THE CONTRIBUTION OF COGNITIVE AND NON-COGNITIVE SKILLS TO INTERGENERATIONAL SOCIAL MOBILITY

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Running Head: Intergenerational mobility

ABSTRACT (149 WORDS)

We investigated intergenerational educational and occupational mobility in a sample of 2594 adult offspring and 2530 of their parents. Participants completed assessments of general cognitive ability and five non-cognitive factors related to social achievement; 88% were also genotyped allowing computation of educational attainment polygenic scores (PGS). Most offspring were mobile. Those scoring at least one standard deviation greater than their parents on both cognitive and non-cognitive measures rarely moved down and frequently moved up. PGS were also associated with mobility. Inheritance of a favorable subset of parent alleles was associated with moving up and an unfavorable subset with moving down. Parent education did not moderate the association of offspring skill with mobility, suggesting low-skilled offspring from advantaged homes were not protected from downward mobility. These data suggest that cognitive and non-cognitive skills as well as genetic factors contribute to the re-ordering of social standing that takes place across generations.

Key Words: Social mobility, parent-offspring transmission, general cognitive ability, non-cognitive skills

Increasing economic inequality has led to concern over erosion of the middle class, exacerbation of health and social problems, and heightened economic and political instability (Neckerman & Torche, 2007). Nonetheless, Americans broadly support an unequal distribution of income so long as it is seen as being fair (Starmans, Sheskin, & Bloom, 2017), the result of individual initiative and talent rather than perquisite of an advantaged family background (Jencks & Tach, 2006). Americans by a large majority believe that getting ahead is due to meritocratic processes rather than a matter of inherited privilege and the strength of this belief does not appear to have waned as income inequality has increased (Reynolds & Xian, 2014). Nonetheless, belief in system fairness may be misplaced, the result of not knowing true rates of economic inequality and motivated by the false hope that individuals get what they deserve (Jost, Gaucher, & Stern, 2015).

A major challenge to a belief in meritocratic processes comes from the observation that advantaged parents are much more likely to have advantaged children than less advantaged parents (Cullen, 2003). Wealth, social capital and involvement are all ways parents can create for their children opportunities not widely available to others (Breen & Goldthorpe, 2001). Yet unequal opportunity is not the only factor contributing to the intergenerational transmission of inequality. High-achieving parents also transmit to their children, genetically and environmentally, the skills that contributed to their own success (Swift, 2004). Whether the persistence of socioeconomic status across generations owes to the unique opportunities high-achieving parents create for their children or the contribution of inherited skills to meritocratic processes is hotly debated (Breen & Goldthorpe, 2001; Saunders, 2002). In a between-family design, the opportunities associated with growing up in a high-achieving home are confounded with the skills children in those homes inherit from their parents. Alternatively, within-family comparisons, such as those used here, help isolate the contribution of individual skills from the correlated consequences of shared home advantages.

We focus on a particular form of within-family comparison, intergenerational social mobility. Identifying when individuals achieve more or less than their parents, effectively controls for the main effects associated with parent status. Intergenerational mobility is multi-faceted and can vary depending on whether assessed in terms of income, wealth, occupation or education (Torche, 2015). For both methodological and substantive reasons, we focus on educational mobility. Educational attainment is reliably established at a relatively early age, since most individuals have completed their formal education by early adulthood. Substantively, education drives other forms of social mobility and is consequently viewed as an appropriate target of policies aimed at addressing economic and other forms of inequality (Hout & Janus, 2011). We also investigate occupational mobility, even though many of the young-adult offspring in our study have likely not yet attained their lifetime highest occupational level. Nonetheless, analysis of occupation provides an opportunity to examine the robustness of the pattern of results we observe with education.

Largely missing in debates concerning whether Americans' endorsement of meritocratic beliefs is misplaced is an analysis of whether hard work and ability are major drivers of social advancement (Reynolds & Xian, 2014). The most widely documented individual-level predictor of educational and occupational attainment is general cognitive ability (GCA) (Johnson, Brett, & Deary, 2010). Non-cognitive factors such as industry and commitment are also, if somewhat more weakly, predictive (Farkas, 2003). These associations are based, however, on between-family comparisons, and so confound offspring skills with the advantages or disadvantages conveyed by their rearing homes. A limited number of studies have investigated the association of offspring-parent differences in social status with individual cognitive (Deary et al., 2005) and non-cognitive (von Stumm, Gale, Batty, & Deary, 2009) skills, although these studies likely under-estimate the degree to which these skills contribute to social mobility. This is because even though highly skilled individuals are expected as a group to achieve more than their parents, they would not necessarily be expected to do so when their parents had even greater skill levels than they do. An unbiased assessment of the association of skills to social mobility requires a determination of whether offspring move up or move down according to whether they are more or less skilled than their parents. Such comparisons are rarely seen because offspring and parent skills are usually not both assessed in a given study (for an important exception see Waller, 1971).

Genetic factors are also predictive of intergenerational social mobility (Ayorech, Krapohl, Plomin, & von Stumm, 2017; Belsky et al., 2018), as expected given the abundant evidence of the heritability of GCA and the non-cognitive skills thought to underlie social success (Bouchard & McGue, 2003). But genetic factors are confounded with the shared family environment (Scarr & McCartney, 1983), complicating interpretation of genetic correlations. Geneticists place a particular emphasis on within-family comparisons because they control for the confounding of genetic with environmental factors (as well as for population stratification). Consequently, if offspring-parent differences in skills contribute to social mobility, then offspring-parent differences in the genetic factors underlying those skills should also be predictive (Belsky et al., 2018).

The current study tests the hypothesis that offspring-parent differences in cognitive and non-cognitive skills as well as a polygenic score predictive of educational attainment underlie intergenerational educational and occupational mobility. Our analysis is based on a sample of 2594 young adult American twins from 1321 families, 1321 of their mothers and 1209 of their fathers. Offspring and parents were both assessed for GCA and an array of non-cognitive predictors of social achievement, allowing us to investigate the degree to which offspring-parent differences in these skills predicted offspring upward and downward mobility.

