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Skills, signals, and employability: An experimental investigation☆

Marc Piopiunik[a], Guido Schwerdt[b], Lisa Simon[c], Ludger Woessmann[d,*]

[a] *Ifo Institute at the University of Munich, CESifo, Germany*
[b] *Department of Economics, University of Konstanz, CESifo, IZA and ROA, Germany*
[c] *Stanford Graduate School of Business, Stanford University, United States*
[d] *University of Munich, Ifo Institute, CESifo, IZA, and CAGE, Germany*

A B S T R A C T

Because most skills of labor-market entrants are not directly observed by employers, individuals acquire skill signals. To study which signals are valued by employers, we randomize several skill signals on resumes of fictitious applicants among which we ask a large representative sample of German human-resource managers to choose. We find that signals in both studied domains – cognitive and social skills – have significant effects on being invited for a job interview. Consistent with their relevance, expectedness, and credibility, different signals are effective for apprenticeship applicants and college graduates. While GPAs and social skills are significant for both genders, females are particularly rewarded for IT and language skills. Older HR managers value school grades less and other signals more. HR managers in larger firms value college grades more.

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1. Introduction

Cognitive and non-cognitive skills predict individuals' labor-market performance (e.g., Heckman et al., 2006a). But employers cannot directly observe the skills of job applicants. Therefore, individuals make costly investments to signal their skills to potential employers. So far, however, it is not well understood to what extent different specific skill signals - characteristics in which workers can invest - affect hiring decisions. When making hiring decisions, employers simultaneously consider many different and potentially highly correlated signals, and researchers typically do not observe all of these sig-

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* Corresponding author.
E-mail addresses: piopiunik@ifo.de (M. Piopiunik), guido.schwerdt@uni-konstanz.de (G. Schwerdt), lksimon@stanford.edu (L. Simon), woessmann@ifo.de (L. Woessmann).

nals. As a consequence, a more nuanced empirical investigation of the relative importance of different skill signals for employability is challenging.

In this paper, we investigate how several skill signals affect labor-market entry in an experimental setting. We conduct a randomized lab-in-the-field experiment among 579 human-resource (HR) managers, exploiting our access to the ifo Personnel Manager Survey, a regular survey of HR managers representative of German firms. The experimental design gives us full control over the information set available to firms. In a factorial design, we simultaneously randomize multiple skill signals that are typically contained in applicants' CVs in Germany. This setup allows us to base our identification strategy on independent and exogenous variation in different signals within two broad skill domains: cognitive and social skills. Due to differing relevance, expectedness, and credibility of various skill signals, the impact of specific signals might critically depend on the educational degree of applicants. Therefore, about half of the HR managers receive applications from secondary-school graduates for an apprentice position. The other half receive applications from college graduates in business administration for a business trainee position.[1]

The choice experiments confront HR managers with resumes of two fictitious job applicants, asking them to indicate the applicant whom they would rather invite for a job interview in their firm. The only information on the applicants available to HR managers are the elements of the resumes. Specifically, cognitive skills are signaled by grade-point averages (GPAs) in school for secondary-school graduates and in college for college graduates, as well as by IT skills, fluency in English, and a second foreign language. Social skills are signaled by social volunteering and team sports (as opposed to single sports).[2] Additional CV elements are age within the cohort and length of internship. We carefully selected these CV elements in a prestudy, conducting qualitative interviews with HR managers to identify the pieces of information that are typically included in resumes of real applicants in Germany. In our survey, we complement the choice experiments with a questionnaire of the HR managers.

We find that signals of both cognitive and social skills significantly affect the probability of being invited for a job interview. GPAs prove important for both genders, with a stronger effect for college graduates than for secondary-school graduates. IT and language skills are particularly relevant for females. Social skills are highly relevant for both genders and particularly important for secondary-school graduates who enter the labor market at a young age.

