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RESEARCH ARTICLE

Genes, Ideology, and Sophistication

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Abstract

Twin studies function as natural experiments that reveal political ideology's substantial genetic roots, but how does that comport with research showing a largely nonideological public? This study integrates two important literatures and tests whether political sophistication – itself heritable – provides an "enriched environment" for genetic predispositions to actualize in political attitudes. Estimates from the Minnesota Twin Study show that sociopolitical conservatism is extraordinarily heritable (74%) for the most informed fifth of the public – much more so than population-level results (57%) – but with much lower heritability (29%) for the public's bottom half. This heterogeneity is clearest in the Wilson–Patterson (W-P) index, with similar patterns for individual index items, an ideological constraint measure, and ideological identification. The results resolve tensions between two key fields by showing that political knowledge facilitates the expression of genetic predispositions in mass politics.

Keywords: Twin studies; heritability; ideology; knowledge; natural experiment

Introduction

Behavioral genetics and biological studies have dramatically amended our understanding of how social, psychological, and political orientations arise (e.g. Alford, Funk, and Hibbing 2005; Eaves and Eysenck 1974; Martin et al. 1986). In particular, natural experiments comparing same-sex identical and fraternal twin pairs raised together to provide evidence that genes exert substantial influence on political attitudes, with biological processes joining (and interacting with) social forces shaping mass political beliefs. However, that heritability seems to imply a breadth of mass

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ideology that clashes with research on belief systems, which finds only a small cadre of political sophisticates holding stable, coherent, potent, and semi-principled views (e.g. Converse 1964, 2000).

The present study integrates scholarship on behavioral genetics and mass belief systems by testing whether political knowledge is a key moderating factor conditioning genetic expression in ideological attitudes. Data from the Minnesota Twin Study strongly support the prediction: ideological views are extraordinarily heritable among the most knowledgeable fifth of the public – much more so than population-level averages – and much less heritable in the least knowledgeable half of the public. Political knowledge provides an "enriched environment" in which genetic predispositions for ideology are maximally expressed. The result helps resolve tensions between one research line that suggests innate ideological predispositions in all of us and another line that finds few ideologues in the public.

Genes and ideology

Eaves and Eysenck (1974) were the first to identify genetic influences on sociopolitical attitudes, which they did by leveraging genetic similarity ratios between identical and fraternal twins (i.e. monozygotic (MN) and dizygotic (DZ)). Although researchers do not randomize or control the genetic similarity of their subjects, comparing twin types among same-sex pairs raised together functions as a natural experiment suitable for causal inferences about additive genetic influence on attitudes and behaviors, as if randomized.[1] Martin and colleagues (1986) updated those findings with the Wilson–Patterson (W-P) ideology index, Alford, Funk, and Hibbing (2005) introduced those genetic tests to political science, and many scholars reinforced these foundations by applying behavioral genetic methods to other political outcomes. In meta-analytic tests, genetic influence accounts for roughly 40% of the variance in ideology, though estimates frequently vary across populations, contexts, and measures, with most between 30% and 50% (see e.g. Hatemi et al. 2014).

Heritability indicates how much "genetic similarity contributes to individual differences in observed behavior" within a specific population sample, with all remaining sample variance attributed to environmental influences (p. 315, Hatemi, Byrne, and McDermott 2012). Heritability is an essential starting point for subsequent investigations with more focused theories and causal models – it "provide[s] important leverage in identifying latent pathways of transmission for social and political attitudes" (p. 316, Hatemi, Byrne, and McDermott 2012).

Methods for testing biopolitical influence have subsequently diversified. These include gene–environment interaction models in which heritability estimates vary across subpopulations based on those moderators (Hatemi, Byrne, and McDermott 2012) and sophisticated twin- and family models that leverage additional relational information (e.g. Hatemi et al. 2010). Other studies identify (or rule out) potential mediators of genetic influence, including physiological reactivity and personality traits (Bakker et al. 2020; Oxley et al. 2008; Smith et al. 2011; Verhulst, Eaves, and Hatemi 2011).

[1]See Shadish, Cook, and Campbell (2002) for an extended discussion on the use of comparison groups for quasi-experimental causal inference.