Materials and Methods

A detailed description of the sample and measures is provided in the Supplementary Online Material (SOM). The sample included 2594 twin offspring (52.6% female), 1321 mothers and 1209 fathers from 1321 nuclear families from the ongoing, longitudinal Minnesota Twin Family Study (MTFS) (Iacono & McGue, 2002). For offspring, cognitive and non-cognitive skills were assessed in adolescence (i.e., at about age 17 or earlier, prior to completing their education or attaining adult occupational level) and social outcomes were assessed in their mid- to late-20s (i.e., at either the age-24, N=105, or age-29, N=2489, offspring assessment). For parents, measures were obtained at a single in-person assessment in mid-life. For a small number of non-participating fathers, we used mother reports of fathers' education (N=106) or occupation (N=76). There was minimal attrition in the MTFS offspring sample. Of the 2764 twin offspring who completed an assessment in adolescence, social outcome data in early adulthood could be determined for 2594, or 93.8%.

Table S1 (SOM) provides a description of all measures. Social outcomes included educational level and occupational level; predictor variables included measures of cognitive and non-cognitive skills implicated in earlier research as predictive of social achievement. Also included in our analysis was a polygenic score predictive of educational attainment derived using results from the most recent large-scale genome-wide association study (GWAS) of educational attainment (Lee et al., 2018). All variables were assessed in the same way in offspring and parents.

Education was coded as highest degree completed on a five-point scale: 1 = Less than High School, 2 = High School or GED, 3 = Some College, 4 = 4-year College, 5 = Professional (e.g., M.A., Ph.D., M.D.). Occupation was coded on a 7-point scale according to the Hollingshead system (Hollingshead, 1957). To facilitate interpretation, the original Hollingshead scale was reflected so that higher scores corresponded to higher perceived occupational status. On this reflected scale, scores ranged from 1 = unskilled labor to 7 = professional positions. Occupation was coded only for those having a full-time occupation at the time of their assessment and was consequently available for 1078 (87.7%) of the sons, 1142 (83.7%) of the daughters, 1211 (91.7%) of the fathers and 756 (57.2%) of the mothers. As expected, education and occupation were moderately correlated in both offspring (r=.55; 95% CI=.51, .59) and parents (r=.61; 95% CI=.57, .64). Offspring were born 1972-1984, although year of birth was not significantly associated with either their educational (χ^2 (1df) = 2.35, p = .13) or occupational (χ^2 (1df) = 0.23, p = .63) level and so was not considered further here.

General cognitive ability (GCA) was assessed using an abbreviated form of either the Weschler Adult Intelligence Scale-Revised (WAIS-R, Wechsler, 1981) for participants age 16 years and older or the Weschler Intelligence Scale for Children-Revised (WISC-R, Wechsler, 1974) for those 15 and younger. Non-cognitive measures were selected from assessments completed by both parents and offspring and included four self-report, multi-item scales from the Multidimensional Personality Questionnaire (MPQ, Tellegen & Waller, 2008) and a fifth measure of Behavioral Disinhibition (Hicks, Schalet, Malone, Iacono, & McGue, 2011). The MPQ scales were: Social Potency (being decisive); Achievement (ambitious and hard-working); Alienation (feeling exploited and unlucky); and Control (being careful and reflective). The Behavioral Disinhibition measure consisted of aggregated symptoms of antisocial behavior and substance abuse obtained by clinical interview. The Non-Cognitive Composite was formed by taking the mean of the five (or in the case of those missing one of the components, four) standardized (i.e., mean of 0 and standard deviation of 1) non-cognitive components after reflecting the Alienation and Behavioral Disinhibition scores.

Single nucleotide polymorphism (SNP) genotypes from a GWAS platform were available for 2463 (94.9%) of the 2594 offspring and 2205 (87.2%) of the 2530 parent participants (Miller et al., 2012). Polygenic scores (PGS) for educational attainment are weighted composites of individual SNP counts (i.e., the count of a reference allele at a specific locus). Weights were based on results from the Social Science Genetics Association Consortium's most recent GWAS of educational attainment, EA3 (Lee et al., 2018). PGS were computed using the LDpred software with a prior probability of 1.0 (Vilhjálmsson et al., 2015), which in effect allows information from all SNPs in the developmental sample to be weighted in the prediction. As the MTFS parent sample was included in EA3, PGS weights were estimated after it (as well as the 23andMe sample) had been removed. PGS were used for genetic parents only and, because genetic prediction varies by ancestral background (Martin et al., 2017), only for individuals identified as being of European ancestry based on previous genomic analysis of the MTFS sample (Miller et al., 2012). This reduced the sample for PGS analysis to 2394 offspring and 2114 parents.

To facilitate interpretation, all predictor variables were standardized separately in the parent and offspring samples. Education and occupation were not standardized. Table S2 (SOM) provides descriptive statistics and available sample sizes for all study variables by gender and generation. In social mobility analyses, the educational and occupational levels of parents in each family were combined by taking the maximum of the mother's and father's education and occupation levels, respectively. For families with only a single parent, parent education and occupation was set to the levels attained by that parent. For predictor variables, mother and father scores were combined by taking their average after standardization. The rationale and empirical support for our approach to combining mother and father scores are provided in the SOM.

