table 1
All studies used in the final analysis of testing changes in delay of gratification ability. [U] = Unpublished data.

Study	Year	Delay time (min)	N	SE	Age	SES	Notes
Mischel & Ebbesen, 1970	1968	1.03	7	0.903	4.5	High SES	Study 1
	1968	3.09	12	1.614	4.5	High SES	Study 2
Mischel et al., 1972	1970	0.483	10	1.337	4.5	High SES	Group 1
Mischel & Moore, 1973	1971	7.07	7	2.38	4.417	High SES	Control group
Schack & Massari, 1972	1971	7.533	10	1.835	6.517	"Lower class urban neighborhood"	Control group
Mischel & Baker, 1975	1973	8.44	12	2.103	4.5	High SES	Control group
Sethi, Mischel, Aber, Shoda, & Rodriguez, 2000	1992	8.017	97	0.608	4.833	Middle to upper-middle class	
Jacobsen, Huss, Fendrich, Kruesi, & Ziegenhain, 1997	1992	9.3	32	1.075	6	Represented the full range of social and educational backgrounds in Berlin	
NICHD (e.g. Connell & Francis, 2014)	1996	4.48	805	0.106	4.5		
Peake, Hebl, & Mischel, 2002	2000	5.333	10	2.024	4.583		Wait alone condition, rewards present; study 1
	2000	5.867	10	1.602	4.5		Wait alone condition, rewards present; study 1
Evans & English, 2002	2000	23.667	98	1.191	9.2	Lower-class	
	2000	26.033	70	1.591	9.2	Middle-class	
Houck & Lecuyer-Maus, 2004	2002	6.94	78	0.707	4.917		
Forzano, Michels, Carapella, Conway, & Chelonis, 2011	2009	8.955	30	1.733	4.467		
Guan et al., 2011[U]	2011	6.074	14	1.165	3		
	2011	7.406	39	0.596	4		
	2011	8.425	23	0.571	5		
Rollins, 2012[U]	2012	4.33	60	0.23	4.62		
Sargent, 2014	2012	18.24	20	2.252	7.68		
Kumst & Scarf, 2015	2013	8.29	29	1.187	3.49		Control group, pre-intervention; smaller vs. larger gift
Cuskelly, Gilmore, Glenn, & Jobling, 2016	2014	7.337	43	0.966	3.843		
Willis, 2016[U]	2014	11.367	19	1.321	4.98	"Mostly middle class"	Control group
Wang, 2015[U]	2015	6.153	13	0.894	5.398		Control group
Saxler, 2016[U]	2015	7.1	90	0.617	4.94		Study 1
Wilbur, 2016[U]	2015	8.033	50	0.49	5.35		
Salik, 2016[U]	2016	6.213	61	0.629	4.1	Very low SES	Philippines
	2016	7.536	83	0.681	4.1	Very high SES	UAE
	2016	9.786	15	1.653	4.1	High SES	Netherlands
Tan, 2017[U]	2017	10.341	139	0.51	5.32		

year data was collected was reported in the article, that is the year the data was collected. Unless the data is archival or from a separate study, peer-reviewed research articles were coded as collected two years prior to publication year. Masters theses and Dissertations were coded as one year before publication date. Coding was done by the lead author, verified by two research assistants separately. Additional notes were added if any of the three coders noticed something germane to the meta-analysis. This left us with a total of 30 studies, both published and unpublished, for the meta-analysis (see Table 1 for final list and notes).

Studies were weighted by the standard error of the mean (Card, 2015). This weighting eliminates the problem of ignoring within-sample variability (as described in Trzesniewski & Donnellan, 2010).[2] We ran a meta-regression on the average amount of time children waited, using a mixed-effects meta-analysis, conditioning on children's age, testing whether average wait times had changed over the past 50 years. Four studies had to have standard deviations imputed due to not being reported or calculable from the manuscripts (Mischel, Ebbesen, & Raskoff Zeiss, 1972; Mischel & Moore, 1973; Schack & Massari, 1972; Wilbur, 2016). We used multiple imputation to generate the standard deviations. Data, search details, exclusion criteria, and pre-registration of analysis plan can be found at https://osf.io/mrqpu/.