Twin study methods are not without controversy: some political scientists object normatively to investigations of biological influences on mass political behavior (e.g. Charney 2008), while others point to possible weaknesses in model assumptions about the social influence that might overstate genetic influence (Suhay, Kalmoe, and McDermott 2008). Heritability *could* be artificially inflated if identical twins influence each other more due to their sameness compared to fraternal twins, but tests show this *potential* violation of that Equal Environments Assumption is less of a concern than critics feared (Hatemi et al. 2010; Smith et al. 2012). Regardless, environment assumptions do not meaningfully affect the analysis here, which tests *relative* heritability estimates across levels of knowledge rather than absolute levels more analytically sensitive to these assumptions.

Ideology and sophistication

Most of the public lacks stable, well-organized, and potent beliefs on most political topics (beyond partisan social identity), but a politically knowledgeable 20–40% is an exception to that rule (Converse 1964; Freeder, Lenz, and Turney 2019; Kalmoe 2020; Kinder and Kalmoe 2017). Politics is complicated, which makes it hard for people to see how their general predispositions connect with specific political choices. People need to know what goes with what (Converse 1964; Freeder, Lenz, and Turney 2019). Knowledgeable people are better equipped than low-knowledge peers to translate predispositions into specific ideological views and coherent liberal–conservative belief structures.

Beyond principled reasoning, political belief structures arise through attention to trusted opinion leaders who bundle attitudes in ideological packages. Political leaders construct coalitions from disparate groups of policy demanders, with platforms that link positions across policy domains that have no principled correspondence (Cohen et al. 2008; Converse 1964). Attentive citizens – the most knowledgeable – adopt those views *a la carte* and *en masse* (Berinsky 2008; Lenz 2012; Zaller 1992).

Scholars debate the extent to which ideological weaknesses are properties of respondents or measures, though heterogeneous strength by knowledge suggest measures are probably *not* the main culprit (Achen 1975; Converse 2000; Freeder, Lenz, and Turney 2019). Combining individual policy views into a reliable index reduces noise in measures due to both measures (Ansolabehere, Rodden, and Snyder 2008), as in the W-P measure.[2] But even lengthy ideological indices stratify enormously by knowledge, including the tests we present, which points to important *substantive* stratification (Kalmoe 2020).

Together, these two literatures present a puzzle: How could genes broadly predispose people to adopt particular constellations of political attitudes, as heritability research shows, when people lack the constraint that defines ideological belief systems and the knowledge to make those links?

[2]Tests with aggregations make policy views look more stable, coherent, and powerful than their constituent items (Ansolabehere et al., 2008) but the same statistical process that zeroes measurement error reduces *all* incoherence and instability, including the substantial portion caused by non-attitudes (Broockman, 2016).

Our Expectations

We expect genetic heritability estimates for ideologically organized political attitudes to vary widely across levels of political knowledge. Pairs in which both twins share high levels of knowledge are better able to express genetic predispositions because they are better prepared to bridge individual attitudes and to organize their beliefs into what we consider to be consistent ideologies. Knowledge, therefore, allows the strong *expression* of genetic predispositions in specific political attitudes. Twin pairs with less knowledge likely struggle to make those connections, causing inconsistency across ideological views for MZ and DZ twins alike. That disorganization would reduce heritability estimates for ideology as correlations for both twin types fall toward zero.

We view political knowledge as an "enriched environment" for ideology, like those in genetic studies of physiology and psychology. Genetic influence in height requires well-nourished humans for its full expression (Silventoinen 2003), much as a genetic influence on cognitive ability rises when people have advantaged socioeconomic contexts that nurture full development (Tucker-Drob, Briley, and Harden 2013). Similarly, we expect political knowledge to provide *political* enrichment that empowers the full force of genetic predispositions in ideological outcomes. Without knowledge, ideological development is stunted, and the estimated role for genetic influence will shrink.

What would knowledge stratification look like operationally? Heritability models partial variance into estimates for genes, shared environment (e.g. twin family), and unshared environment (e.g. different experiences). If ideology-linked genes can't fully express in low-knowledge twin pairs, how does that variance get reallocated? Our theory predicts a rise in *unshared* environment estimates – a residual category after accounting for genes and shared twin experiences, both of which are systematic. Unshared environment would include noise from disorganized beliefs associated with ideological innocence.[3]

Our hypothesized information dynamics for heritability could partly explain the relationship between heritability, ideology, and age, in which genetic estimates grow among older participants (Eaves et al. 1997; Hatemi et al. 2009), given that age and experience in the political system correspond with higher levels of political knowledge (Delli Carpini and Keeter 1996). Notably, Arceneaux, Johnson, and Maes (2012) find that political knowledge itself is genetically heritable.