Analyses involved fitting alternative regression models and correlation estimation. Regression models included age at assessment and gender as covariates. Analyses that included the PGS as a predictor also included the first ten principal components of the genetic covariance matrix as covariates to account for residual stratification not eliminated by restricting analyses to individuals of European ancestry (Miller et al., 2012). Generalized estimating equations (GEE) was used to account for sample clustering by family (Hanley, Negassa, Edwardes, & Forrester, 2003); otherwise the twin nature of the sample was not utilized in analyses reported here. In cases where a statistical null hypothesis was tested, the p-value threshold was set at .01 (two-tailed). Sample size was determined by taking all participants in the longitudinal MTFS that met the eligibility criteria described above. Power was conservatively estimated based on an N of 1321 families (rather than number of individuals) as greater than 85% to detect effects accounting for at least 1% of variance at an alpha level of .01 (two-tailed).

RESULTS

Association of Cognitive and Non-Cognitive Skills with Social Achievement

Each of the five non-cognitive components (Social Potency, Achievement, Alienation, Control, and Behavioral Disinhibition) was significantly but modestly correlated with both education and occupation in both the offspring and parent samples (Table S3, SOM). In general, there was little evidence that gender moderated these correlations. The single possible exception was Achievement, which consistently predicted social outcomes more strongly for women than men, although significantly so only for education in the offspring sample. GCA and the Non-Cognitive Composite were moderately and similarly correlated with both education and occupation in the offspring sample. A different pattern was observed in the parent sample, where both social outcomes were correlated more strongly with GCA than the Non-Cognitive Composite (Table S3). Nonetheless, sample differences were modest, as mean standardized GCA and Non-Cognitive Component increased similarly across the four gender X generation groups for both education (Figure 1) and occupation (Figure S1, SOM). The cognitive and non-cognitive contributions to social success appeared to be generally similar in men and women and for offspring and their parents.

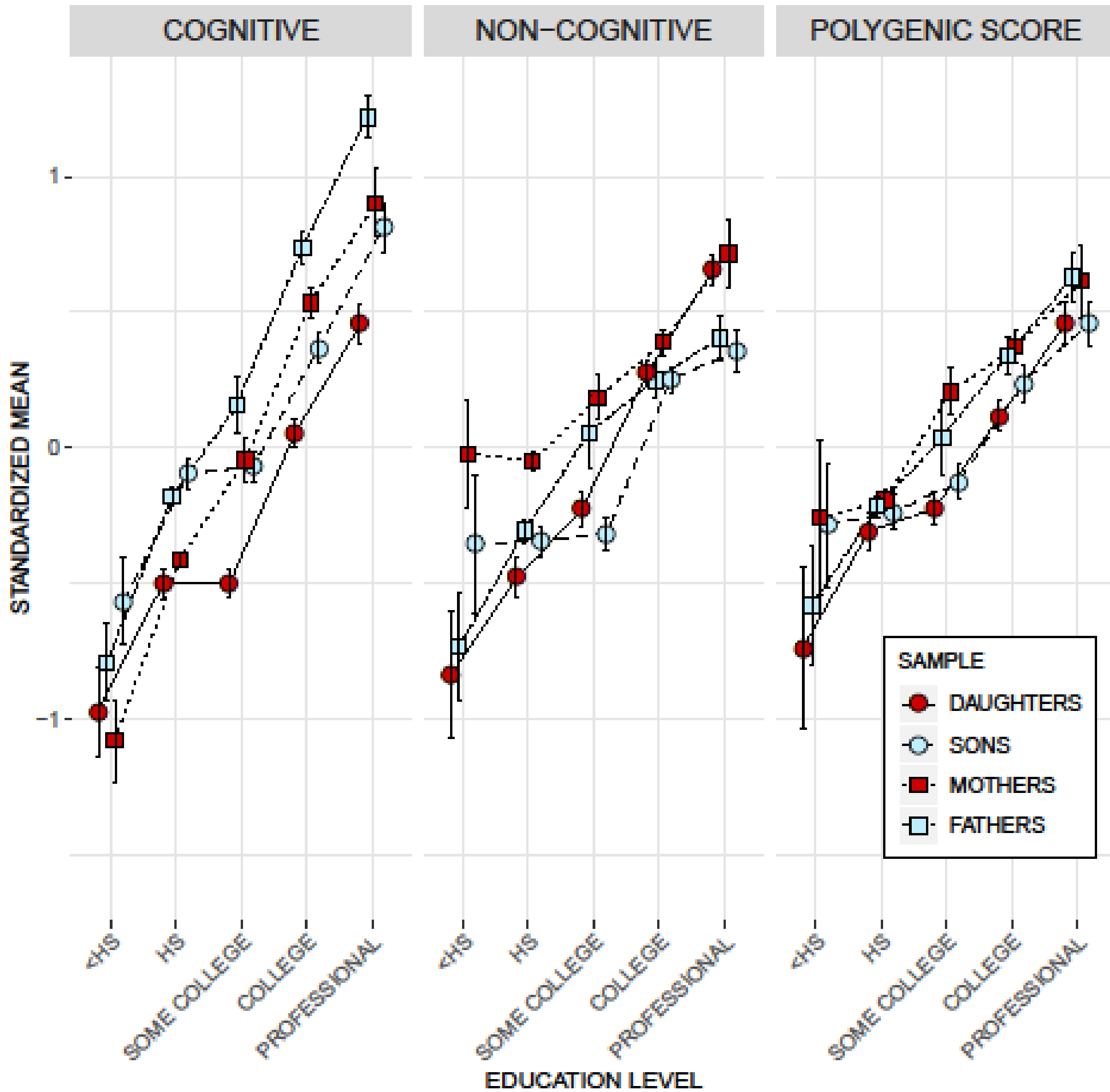


Figure 1: Mean standardized General Cognitive Ability, Non-Cognitive Composite and Polygenic Score for educational attainment as a function of attained education level in parent and offspring samples separately by gender. Sample sizes given in Table S2 and correlations in Table S3, SOM. Error bars represent ± one standard error.

Intergenerational Social Persistence

The persistence of social achievement across generations is typically assessed either by the regression of offspring achievement on parent achievement or by the correlation between offspring and parent achievement (Black & Devereux, 2011). Although the two indicators can differ, particularly when the variance in social achievement expands across generations, both approaches gave qualitatively similar results here.