2.2. Survey of experts in cognitive development

A survey was sent to experts in cognitive development via the Cognitive Development Society listserv on May 13, 2017. This is a collection of cognitive developmental psychologists around the world as members of the Cognitive Development Society. This was chosen to sample people (cognitive developmental psychologists) most informed about child cognitive development and this email went out to a total of 4273 subscribers.

All who took the survey were told the data had not yet been analyzed from over 30 studies of the past 50 years on the administration of the 'Marshmallow test'.[3] Experts were asked if they believed there would be increases, decreases, or no change in children's ability to delay gratification over the past 50 years. If they selected 'no change', they were asked if this is because of contrasting forces cancelling out, no genuine change, or whether there is not enough data to tell. We further asked the experts their age, level in their professional career, and whether they were developmental psychologists, personality psychologists, or from some other field. This study was found exempt by the local institutional review board. Exact question wording, data, and pre-registration can be found at https://osf.io/mvup7/.

[2] Ignoring this variability can create artificial time trends from data generated with no trends (Trzeniwsky & Donnelan, 2010). *Re*-analyzing their hypothetical data using the meta-analytic procedures we used here take the artifactual trend of $p < .001$ in Trzeniwsky & Donnelan, 2010 and eliminates it ($p = .847$).

[3] At the time of administering the survey we believed we had 31 studies, it later turned out one study (Turnbull, 2016) had to be excluded as Dr. Turnbull informed us there had been substantial changes to the task administration. This left us with the final 30 presented here.

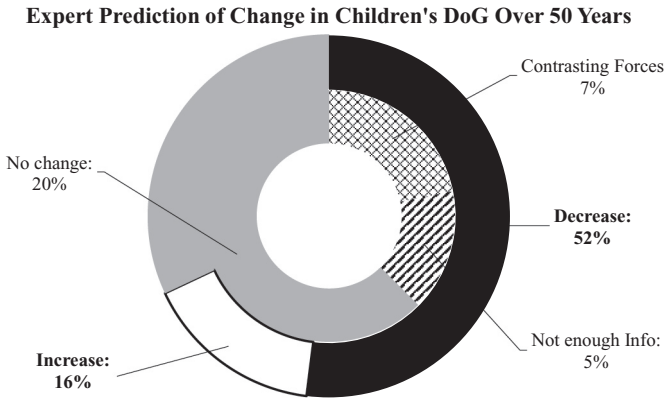

Fig. 2. $N = 260$. All participants who selected 'no change' (32%) were subsequently asked if this was because there was no change in DoG time, contrasting forces pushing ability up and down, or if there was not enough information to tell.

3. Results

3.1. Preliminary notions: expert prediction

There was not an even distribution of expert beliefs regarding change (χ^2 (2, N = 260) = 48.221, $p < .001$; see Fig. 2). Experts largely believed that children's ability to delay gratification would decrease over time ($N = 134$). The least common belief was delay of gratification ability would improve over the past 50 years ($N = 41$). For those who believed there would be no change, the most common reason was simply that there was no change in ability. There were no differences based on whether the participants were tenured professors, tenure-track professors, post-docs/adjuncts, or graduate students (all $ps > 0.19$ from ordered logistic regression). This suggests that scientific predictions about changes in delay of gratification ability do not change with experience. Finally, our prediction that older experts would show a different belief was not supported ($p > .9$).

3.2. Results of the meta-analysis

Children's ability to delay gratification, conditioning on age of test administration, has increased over the past 50 years ($b_{year} = 0.107$, $p < .001$, 95%CI = 0.047 to 0.167; see Fig. 3). This was found using all of the available published and unpublished studies using the marshmallow test.

Children today are able to wait longer than children were on the same exact task 50 years ago. As a check on the veracity of the data, we were also able to confirm the repeated finding that the ability to delay gratification increases with age ($b_{age} = 3.254$, $p < .001$; 95%CI = 2.54 to 3.968; e.g. Melikian, 1959, Mischel & Metzner, 1962; Toner & Smith, 1977; Yates et al., 1981; Hongwanishkul et al., 2005). Furthermore, in an exploratory analysis, there were no differences between published and unpublished data ($p = .6$).