Our study is the first to test the heritability of political belief systems as a function of political knowledge, but ours is not the first to test how context affects heritability in politics. For example, Ksiazkiewicz and colleagues (2020) examine how national political culture, age cohort, and ideology type condition the stability of ideological orientations over time and the role of genetic influence in producing that stability. Similarly, Fazekas, and Littvay (2015) examine the heritability of partisanship and ideology within the USA across decades, from the 1980s to the mid-2000s, finding that estimates of genetic influence for party identification increased with national political polarization and the alignment of ideology and party identification.

[3]Measurement error also falls into the unshared environment category, but there is no reason to suggest measurement error in low-knowledge respondents when that noise is minimal among their high-knowledge peers, and when large item additive indices strip most noise from measures (Ansolabehere et al. 2008).

Finally, beyond zygosity differences that affect heritability estimates, we expect high-knowledge subpopulations of both types to have higher twin–pair correspondence than low-knowledge respondents. This is because knowledgeable twin pairs are comprised of individuals with better-developed belief systems, attributable to systematic influences including shared genetic and environmental effects versus unshared noise. Their political sophistication also facilitates mutual twin influence. This secondary expectation replicates and extends past non-twin ideological studies (e.g. Converse 2000) and provides additional validity for our main expectations involving knowledge.

Methods

The most common twin study designs leverage a natural experiment produced by comparing the relative similarity of fraternal and identical twin pairs. MZ twins share all of their genes. DZ twins share 50% of their genes, on average, just like other siblings. Basic heritability models calculate additive genetic heritability as twice the difference in twin–pair correlations between MZ versus DZ twins since MZ twins share twice the genetic material. Nonheritable portions of influence are partialed into shared and unshared environments the individuals in each twin–pair experience.

We use data from participants in the Minnesota Twin Registry, comprised of twins born between 1947 and 1956 and raised together (Lykken et al. 1990). Principal investigators John Hibbing, John Alford, Carolyn Funk, Peter Hatemi, and Kevin Smith contacted twins in the long-standing panel with a politics-focused survey supported by the National Science Foundation (Grant #0721378). We downloaded data from the University of Nebraska Political Physiology Lab website (https://www.unl.edu/polphyslab/data). Five-hundred and seventy-seven same-sex twin pairs (62% MZ) answered the survey administered online just before the 2008 presidential election, supplemented by a follow-up mail survey in early 2009.[4] Twin pairs are the unit of analysis. We compare items and index scores for the W-P battery, a folded W-P index indicating ideological constraint, and ideological self-identification.

Hatemi, Byrne, and McDermott (2012) describe the sample's characteristics, including a narrow age range (52–61 years old), 62% female, and 39% with at least a college degree (~30% nationally in 2008). These divergences from national parameters potentially limit the generalizability of inferences, though not in obvious ways. Education and age correlate moderately with knowledge, but we directly model knowledge levels in the analysis here. Additional tests in our Online Appendix show estimates differ somewhat by sex, but our overall conclusions about the conditioning role of knowledge are similar for both sexes, and so we combine the two below. No twin dataset across decades of research has a representative sample with the relevant political questions, given the unusual challenges of doing so.

[4]Excluding opposite-sex pairs avoids confounds with sex differences.

Measures

This W-P index includes 27 items on culture, politics, and social groups, presenting words or phrases (e.g. death penalty, military, pornography) followed by agree/disagree/uncertain responses. We use a 3-point attitude strength follow-up question to turn each response into a 7-point scale. We analyze responses as individual items and as an additive index. The index is coded −1 to +1, with 1 as Most Conservative (Twin 1: $m = .07$, $SD = .29$, $\alpha = .87$; Twin 2: $m = .08$, $SD = .28$, $\alpha = .87$). Ideological identification is measured with a standard 7-point scale (but without "haven't thought much about"), coded −1 to 1, with 1 as Extremely Conservative (Twin 1: $m = .09$, $SD = .49$; Twin 2: $m = .09$, $SD = .48$).[5]