These heterogeneities by labor-market entry age and gender are consistent with varying relevance, expectedness, and credibility of the different skill signals in different contexts. In particular, gender differences in the effects of IT skills and language skills are generally in line with gender stereotyping. Social skills are most effectively signaled by social volunteering among secondary-school graduates but by engaging in team sports among college graduates, possibly reflecting limited credibility of volunteering activities of older individuals who may behave strategically. In addition, skill signals that are easily verifiable in real hiring situations such as GPAs (available on transcripts usually included in German applications), age, and internships, tend to have higher returns than skills that are costlier to verify, such as language skills and social volunteering.

Exploiting our HR-manager questionnaire, we also find heterogeneities with respect to HR managers' personal characteristics. Most importantly, managing directors and older HR managers put less weight on the school GPAs of apprenticeship applicants, but instead put more weight on IT skills, social volunteering, and experience through internships. HR managers in large firms value the college GPAs of college graduates more, possibly due to a more standardized procedure of applicant selection.

In the questionnaire, we also ask HR managers to indicate the importance they attach to various resume attributes of actual job applicants in their firm. We find that HR managers' self-reported hiring priorities tend to be in line with their decisions between the fictitious candidates' resumes in the choice experiments. This finding increases our confidence that the preferences of HR managers observed in the choice experiment are informative about their actual decision making in real hiring situations.

Overall, our results indicate that a broad range of skill signals indeed causally affect employment chances at labor-market entry. Employers value skill signals in different domains. While situated in a specifically designed experimental setting, the results add an important dimension to our understanding of how labor markets process and use information on skills. When observational data indicate that signals such as high-school grades are associated with labor-market outcomes, it remains unclear whether employers really value grades or whether the association captures other productivity aspects that happen to be correlated with grades, whereas grades are potentially never conscientiously observed by employers. Even in the setting of a convincing natural experiment, it is hard to imagine a research design that can separately identify independent exogenous variation in different skill dimensions such as GPAs and social engagement.

[1] To avoid unrealistic situations, the resumes are adjusted to the firm of the HR manager. Most importantly, using information on the educational composition of the firms' workforce that we elicited in a pre-survey, secondary-school graduates applying for an apprentice position are presented only to HR managers in firms that currently offer apprenticeship positions. Similarly, applications of college graduates are only shown to HR managers whose firms employ college graduates.

[2] Note that the categorization of the various CV elements into two broad domains is meant as a structuring device. Hence, we do not claim that each CV element falls cleanly into one domain only. Likely, signals that are included in real-world CVs - the subject of this study - always reflect components of different domains but tend to be perceived as having a focus in one of the domains. For example, foreign language fluency may be directly productive in a non-cognitive way (e.g., for sales) in addition to signaling cognitive skills.

Our results contribute to the large literature that has established that labor-market outcomes are associated with different types of skills.[3] Skills may be reflected through educational degrees (e.g., Heckman et al., 2006b) or more directly observed in terms of cognitive skills (e.g., Hanushek and Woessmann, 2008; Chetty et al., 2011; Hanushek et al., 2015; 2017). Social skills seem to have become increasingly important on modern labor markets that value team production (Deming, 2017, see also Weinberger, 2014). Despite the wide evidence that these different types of skills are associated with labor-market success, it is less clear whether, and for which groups of applicants, *signals* of these skills that can be observed at the application stage have a causal impact on the employability at career start.

Our results on heterogeneous effects by relevance, expectedness, and credibility contribute to the literature indicating that the importance of skill signals differs by context.[4] For example, returns to skill signals may depend on tenure because of employer learning (Altonji and Pierret, 2001) and on the better observability of ability for college graduates than for high-school graduates (Arcidiacono et al., 2010). Returns to college reputation depend on the availability of college exit exams as an additional skill signal (MacLeod et al., 2017), and the information value of high-school grades depends on whether they are obtained in local or centralized exams (Schwerdt and Woessmann, 2017). If because of stereotyping, members of a specific group are perceived as having certain skills while non-members are not, signals for the same skills may matter more for non-members (e.g., Lummis and Stevenson, 1990; Gorman, 2005; Lang and Manove, 2011).