There were two meta-analytic outliers in the data (Viechtbauer & Cheung, 2010): one study where nine-year-olds waited an abnormally long 26.033 min (Evans & English, 2002), one where five-year-olds waited an abnormally short 6.153 min given the increasing ability of children to delay over time (Wang, 2015). Removing these two studies from the analysis did not change the results ($b_{year} = 0.115$, $p < .001$, 95%CI = 0.06 to 0.169).

The standard deviation of delay times has not changed over time ($b = .011$, $p > .65$). This suggests the secular increase in the ability to delay gratification occurs for all children, not those at the bottom of ability (which would correspond to a shrinking of variance) or increasing only for people at the upper end of the distribution (which would correspond to an expanding of variance).

The absence of studies using the marshmallow task in standard administration during the 1980s is most likely due to the invention and popularization of the gift-delay task, which purportedly targets the same abilities but takes considerably shorter time to administer (e.g. Funder, Block, & Block, 1983).

Overall, consistent with previous evidence and contrary to not only popular wisdom (see Carlson et al., 2018), but also expert prediction, children have been getting better at delaying gratification. Each year, all else equal, corresponds to an increase in ability to delay gratification by another six seconds. This represents a little over a minute per decade; given the sample average standard deviation (SD = 5.606 s) this is a little less than a fifth of a standard deviation per decade (effect size = 0.18 SDs); the same magnitude as Flynn effects on IQ (e.g. Trahan et al., 2014). Using the regression equation derived from this study, conditioning on age, children in 1968 could wait an average of 2:58, while children in 2018 could wait 8:19.

4. Discussion

Over the past 50 years, children have been getting better at their ability to delay gratification. Seen in 30 studies, the rate of increases in children's ability to delay gratification is occurring at the same rate

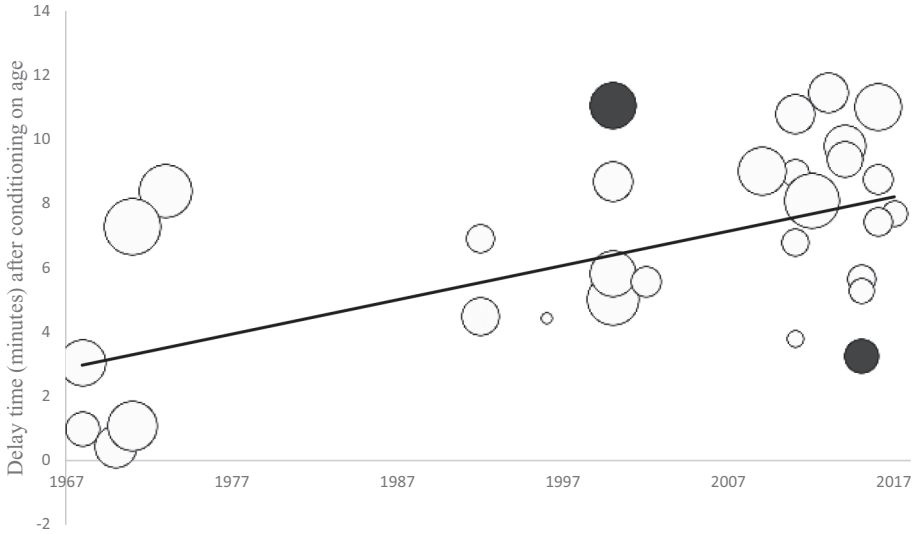

Fig. 3. Meta-regression of changes in the ability of children to delay gratification over the past 50 years on the marshmallow test, conditioning on age. Bubbles are weighted by the meta-analytic standard errors and represent age-conditioned times (A previous version of this manuscript presented this graph in raw times, not age-conditioned times.). Smaller bubbles represent studies with larger N's and thus, smaller standard errors. Black bubbles indicate meta-analytic outliers.

previously shown for increases in IQ across generations—a little less than a fifth of a standard deviation every 10 years (Flynn, 1984). Thus, results also seen across three cohorts (Carlson et al., 2018) can now be understood to be a more generalizable principle of secular increases.