Lastly, we follow Arceneaux, Johnson, and Maes (2012) in examining ideological constraint, which lacks the liberal/conservative direction of the other three measures. Ideological sophistication is a decent proxy for political knowledge and vice versa, which reduces the chances of finding stratification by knowledge. Nonetheless, we test the construct here because of its close relationship with the W-P index. We measure constraint by folding the W-P index at its midpoint, coded 0–1 (Twin 1: $m = .23$, $SD = .18$; Twin 2: $m = .23$, $SD = .17$). This captures both the degree to which respondents choose the same ideological side on each item and the strength of that attitude. The result effectively weights consistency by attitude strength. Notice that the average consistency-strength score is low, and even the 90th percentile is below the midpoint of the scale. This reaffirms the weakness and inconsistency of ideological views in the public overall.

We measure political knowledge with five standard items (Delli Carpini and Keeter 1996), all but one with four response options: what portion of Congress votes to override a veto, which branch of government interprets the constitution, which branch nominates federal judges, what is the main duty of Congress, and which party is more conservative (three options). The index is reliable, and since more than a third of respondents answered all five questions correctly, we dichotomize the responses as all correct or not to indicate unusually high knowledge (Twin 1: 39%, α=.69; Twin 2: 35%, α=.70).[6] Next, we classify twin *pairs* as "high-knowledge" if both answer all items correctly (21%), mid-knowledge if only one answers all right (32%), and low knowledge if neither answers all five correctly (47%). We also test an alternative median split on twin–pair knowledge, where both twins answering at least four of five correctly (45%) or don't (55%).

Like Arceneaux, Johnson, and Maes (2012) ordinal coding, our dichotomous knowledge measure is heritable for the full sample (H = 48%, MZ $\rho = .574$, DZ $\rho = .338$). The knowledge bin proportions correspond with ideology studies that find that a top quarter (or third) of the public is substantially more ideological

[5]With 27 items in the index, construct instability due to measurement error and non-attitudes alike is minimized. Variance in these measures is slightly lower among low-knowledge respondents compared to mid- and high-knowledge on these outcomes, roughly four-fifths the size (see Online Appendix). "Uncertain" responses to W-P items were slightly likelier among low-knowledge respondents by similar proportions (28% and 29% vs. 24% and 23%). The differences are generally insubstantial.

[6]The rate of five correct responses is equal to or perhaps slightly higher than in representative population surveys. For example, the proportion answering five similar questions correctly in the 1992 American National Election Study is 27%.

in many metrics than lesser groups (Freeder, Lenz, and Turney 2019; Kalmoe 2020). As expected, knowledge has a U-shaped relationship across the W-P index, with knowledge scores over 90% at the ends and knowledge levels near 60% in the middle.

Results

We estimate heritability in two ways, reflecting the evolution of research methods in behavioral genetics. Many readers are familiar with the basic calculation used in canonical studies – including Alford, Funk, and Hibbing's work that introduced the field to political science – which simply doubles the difference in correlations between MZ and DZ twin pairs (e.g. Alford, Funk, and Hibbing 2005; Martin et al. 1986). We present those intuitive tests in the Online Appendix (Table A3) rather than in the main text because, although roughly sound, they make untenable assumptions that can lead to nonsensical estimates (e.g. negative proportions of variance explained). For our main tests in the text, we estimate the more sophisticated structural equation models (OpenMX software; Neale et al. 2016) that are standard in recent work on heritability. Both methods support the same strong inferences about heritability conditioned by political sophistication.

Table 1 presents estimated percentages of variance attributable to genetics (A) and both kinds of environmental factors (C and E) for all twin pairs and for subgroups by knowledge. Table A2 in the Online Appendix presents the estimated variance components from which these percentages are computed, along with 95% confidence intervals bounding those estimates.

Overall heritability estimates for the full sample (left column) are similar to past reports: the W-P index is substantially heritable (59%), and an average of individual items shows somewhat lower heritability (38%). Ideological identification heritability (60%) is close to what Hatemi and colleagues (2014) find with SEM models. W-P ideological constraint is similar to Arceneaux, Johnson, and Maes (2012), though our operationalization differs by incorporating attitude strength.