Our research design also adds to the literature on resume audit studies. This literature has largely focused on discrimination in the labor market, investigating the effects of *innate* characteristics such as gender and race (for recent overviews see Rich, 2014; Bertrand and Duflo, 2017; Neumark, 2018; Baert, 2018).[5] By contrast, we are interested in the returns to resume characteristics that firms use as signals of productivity, with a focus on the effects of characteristics that are typically *acquired intentionally*.[6] A related important difference between most of the existing CV study literature and our study is that statistical discrimination based on innate characteristics is typically considered unfair in the sense that it is based on circumstances that are beyond a person's control (Roemer, 1998).[7] By contrast, differential treatment of job applicants is generally considered fair to the extent that it is based on differences in signals that reflect differences in ability or effort. According to theories of job market signaling and screening (e.g., Riley, 2001), these skill signals have to be acquired by individuals since actual skills are not directly observed by employers at the application stage.[8]

Recently, several randomized CV studies have started to investigate the importance of signals of non-innate characteristics in the hiring process. These studies cover a wide range of characteristics such as leisure sports activities (Rooth, 2011), math skills (Koedel and Tyhurst, 2012), unemployment duration (Kroft et al., 2013; Eriksson and Rooth, 2014; Farber et al., 2016), school grades and teacher evaluations (Protsch and Solga, 2015), field of study (Humburg and Van der Velden, 2015), professional experience (Humburg and Van der Velden, 2015; Boyd-Swan and Herbst, 2018; Beam et al., 2020), internship experience (Nunley et al., 2016), student work experience (Baert et al., 2016), for-profit college credentials (Darolia et al., 2015; Deming et al., 2016), overqualification (Baert and Verhaest, 2019; Verhaest et al., 2018), social volunteering (Heinz and Schumacher, 2017; Baert and Vujić, 2018), criminal records (Agan and Starr, 2018), membership in student unions (Baert and Verhaest, 2018), and additional training (Kübler et al., 2019).[9] A common feature of these studies is the focus on one (or a few) specific characteristic(s). This has the advantage that it allows for a greater conceptual sharpness in the sense that it becomes easier to ensure a high correspondence between the specific text signal on the resume and the underlying characteristic. In practice, however, many of the most common important text signals in resumes cannot necessarily be exclusively mapped to a single trait. Still, these text signals may very well be the most important signals for the decision maker, but the relative relevance of different signals typically included in resumes is largely unknown.

Our study investigates the joint and relative relevance of several resume characteristics that are typically included in real-life resumes by simultaneously randomizing multiple signals, such as school GPA, college GPA, foreign language skills, social volunteering, type of sports, and length of internship. This focus on a broad array of skill signals reflects the fact that marketable skills are not unidimensional. Furthermore, our study highlights that the importance of resume characteristics may strongly depend on the educational level of applicants (high school or college degree) that is required for the job. For

[3] Section 2 of the working-paper version of this paper (Piopiunik et al., 2018) provides a more extensive literature discussion, covering how the labor-market effects of different skills may depend on skill observability, signal quality, and context, with a particular focus on the relevance, expectedness, and credibility of the signal.

[4] For the literature on the role of costly skill signals in determining labor-market outcomes, see Spence (1973), Arrow (1973) and Stiglitz (1975) for seminal contributions and Riley (2001) for a survey. A recent study investigating the signaling value of educational credentials is Clark and Martorell (2014).

[5] A general limitation of CV studies that our study has in common with this literature is that only the first stage of the application process - the interview invitation - is observed, but not actual job offers or wages.

[6] To abstract from the aspects studied in the discrimination literature, we keep gender fixed within CV pairs and use only standard German names.