The regression of offspring education on parent education yielded an estimated regression coefficient of .63 (95% CI = .55, .71) and a correlation between parent and offspring education of .36 (.31, .41). The corresponding results for occupational attainment were .24 (.18, .29) and .24 (.19, .29), respectively. The lower coefficients for occupation than education likely reflect at least in part that many offspring in this relatively young sample have yet to attain their highest occupational level. Gender did not significantly moderate parent-offspring similarity for either education ($\chi 2$(1df) = .02, p =.90) or occupation ($\chi 2$(1df) = 3.9, p = .05).

There was significant parent-offspring correlation (see Table S4, SOM) for both GCA (.48; 95% CI=.44, .52) and the Non-Cognitive Composite (.23; 95% CI=.18, .28). Including parent GCA and parent Non-Cognitive Composite into the intergenerational regression reduced the estimated parent-offspring regression coefficient to .45 (.35, .54) for education and .13 (.07, .20) for occupation, indicating that approximately 30%-40% of the observed persistence in social achievement could be attributed statistically to the intergenerational transmission of GCA and the Non-Cognitive Composite.

Intergenerational Social Mobility

Intergenerational social mobility was indexed by offspring-parent differences in educational or occupational attainment. Nearly half of the 1365 female offspring (46.7%; 95% CI=43.4%, 50.0%) and 40.4% (37.1%,43.7%) of the 1229 male offspring achieved a higher educational level than their parents; only 16.9% (14.4%, 19.4%) of women and 22.9% (20.0%, 25.8%) of men were educationally downwardly mobile (Figure 2). For occupation, 37.0% (33.7%, 40.3%) of 1105 women and 31.8% (28.5%, 35.1%) of 1042 men had a higher occupational level than their parents, while 43.0% (39.5%, 46.5%) of women and 45.4% (41.9%, 48.9%) of men had a lower level. It is notable that a similar percentage of the 1426 offspring with parents in the lowest educational class moved up (61.2%, 95% CI=58.3%, 64.1%) as the 300 offspring of the most highly-educated parents moved down (59.0%, 95% CI=52.5%, 65.5%) (Figure S2, SOM). The difference in mobility for education and occupation likely reflects the general expansion of educational opportunities between generations and the relative youth of offspring who have not all established their highest occupational level.

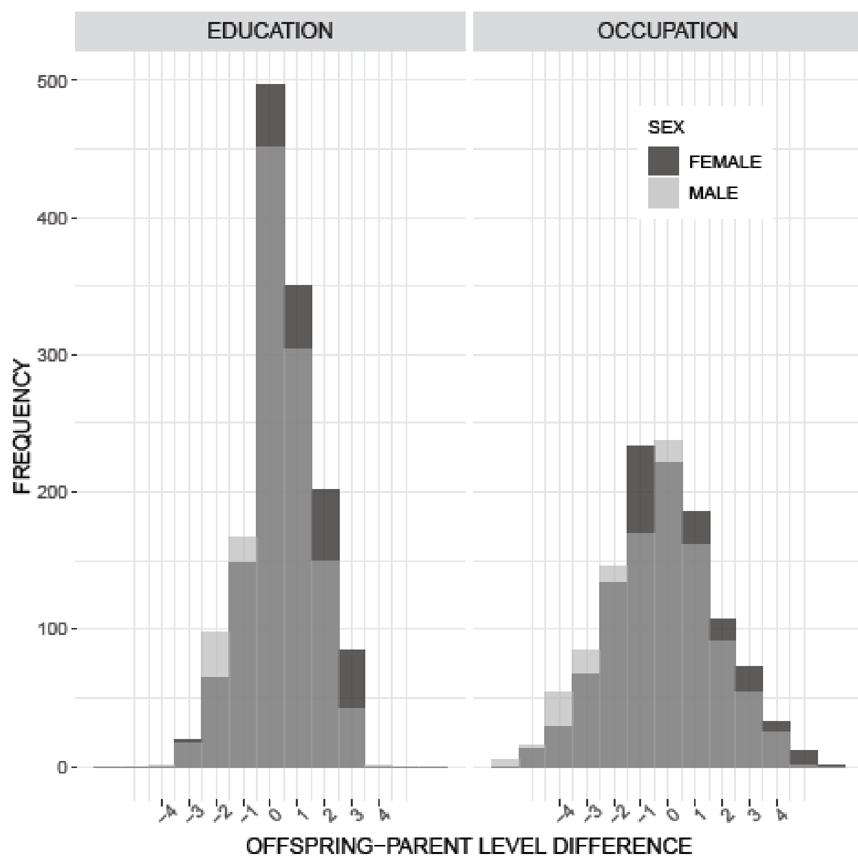


Figure 2. Offspring-parent differences in educational and occupational attainment; positive scores reflect that offspring moved up relative to parents and negative scores the reverse.