Our main focus is on tests stratified by twin–pair political knowledge. We present these results two ways: three knowledge groups, then a median split.[7] The tripartite divide is most theoretically appropriate given the size of various sophistication strata in past research (e.g. Converse 1964). The two-part categorization shows robustness with an alternate specification and it adds more statistical power for detecting subgroup differences, given the unavoidable challenges posed by subgroup tests with a relatively small total sample size.

As predicted, heritability estimates for ideology are highly dependent on information levels. When both twins correctly answer all questions (top 21%), heritability for the W-P index leaps to 74%. When neither twin aces the quiz (bottom 47%), heritability falls to 32% – a 42% point gap. The most knowledgeable fraction of the public has an estimated heritability more than double the estimate for the least-sophisticated half on the W-P index. Strata contrasts with the median split are somewhat smaller due to the doubled size of the "top" group, but the sophisticated

[7]Correlation differences by zygosity are statistically significant ($p<.05$) in three-part knowledge groupings when at least: .25 (high), .18 (mid), and .15 (low). For two-part groupings: .16 (high) and .14 (low).

Table 1.
ACE Structural Equation Models

	All twin pairs			High knowledge: Both twins (21%)			Mid-knowledge: One twin (32%)			Low knowledge: Neither twin (47%)		
	A	C	E	A	C	E	A	C	E	A	C	E
Three knowledge groups – all five are correct (Both, One, Neither)												
W-P index	**59.3**	5.4	35.4	**74.0**	0.0	26.0	**57.6**	0.0	42.4	**31.6**	27.0	41.4
W-P item average	**25.3**	7.7	67.0	**40.2**	2.9	56.9	**22.6**	7.8	69.5	**14.7**	12.0	73.3
Ideology ID	**50.4**	0.0	49.6	**61.3**	5.7	33.0	**48.4**	0.0	51.6	**33.3**	0.0	66.7
W-P constraint	**29.9**	17.4	52.7	**45.8**	2.2	52.0	**30.6**	0.0	69.4	**17.8**	30.7	51.5

	High knowledge: Both twins (45%)			Low knowledge: < Both twins (55%)		
	A	C	E	A	C	E
Two knowledge groups – four or five are correct (Both, Not Both)						
W-P index	**69.3**	0.0	30.7	**47.9**	10.1	42.0
W-P item average	**35.9**	3.9	60.2	**15.4**	10.2	74.4
Ideology ID	**52.7**	8.5	38.9	**36.4**	0.0	63.6
W-P constraint	**41.5**	3.5	55.0	**30.1**	13.7	56.2

NOTES: Cells report additive percentage estimates from ACE structural equation models. A = genetic percentage; C = common environment percentage; E = unshared environment percentage.

half still has heritability estimates twice as large as the less sophisticated half (e.g. W-P $H_{high} = 69\%$, $H_{low} = 48\%$). The differences are statistically significant for the two- and three-category knowledge stratifications: the lower bounds for the high-knowledge estimates do not overlap with the upper bounds of the low-knowledge estimates (95% confidence intervals in Table A2). The basic calculation method suggests even larger heritability differences for the W-P index across strata (e.g. W-P $H_{high} = 80\%$, $H_{low} = 24\%$, Table A3), but the SEM models should be considered more definitive.

The average heritability for individual W-P items (see Online Appendix) shows similar heritability gaps by knowledge. The tripartite estimates attribute 40% of variance in the top group to genes and just 15% in the bottom half, with 23% in between. Although the % point heritability gap here resembles the W-P index, the item average has lower levels of heritability in each knowledge category due to noise from measurement error and non-attitudes (e.g. Ansolabehere et al., 2008).[8]

[8]Heritability estimates can shrink when MZ correlations decline or when DZ correlations rise. For the W-P index, both changes seem to be at work: The MZ correlation is substantially higher for high-knowledge pairs than others, as is the low-knowledge DZ correlation. For W-P items, all DZ correlations are equally low while the MZ correlation rises in each category. These patterns are generally consistent with our expectations, apart from the high DZ correlation in the low group.