[7] According to the nondiscrimination principle, individuals who compete for positions in society should be judged only on attributes that are relevant to the performance of the duties of the respective position. Therefore, attributes such as gender or race should not be considered.

[8] Throughout the paper, we refer to *signaling* simply as the revelation of otherwise unobserved information, without any claim about whether the signaling process is productive or unproductive from a welfare perspective.

[9] Oreopoulos (2011) looks at the impact of language fluency, multinational firm experience, education from selective schools and extracurricular activities, but exclusively in the context of discrimination against immigrants. In a non-randomized pre-post setup of a CV study, Falk et al. (2005) study the effect on job interview invitations of a training course meant to raise basic computer skills.

example, participating in team sports might have different effects on the probability of being invited to a job interview depending on whether the applicant is a 17-year-old school graduate or a 24-year-old college graduate.[10]

In our study, HR managers are fully aware that they are dealing with fictitious job applicants, which is not the case in most existing CV studies. One leading motivation for not being transparent about the true nature of applications in conventional CV studies is concern about social desirability bias in HR managers' behavior. We are less concerned about social desirability bias in our setting because we do not study discrimination against certain groups of applicants such as women, blacks, or foreigners. Another potential disadvantage of our experimental setup is that participating HR managers are aware that they make hypothetical rather than real choices, so they lack monetary incentives to provide their best choices.[11] Apart from not deceiving participants, the transparency of our research design also has several advantages. First, the proliferation of correspondence audit studies puts substantial costs on the hiring systems of firms (see the critique by Hamermesh, 2012). Second, the flooding of online portals with fictitious CVs might lead to artificial results because initial hiring decisions are increasingly computerized, whereas final job offers are made by HR managers. Instead, we make use of evaluations by those HR managers who actually make the hiring decisions in their firms. Third, in contrast to studies that contact job portals, our survey-based approach enables us to collect information on decision-makers' characteristics and hiring preferences.[12] This allows both investigating effect heterogeneity by HR manager characteristics and assessing whether self-reported hiring priorities are consistent with decisions in the experimental setup.[13] Fourth, in our setting we have complete information on *all* applicants that an HR manager faces. In contrast, researchers sending fictitious resumes to real job openings do not have information on the characteristics of the other (real) job applicants for the same position. The distribution of relevant resume characteristics of the other job applicants, however, likely affects job interview decisions.[14]

In what follows, Section 2 describes the experimental design of our CV study. Section 3 reports the baseline results of the choice experiments. Section 4 investigates heterogeneous effects for different HR managers. Section 5 concludes.

2. Experimental design

To investigate the importance of skill signals for employability, we conduct a lab-in-the-field experiment with randomized CVs among German HR managers. We apply a factorial design in which several random treatments of skill signals are assigned independently of each other.

2.1. Choice experiments in the HR manager survey

We conduct our online survey experiment among HR managers who participate in the ifo Personnel Manager Survey.[15] The ifo Institute is an independent economic research institute that regularly administers business surveys including Germany's main business climate index. The quarterly survey of personnel managers is generally used to construct an index of the usage of personnel management instruments and to investigate current topics of personnel policy. We conducted our survey as a special additional survey in August 2016.[16] The firms covered by the database are a representative sample of firms in Germany (Sauer and Wohlrabe, 2020).

In our survey, we confront each HR manager with two choice experiments. In each choice experiment, we ask HR managers to compare resumes of two fictitious applicants (either two secondary-school graduates or two college graduates) which are presented side by side on the same screen.[17] The HR managers are asked to choose the candidate they would

[10] Similar to field experiments using randomized CVs, we measure the impact of various CV characteristics without investigating the underlying mechanisms of what exactly is signaled by the CV characteristics to potential employers. However, in contrast to field studies, we show that HR managers' self-reported hiring priorities (reported after the experiment) are consistent with their decisions in the experimental setup (see Section 4.2)