Caution must be taken when interpreting these results, especially extrapolating linear assumptions backwards and forwards in time outside the bounds of the data. Children from 1917 exposed to the marshmallow task would not necessarily have universally and immediately failed. Likewise, in 2068, preschoolers will not necessarily be able to wait even longer than today (predicted delay time: 13:40 all else equal). Similar to secular changes in cognitive ability, delay times may stall or even reverse in the future (e.g. Teasdale & Owen, 2005).

4.1. Limitations

As the results of this meta-analysis go against not only 'common wisdom' but also expert prediction, a number of exploratory analyses and cautions may be warranted. Only 10% of our studies were unpublished, so there is not enough variance to interpret the non-significant difference between published and unpublished studies. Our primary dependent variable was wait times, which simply represent a mean and standard deviation. As there are no statistical comparisons being made by a wait time mean, there can be no associated *p*-value within each study, meta-analytic tools such as *p*-curve (Simonsohn, Nelson, & Simmons, 2014) cannot be used. Furthermore, the wait times are averaged across all sexes and ethnicities, as nearly all studies do not break down wait times by such demographics. Therefore, the data here cannot determine the possibility of group differences in delay of gratification ability over time.

Unfortunately, 53% of studies did not report any information about the socioeconomic status (SES) of their participants (see Table 1). The results here are likely robust to potential differences in the SES of the participants, however. Children from poorer homes have shown worse ability to delay gratification (e.g. Evans & English, 2002). The original and oldest studies done on the marshmallow test were using children from the pre-school for Stanford University faculty and staff, an unquestioningly higher SES sample. Many of the studies included here had no information regarding parental income or education or SES (see Table 1). This is largely unproblematic, however, given the direction of results. The only way the results here could be confounded by differences in SES would have been negatively, with newer studies using children from lower SES environments. Thus, changes in SES could be problematic if we found decreases in delay times, but not when observing the increasing delay times we found. If any such confounding exists, it would only serve to dampen the rate of increase over time. If research using the delay of gratification tasks here has focused more on children form lower SES homes over time, then our results, while robust to such changes, would actually be an underestimation of the rate of increasing abilities.

Procedural changes may also represent a threat to the results here. If there had been substantial changes to the administration or context of the administration of the marshmallow task, it could plausibly account for the higher wait times, provided such changes would lead to longer wait times. The earliest studies, for example, used wait times that could last as long as 15 min. Thus, a child able to wait longer than 15 min would count as lasting the full 15 min but could not have scores any higher. If later studies, after conditioning on age, used *longer* wait times, this may create the appearance of an artificial increase as children in the 60s *could* have scored higher but their scores were truncated. Instead, if anything, maximum duration times have either stayed the same across studies or *decreased* (e.g. Connell & Francis, 2014), meaning scores may be artificially depressed and the secular increases potentially even larger than observed here (slightly less than a fifth of a standard deviation). We did everything we could to ensure the administration procedures were as similar as possible across studies (see exclusion criteria), but subtle changes cannot be ruled out across studies. As our results across laboratories matches perfectly that seen when administered by the same team using the same procedures (Carlson et al., 2018), however, it is unlikely such changes are an alternate explanation for our results.

Finally, the measurement used for comparison was a single measurement (wait times in mean number of seconds). As there was only one measurement, we cannot investigate whether the *measurement* of delaying gratification on the marshmallow task is invariant over time. In the context of the positive manifold, IQ scores have been shown to not be invariant over time (e.g. Wicherts et al., 2004), which can lead to differing conclusions regarding secular gains. Thus, we would have to wait in the future for batteries of delay of gratification tasks to be administered to children over time to look at the relationship between changes and measurement invariance.