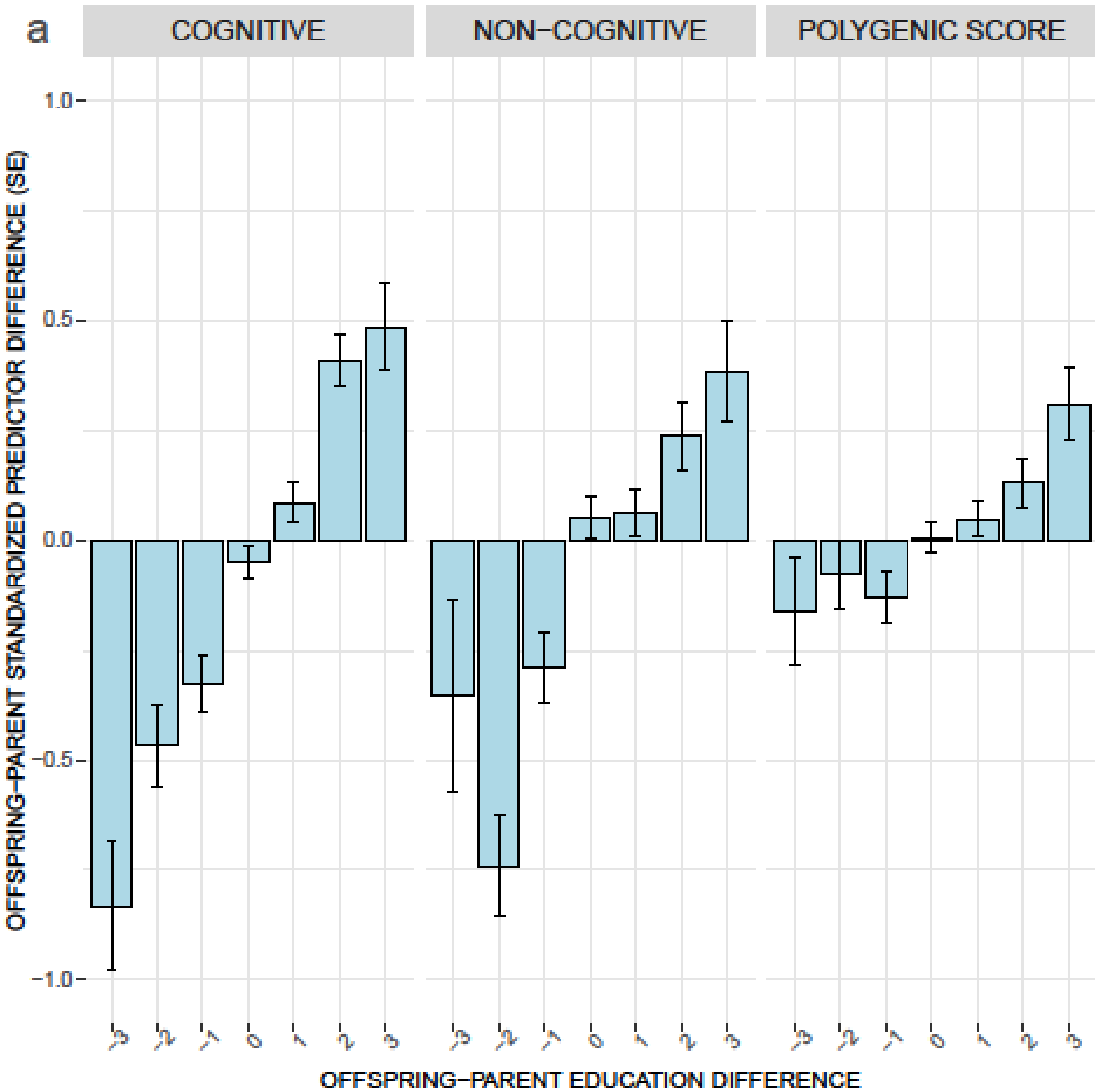
Results of regressing offspring-parent education and occupation differences on GCA, the Non-Cognitive Composite and the PGS are summarized in Table 1; results for the individual non-cognitive components are given in Table S5 (SOM). The Offspring Univariate columns give results when offspring-parent outcome differences are regressed separately onto offspring scores on each of the three predictors. This analysis, which does not make use of the parent scores, shows that only the Non-Cognitive Composite is consistently predictive of both educational and occupational mobility. A much different pattern emerged, however, when social mobility was predicted by offspring-parent score differences. Offspring-parent differences in GCA and the Non-Cognitive Composite were consistently and significantly associated with social mobility (columns labelled Offspring-Parent Difference Univariate in Table 1). The effect sizes were moderate in magnitude, stronger for GCA than the Non-Cognitive Composite, with increasing offspring-parent difference in social attainment being associated with increasing offspring-parent difference in underlying skills (Figure 3).

Table 1. Ordinal regression of offspring-parent difference in education and occupation level (i.e., mobility) as a function of both offspring and offspring-parent difference in general cognitive ability (GCA), Non-Cognitive Composite and Polygenic Score (PGS)

Predictor	Educational Mobility						Occupational Mobility					
	Offspring Univariate		Offspring-Parent Difference Univariate		Offspring-Parent Difference Multivariate		Offspring Univariate		Offspring-Parent Difference Univariate		Offspring-Parent Difference Multivariate	
	OR (95% CI)	χ^2 (1df) P	OR (95% CI)	χ^2 (1df) p	OR (95% CI)	χ^2 (1df) p	OR (95% CI)	χ^2 (1df) P	OR (95% CI)	χ^2 (1df) p	OR (95% CI)	χ^2 (1df) p
GCA	1.03 (0.95,1.12)	0.58 p = .45	1.61 (1.48,1.76)	120.0 p < .001	1.55 (1.40,1.71)	76.2 p < .001	1.13 (1.03,1.23)	7.3 p = .007	1.58 (1.45,1.73)	108.1 p < .001	1.46 (1.32,1.62)	54.6 p < .001
Non-Cognitive Composite	1.36 (1.26,1.48)	55.6 p < .001	1.31 (1.21,1.41)	50.5 p < .001	1.24 (1.15,1.34)	29.4 p < .001	1.40 (1.28,1.52)	58.3 p < .001	1.36 (1.27,1.47)	67.8 p < .001	1.32 (1.22,1.43)	48.2 p < .001
PGS	1.03 (0.94,1.12)	0.43 p = .51	1.30 (1.16,1.46)	20.5 p < .001	1.20 (1.07,1.36)	9.0 p = .003	1.04 (0.95,1.14)	0.78 p = .38	1.31 (1.16,1.47)	19.8 p < .001	1.25 (1.10,1.41)	12.2 p = .001

Note: In all regressions, the outcome was offspring-parent difference in either education or occupation level. Offspring Univariate gives results when outcome was regressed on each of the three offspring scores separately; Offspring-Parent Difference gives results when outcome was regressed onto offspring-parent differences in predictors either separately (Univariate) or simultaneously (Multivariate). All regressions included sex and age as covariates and regressions with the PGS also included ten principal components to account for residual population stratification. All predictor variables were standardized to facilitate interpretation of ORs.