The evidence looks similar for ideological identification and W-P constraint. Nearly twice as much variance in ideological identification is attributable to genes among high-knowledge Americans (61%) than low (33%) in the three-part categorization. Likewise, our measure of ideological constraint using the W-P items is estimated as 46% heritable for the high-knowledge group and 18% heritable for the low-knowledge group. That is surprising since constraint itself can be a sign of political sophistication, which should mute these differences. Notably, unlike the W-P index itself, the large heritability stratification differences for ideology ID and W-P constraint are not quite statistically distinct when we examine the confidence intervals on the variance components for each subgroup (Table A2). Thus, while these stratified estimates are substantively similar to the W-P index results, small sample sizes make the differences less definitive for these related constructs.

Across all constructs, shared environment estimates were generally low across knowledge groups, and unshared environment estimates rose as knowledge decreased. That last result is consistent with our argument that knowledge stratifies belief organization, and that noise manifests as an unshared variance. The evidence is more mixed for our expectation that pair correlations will be higher for high-knowledge twins, for both zygosity types (see Table A3). That holds for all four median split tests with MZ twins, but only for two of the four DZ tests.

Overall, these results match our expectations that the high-knowledge group is best able to translate latent genetic predispositions into concrete attitudes. We regard the much lower heritability estimates among low-knowledge citizens not as evidence of a lack of genetic predispositions for ideology, but rather as a sign that they are less able to channel those predispositions into realized ideological attitudes and belief systems – they don't know what goes with what.

What about alternative forms of political engagement besides knowledge? We measure political interest using a standard item with four response options. Parallel to knowledge, we distinguish twin pairs with both individuals indicating highest interest (13%), one does (28%), or neither (60%), plus a second median-split model. We find huge distinctions for high-interest twin pairs. These strata differences are even larger than knowledge due to a smaller top category, which sharpens contrasts (e.g. W-P $H_{high} = 86\%$, $H_{low} = 36\%$, Online Appendix Table A4). Differences remain large when contrasting at least one twin with top interest (41%) versus neither (e.g. W-P $H_{high} = 72\%$, $H_{low} = 36\%$).

Finally, we consider sex differences. Given already limited sample size, we combine high and middle knowledge categories and then estimate heritability for that group and the low-knowledge group separately by sex for each construct. Average heritability estimates for men and women vary but are generally similar. For example, W-P index heritability is estimated as 61% and 54% for women and men, respectively, with higher knowledge women and men at 74% and 70%, while low-knowledge groups are 39% and 0% (Table A6).

Discussion

We set out to test whether political knowledge provides an "enriched environment" for genetic expression in ideology, as research on mass belief systems suggests it

might do. Our approach leveraged the natural experiment derived by comparing identical and fraternal twin pairs (same-sex, raised together), a method common in behavioral genetics. The results handsomely supported our expectations: High-knowledge twin pairs show extraordinarily high heritability across varieties of ideology, while the least knowledgeable half showed more meager genetic influence, with robust results across alternative specifications. We conclude that genetic predispositions toward ideological beliefs are highly contingent (though not wholly dependent) on political knowledge for their actualization, because knowledge provides ideal conditions for making those connections.

How well does this sample reflect the national population on traits linked to ideology and knowledge? Minnesota Twin Study respondents are older and more educated than the American public, on average, but they are similarly interested in politics and unconstrained in attitudes, like national samples (Arceneaux, Johnson, and Maes 2012). Crucially, we found that sample knowledge levels are proportionate to general population surveys. That makes these tests a reasonable basis for inferring general population dynamics on ideological heritability and political sophistication.

More broadly, we recognize our tests as the first look and not the last word. In particular, the small Minnesota samples prevent more precise subsample tests, and public access is limited for data enabling further tests. We look forward to future studies replicating and extending our results.

Philip Converse (2000) always said that ideological analysis must account for huge variance in the public's political knowledge – and that doing otherwise risked concealing more than it revealed. The tests here show the value of extending Converse's exhortation to estimates of genetic influence in belief systems. Low-knowledge citizens may inherit genetic ideological predispositions like their high-knowledge peers, but those orientations are weak without the knowledge necessary to determine concrete attitudes and broader structures. Political knowledge is a key binding element for that political development. Merging two important and related but isolated fields in this way adds insight into the origins of ideology and the conditions for genetic influence in politics.

Conflict of Interest. Neither author has any conflict of interest to report.

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