4.2. Mechanisms or reasons for the incline

What could cause an increase in children's' delay of gratification? A number of possibilities can be speculated, but none solved here. The first place to look would be suspected causes of the secular increases in intelligence (Flynn effects), as the pattern and magnitude of increases are equal. A non-exhaustrive list includes: Earlier education/more preschool, increased health, better education, rising standards of living, better-educated parents, increased test experience, more demanding environment, technology, increased test awareness, immigration, genetic changes, increased prenatal and perinatal nutrition, more rapid maturation, and changing family dynamics (see Rindermann, Becker, & Coyle, 2017; Bratsberg & Rogeberg, 2018 for a review and evidence for Flynn effects; Wyshak & Frisch, 1982 and also Herman-Giddens et al., 2012 for maturation effects; Figueredo, Cabeza de Baca, & Woodley, 2013 for genetic changes). We address these only briefly, as their possible causal role in Flynn effects have been debated since the 1980s without complete resolution. It would therefore be premature to draw conclusions about their putative role in increasing delay of gratification ability. The treatment here is mostly to screen out some explanations while providing testable future predictions.

Earlier education/More Preschool Attendance is another possibility. In the 1960s and before, randomized controlled trials of the effects of preschool on IQ were more easily conducted because preschool was less common and the control group did not attend. As preschool has become more ubiquitous, the beneficial effects of preschool on cognition (e.g. Skeels, Ruth, Wellman, & Williams, 1938; Dawe, 1942; Ametjian, 1965; Weikart, 1966; see Protzko, Aronson, & Blair, 2013 for a meta-analysis of preschool effects) may be operating for larger parts of the population. Thus, the expansion of preschool may have had an effect on increasing children's' delay of gratification ability. *Increases in health* could lead to possible gains in the ability to delay gratification. This explanation, popular in understanding nation-level increases in IQ, in this data alone is less likely as the early studies involved higher SES children who likely had good health (e.g. Colom, Lluis-Font, & Andrés-Pueyo, 2005; Lynn, 2009). *Rising standards of living* over the past 50 years could increase children's ability to delay gratification. As standard of living have improved throughout the United States, economic uncertainty may have been decreasing, lading to better ability to delay gratification (see Kidd et al., 2013). *Better-educated parents* could be increasing children's ability to delay gratification, since the 1960s there has been a rise in the number of U.S. parents receiving High School and Bachelor's degrees. If the parents' education to child's ability to delay gratification link is causal, this could account for the increasing ability (Pietschnig & Voracek, 2015). *More demanding environments* could increase a child's ability to delay gratification. If the complexity of an environment has a causal effect on the relevant traits needed in that environment (see Protzko, 2016), then as American culture has gotten more fast-paced and complex, children's ability to delay gratification may also have increased. *Increased test awareness* could cause the illusion of an increase in ability to delay gratification if tasks like the marshmallow test

are being routinely used in preschools. A possible explanation for Flynn effects includes increasing familiarity with IQ-like test material (Blair, Gamson, Thorne, & Baker, 2005; Flynn, 2007). Although we know of no evidence of training on delay of gratification, any such practices could lead to the illusion of gains, and measurement invariance testing would be required as that data becomes available. *Genetic changes* could partially account for increasing ability to delay gratification if over the past 50 years people with slower life histories (longer time preferences being associated with slow life history orientation) enjoyed higher relative lifetime reproductive success (e.g. Woodley of Menie et al., 2017). A prediction stemming from this would be positive correlations between relative lifetime reproductive success and DoG as measured using the marshmallow test ought to be present. *Increased prenatal and perinatal nutrition* could account for changes in ability to delay gratification. A common explanation for international Flynn effects, increases in prenatal and perinatal health and nutrition could cause increases in abilities. One piece of evidence against this data is there has been no change in variance over time. Improvements in nutrition often manifest as reductions in variance due to increased effects on only those low in the population (Colom et al., 2005). Still, overall improvements in the U.S. could underlie the trends seen here. *Earlier Maturation* could also explain the increases (Woodley, Figueredo, Brown, & Ross, 2013). As the ability to delay gratification increases with age, being a physiological process, earlier maturation could mean current four-year-olds are biologically more mature, more akin to slightly older children, than they were 50 years ago. *Changing family dynamics* could also underlie increased ability to delay gratification (Khaleefa, Abdelwahid, Abdulradi, & Lynn, 2008). As delay of gratification and the 'marshmallow test' have been popularized outside the academic literature, parents may have been influencing children's abilities through enforcing delaying gratification at home.