OR = Odds ratio, GCA = general cognitive ability, PGS = polygenic score, CI = Confidence interval



a
COGNITIVE
NON−COGNITIVE
POLYGENIC SCORE
OFFSPRING−PARENT STANDARDIZED PREDICTOR DIFFERENCE (SE)
1.0
0.5
0.0
−0.5
−1.0
-3
-2
-1
0
1
2
3
OFFSPRING−PARENT EDUCATION DIFFERENCE

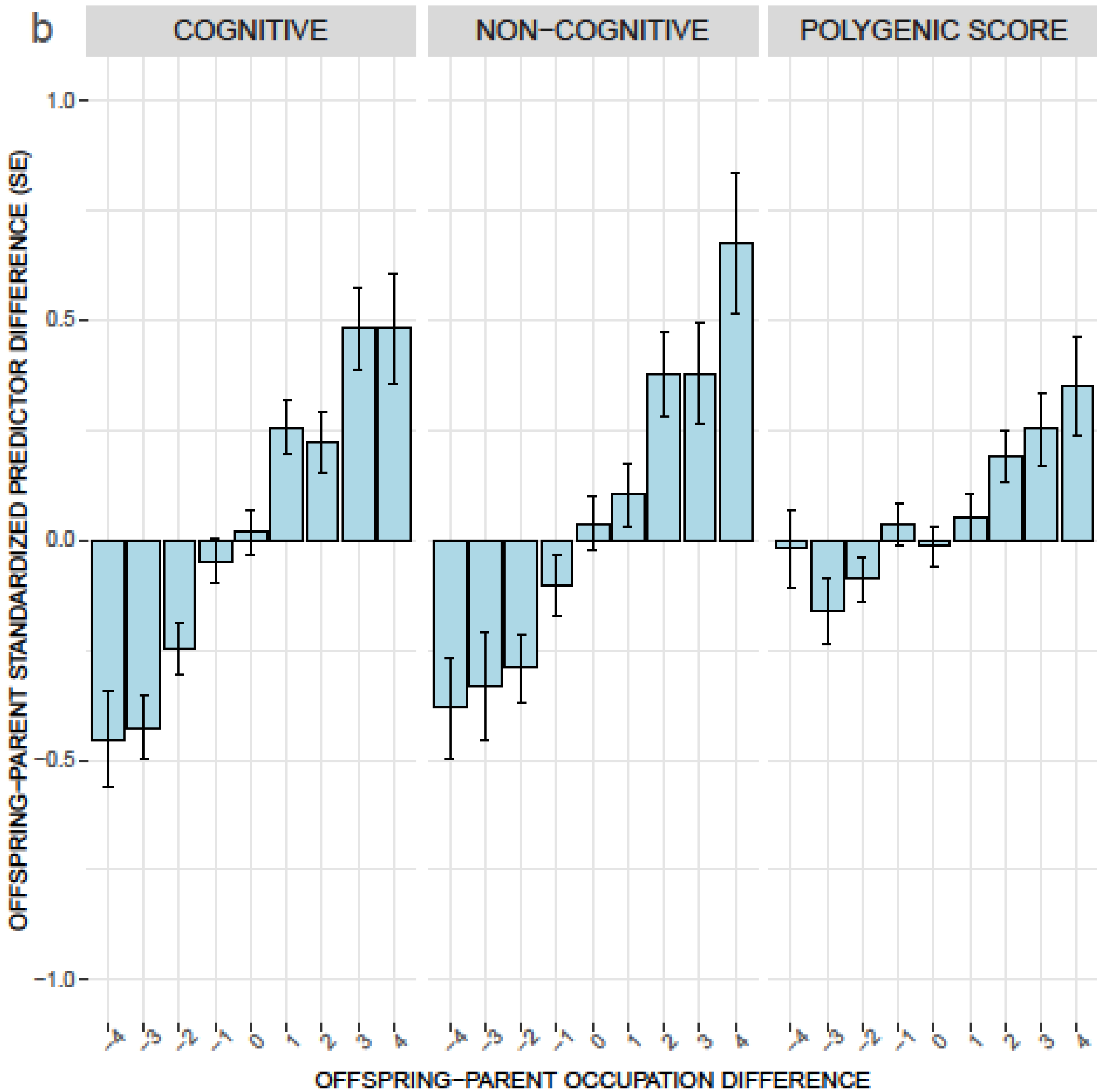


Figure 3. Mean offspring-parent differences in General Cognitive Ability, Non-Cognitive Composite and educational attainment Polygenic score by number of education (a) and occupation (b) levels adult offspring had moved relative to their parents (positive scores reflect greater offspring achievement). Measures were all standardized separately in the offspring and parent samples before taking the offspring-parent difference. Error bars demarcate + one standard error; difference scores were winsorized to + 3 for Education and + 4 for occupation to provide adequate samples at the extremes (see SOM)

GCA and the Non-Cognitive Composite were only weakly correlated in both the offspring (correlation of .18, 95% CI=.13, .23) and parent (.17, 95% CI=.12, .22) samples (Table S6, SOM). Consequently, together they should predict social mobility better than either alone. The combined associations of offspring-parent differences in GCA and the Non-Cognitive Composite with educational and occupational mobility are illustrated in Figure 4. Among offspring who scored at least one standard deviation higher than their parents on both GCA and the Non-Cognitive Composite, 58.8% (N=97; 95% CI=48.6%, 69.0%) exceeded the highest educational level of their parents and 63.7% (N=82; 95% CI=52.3%,75.1%) exceeded their parents' highest occupational level. At the other extreme, only 7.2% (N=97; 95% CI=0.6%,13.8%) and 23.8% (N=82; 95% CI=13.8%, 33.8%) of these individuals failed to achieve as much as their parents did educationally and occupationally, respectively.

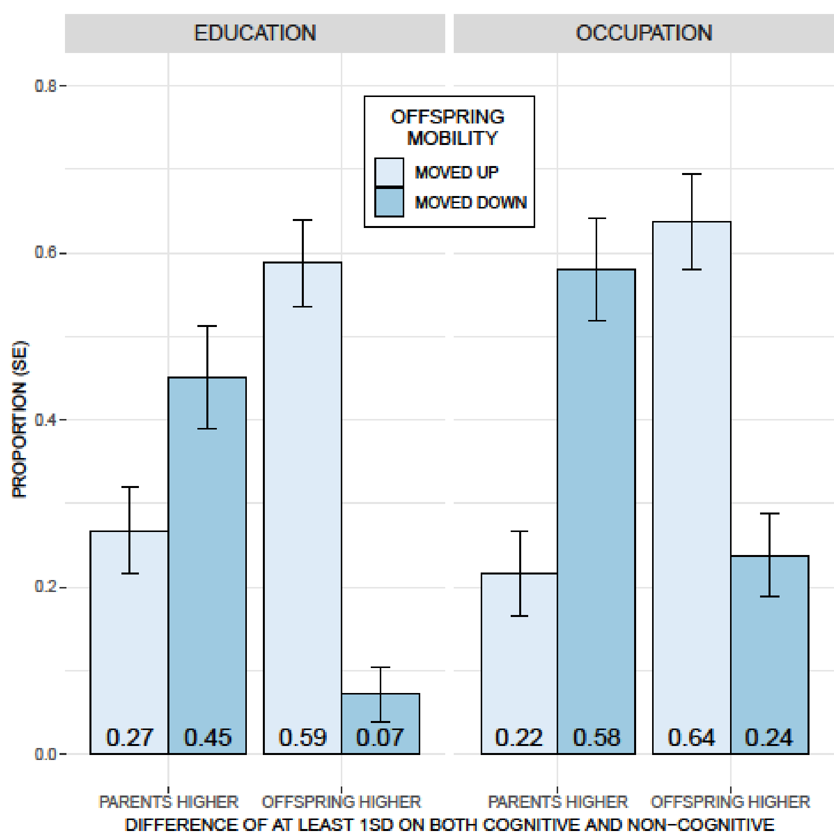


Figure 4: Combined effect of offspring-parent differences in cognitive and non-cognitive factors on intergenerational mobility. Plotted is the proportion of offspring that either moved up or moved down relative to their parents according to whether they exceeded their parents' cognitive and non-cognitive scores by at least one standard deviation (SD) each or fell below their parents' scores by at least one standard deviation on both.

To test whether the association of each predictor with social mobility depended on social origin, we followed the method proposed by Nettle (2003) and regressed each predictor variable on offspring-parent difference in attainment, parent level of attainment and their interaction, separately for education and occupation. Regression results are given in Table S7 and illustrated for educational attainment in Figure S3 (SOM). The coefficients associated with the interaction were uniformly small and none approached statistical significance (all χ^2 (1df) < 1.2; all p > .29). As shown in Figure S3, the association of each predictor with upward and downward mobility showed no clear dependence on level of parent education.

The Role of Genetics in Intergenerational Mobility

As expected, the PGS based on weights from an independent GWAS of educational attainment was associated with both educational and occupational achievement in both the parent and offspring samples (Figure 1). Correlations ranged from .26 to .32 for educational attainment and from .19 to .24 for occupational attainment (Table S3, SOM). There was no evidence of gender moderation in the regression of either education (χ^2(1df) = 0.20, p = .66) or occupation (χ^2(1df) = 0.15, p = .70) on the PGS.

Associations of the PGS with social outcomes may reflect genetic causation or environmental confounding due to passive gene-environment correlation. Although offspring inherit all their genetic material from their parents, they inherit random subsets of their parents' genes due to meiotic segregation. Consequently, we can address the possibility of passive gene-environment correlation by determining whether inheriting a favorable combination of genes is associated with upward social mobility while a less favorable combination is associated with downward mobility. This is what occurred in the present sample (Figure 3, Table 1). Specifically, offspring who achieved a higher educational or occupational level than their parents, tended to have higher PGS than their parents. Conversely, children who fell short of their parents' social achievements tended to have PGS that were lower than their parents.

We expected that genetic variants contributing to educational attainment would also be associated with to the cognitive and non-cognitive skills necessary to attain it. Consistent with this expectation, a PGS for educational attainment has been shown in earlier research to be correlated with both cognitive and non-cognitive predictors of social success, with the magnitude of the former being generally greater than the latter (Krapohl et al., 2016). Consequently, genetic contributions to intergenerational mobility may overlap with genetic contributions to the cognitive and non-cognitive factors underlying social success. Supporting this, offspring-parent PGS difference was significantly correlated with offspring-parent differences in GCA, although not with the Non-Cognitive Composite (Table S8, SOM). Regressing offspring-parent difference in educational or occupational level on differences in GCA, the Non-Cognitive Composite and the PGS simultaneously we observed that all three predictors remained significantly associated with both social outcomes (Table 1, columns labelled Multivariate). The cognitive and non-cognitive skills we assessed did not fully account for the genetic contributions to within-family mobility we observed.