The mechanisms suggested above are certainly not exhaustive, but represent a menu of possibilities underlying secular increases in *any* cognitive ability. We do not yet know why ability at delaying gratification has been increasing. That the magnitude of increase (ES = 0.18/decade) is nearly exactly that of IQ gains may tell us that the two increases share an underlying common cause. This is certainly not necessary, however. As we are not certain of the cause for secular increases in IQ, we cannot know the cause of the secular increases in delay of gratification ability yet. The basic finding, and its failure to be predicted, however, does inform how scientists, along with lay people, reason about such findings.

4.3. Scientific prediction

How could so many experts in cognitive development believe the ability to delay gratification would decrease? This, we believe is an example of what can be called the kids these days effect (see Protzko & Schooler, 2019). The kids these days effect is the belief that children in the present are substantively different and necessarily worse than children a generation or two ago, specifically on traits in which one happens to excel. This belief is generations old (e.g. Sternheimer, 2006) with the earliest citation to this may be from 1900bce (Patrick, 1913; although the present authors have been unable to verify this inscription with the Suna and İnan Kıraç Foundation; İstanbul Research Institute). Members of the Amazon MechanicalTurk platform likewise overwhelmingly predicted a decline in children's ability to delay gratification (in Carlson et al., 2018). A supposed modern culture of instant gratification has not stemmed the march of improvement, and it appears that even experts in cognitive development would fall victim to such beliefs. This could be because those who are high in a given trait are more likely to see assumed declines in children specifically on that trait (Protzko & Schooler, 2019). As the type of person who gets into and completes a Ph. D. is likely one who has a high level of personal ability to delay gratification, they may be susceptible to believing a purported decrease in children's abilities.

4.4. Societal ramifications

Ability to delay gratification is associated with numerous positive outcomes. Unfortunately, those previous findings have not established causal links, mostly just associations. Intervention work, for example, has shown changes to children's rated self-regulatory abilities do not transfer to changes in later obesity (Lumeng et al., 2017). If, however, the relationships between childhood ability to delay gratification and other long-term health outcomes are indeed causal, this increasing ability holds potential hope for future generations. Increases in ability to delay gratification may correspond to a healthier and more successful society.

Contrarily, the underlying pattern between delaying gratification ability and risky outcomes may be of a relative instead of an absolute level. Meaning, our ability to delay *relative to others*, not raw ability, is the risk factor. Under this hypothesis, unhealthy and risky behaviors representing a lack of ability to delay gratification (e.g. substance use, unprotected sex, unhealthy diets, etc.) will likely persist for humans without explicit intervention. The behaviors will not wash out once humanity becomes able to delay gratification enough. Despite the overall ability to delay gratification increasing, people with the lowest level of ability may be more likely to partake in risky acts. Thus, increasing ability to delay gratification across years may have no practical effect on the likelihood of engaging in such behaviors. People relatively at the bottom in a population, regardless of their absolute level of ability, are the ones at risk. This is similar to how people who are poor in the United States are at risk for numerous outcomes, yet in terms of *absolute wealth* in the world, they are still high in income. The future existence of relationships between ability to delay gratification and outcomes, we predict, will continue to arise from cultural adaptations to increasing abilities. This cultural adaptation will continue to keep people at the low end of ability more inclined to engage in unhealthy or risky behaviors, regardless of average population ability. This is just one prediction from this data. Future research will be required to test the empirical implications.

Whatever the underlying causes, we can now assert that children are better at delaying gratification than in the 1960s, with average ability increasing for at least the past 50 years. The data here corroborate other work (Carlson et al., 2018), now extended over numerous studies. Only future research will be able to determine whether these trends will continue, stall, or reverse, and the societal consequences.

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