Discussion

The inverse association of inequality with social mobility has raised the specter that individuals from disadvantaged backgrounds will have limited opportunity to rise above the circumstances of their births, especially in high-inequality countries such as the U.S. (Corak, 2013). The persistence of social standing across generations we observed provides some support for this concern. Offspring of parents with the lowest educational credentials, for example, were 3.5 times more likely than offspring of the most highly educated parents to achieve no more than the lowest educational level. Nonetheless, our findings do not support the claim that educational and occupational success is a matter of inherited privilege (McNamee, 2018). We found that a majority of individuals from the least advantaged homes achieved more educationally and occupationally than their parents, and, conversely, a majority of individuals from the most advantaged homes achieved less. Our study implicated offspring-parent skill differentials as contributing to the considerable re-ordering of social standing we observed across generations. Individuals rarely moved down and frequently moved up when they were more skilled than their parents.

Our finding that offspring-parent differences in skills and genetic endowment were consistently and robustly associated with intergenerational mobility does not unequivocally imply the former causes the latter. Nonetheless, our prospective, within-family design provides a basis for stronger inference than a standard cross-sectional design. We believe a reasonable explanation of our findings is that the degree to which individuals are more or less skilled than their parents contributes to their upward or downward mobility. Behavioral genetic and genomic research has established the heritability of social achievements (Conley, 2016) as well as the skills thought to underlie them (Bouchard & McGue, 2003). Nonetheless, these associations may be due to passive gene-environment correlation, whereby high-achieving parents both transmit genes and provide a rearing environment that promote their children's social success (Scarr & McCartney, 1983). Our within-family design controlled for passive gene-environment correlation effects. Although offspring inherit all their genes from their parents, they inherit a random subset of parental alleles due to meiotic segregation. Consequently, some offspring inherit a favorable subset of their parents' alleles while others inherit a less favorable subset. As in previous research (Belsky et al., 2018), we found that the inheritance of a favorable subset of alleles was associated with an increased likelihood of upward mobility while inheriting a less favorable subset was associated with an increased likelihood of moving down. It is noteworthy that the offspring-parent difference in measured genetic endowment was significantly correlated with offspring-parent difference in general cognitive ability but not the non-cognitive composite. While our within-family analysis of measured genetic endowment provides additional support for a causal influence of general cognitive ability on social mobility, the PGS clearly accounted for a small portion of the mobility effects we observed. Even in a GWAS of over one million participants the vast majority of heritable effects on education remains undetected (Lee et al., 2018), limiting the predictive utility of our PGS.

Throughout much of the 20^{th} century, expanding opportunity ensured that a large majority of individuals in each generation achieved more than their parents, reinforcing belief in the "American Dream". Expansion has, however, slowed in the 21st century (Hout & Janus, 2011), so that upward movements are increasingly offset by downward movements. Several have posited the existence of a "glass floor", whereby those from the most advantaged backgrounds are preferentially protected from downward forces (Gugushvili, Bukodi, & Goldthorpe, 2017). A glass floor effect should manifest as attenuated downward mobility among low-skilled individuals from advantaged backgrounds; that is, an interaction (Nettle, 2003). We found no evidence of a glass floor, however, as parent education level did not moderate the association of offspring skill with social mobility. This is not to claim that social background was unimportant. We found consistent social background effects on educational and occupational attainment even when accounting for the effects of the skills we assessed. Yet rather than being a consequence of exclusive opportunities advantaged parents provide their children, a residual social background effect could, in part, reflect skills unassessed in our study. Most notably, relative to the cognitive domain, we know little about the full range of non-cognitive contributors, which likely span health and physical attributes through higher-level personality factors. There is a need for research on the nature and structure of non-cognitive contributors so that we might better understand how psychological, physical and social factors combine to contribute to social advancement (Humphries & Kosse, 2017). In any case, the absence of interaction effects implies that there are constraints on the extent to which advantaged parents can protect their low-skilled offspring from downward mobility.

Americans acceptance of income inequality is linked with their perception that the American socioeconomic system is meritocratic (Reynolds & Xian, 2014), which can have the salutary effect of motivating individual effort (Browman, Destin, Kearney, & Levine, 2019). For those who appear to be disadvantaged by the current socioeconomic system, belief in meritocratic processes may nonetheless appear paradoxical. In a series of studies, Jost and colleagues (Jost et al., 2015) have presented evidence suggesting that people are motivated to justify the existing social system because doing so reduces uncertainty and threat and increases their satisfaction with the world in which they live. Our results suggest that other factors may also contribute to a belief in system fairness. Specifically, many people are likely to observe directly social mobility within their own families. Seeing first hand that family members who work harder and are more skilled tend to be the ones who also achieve more educationally and occupationally may be a powerful influence on belief in meritocratic processes.

In interpreting our findings it is important to consider several study limitations. First, as was typical for the Minnesota birth years considered, our sample is overwhelmingly of European ancestry and applicability to other populations is uncertain. Second, the assessment of skills occurred at different developmental stages for parents and offspring. What impact, if any, this has on our results is difficult to say, although the behavioral genetic literature does indicate that the importance of genetic factors increases with age for many behavioral traits. Finally, our focus has been on intergenerational educational mobility, which we believe is an appropriate focus for a psychological investigation. Nonetheless, other aspects of mobility, and in particular income mobility, may show much different patterns than the ones shown here.

In summary, our analysis of intergenerational social mobility in a sample of 2594 offspring from 1321 families found that: 1) most individuals were educationally and occupationally mobile; 2) mobility was predicted by offspring-parent differences in skills and genetic endowment; and 3) the relationship of offspring skills with social mobility did not vary significantly by parent social background. In an era where there is legitimate concern over social stagnation, our findings are noteworthy in identifying the circumstances when parent educational and occupational success is not reproduced across generations.

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Supplementary Materials

Additional methodological descriptions are provided in the supplementary materials.

Data Availability

Once in press, the data (anonymized) used in all analyses here will be made available to the general public. This data and associated documentation has been placed at the Open Science Framework (OSF) website and is available to reviewers through the following link:

https://osf.io/xhnsy/?view_only=d284718a56034df2bdb51184a23d47b9

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