[11] If relevant, the most likely concern would be bias from inattention, which would likely attenuate our estimates. Recent evidence indicates, however, that non-incentivized survey responses on economic preferences are correlated with revealed preferences elicited in incentivized choice experiments (Falk et al., 2018) and that non-incentivized survey responses correspond closely to actual real-world behavior (Grigorieff et al., 2016; Haaland and Roth, 2017; Alesina et al., 2018). Concerns of intentional false answering behavior are also mitigated by evidence that lying costs in a German survey were found to be large and widespread (Abeler et al., 2014). In addition, our evidence of lack of effects of left- vs. right-side placement of CVs and of consistency between choices and self-reported hiring priorities speaks against major bias from lack of incentives.

[12] We also have access to rich information on the firms, including their workforce's educational composition.

[13] In an alternative attempt to learn about heterogeneity across screeners of resumes, Lahey and Oxley (2018) use eye-tracking technology, albeit on a sample of students in the lab rather than actual HR managers.

[14] For example, assuming that employers value math skills, the estimated returns to math skills will be lower if most applicants possess high math skills (since this lowers the probability that a fictitious applicant with high math skills gets invited to a job interview), compared to a situation where hardly any applicant possesses high math skills. Since we have complete information on the distribution of characteristics of all applicants, the magnitudes of the estimated skill signals are directly comparable with each other and not influenced by resume characteristics of unknown job applicants.

[15] For more information on the ifo Personnel Manager Survey, see https://www.cesifo-group.de/ifoHome/facts/Survey-Results/Personalleiterbefragung.html.

[16] HR managers of firms in the ifo database were first contacted by mail with the request to participate in a special additional survey. The letter informed the HR managers that the ifo Institute was to carry out a scientific study that was financed by the German Ministry of Education and Research. They were told that they would receive an email a few days later that included a link to the online survey and that completing the survey would take about three minutes. Additionally, the letter stated that the goal of the survey was to study hiring decisions in Germany and that all answers would be kept strictly confidential.

[17] In the instructions of the choice experiment, HR managers were asked to imagine that their firm had a vacancy - either an apprenticeship position or a traineeship position for a business university graduate - and to consider the two shown fictitious applicants for that position.

rather invite for an interview in their firm.[18] We force HR managers to select exactly one of the two candidates to mimic the fact that HR managers ultimately have to make choices and to increase statistical power in the empirical analysis. HR managers complete the two choice experiments sequentially and are not able to revise their decisions.

To present realistic candidates to HR managers, we elicited information on the educational structure of the firms' workforce in a pre-survey, conducted in the context of a regular ifo Personnel Manager Survey prior to our main survey. Based on the share of employees with college degrees and the presence of apprentices in the firm, we split firms in our database into two groups meant to be of roughly equal size. HR managers in firms with a high share of college-educated employees were shown resumes of fictitious college graduates applying for a fictitious graduate trainee position.[19] The second group of HR managers, who had apprentices in their firm at the time of our survey, were shown resumes of fictitious secondary-school graduates with an intermediate school degree applying for a fictitious apprentice position.

To create realistic resumes, we used real resumes to set up our fictitious resumes.[20] Prior to our main survey experiment, we conducted field interviews with HR managers responsible for selecting candidates in six firms located in Munich (also drawn from the ifo Personnel Manager Survey database) to assess whether our fictitious resumes were realistic. Importantly, all interviewed HR managers stated that our skill signals included in the fictitious resumes are relevant criteria at the first stage of the hiring process. We also discussed the values that these signals typically take on in practice, e.g., the common range of values of school and college grades. The expert interviews helped to set up realistic resumes appropriate to answer our research questions and provided feedback on the HR-manager questionnaire (see Section 4).

2.2. The resumes

Secondary-school graduates

The resumes shown to the HR managers are one-page CVs that contain standard information that would generally be included in job applications in Germany.[21] Appendix A.1 describes all elements of the resumes of secondary-school graduates in detail. Fig. A.1 shows the English translation of an example of a resume of a secondary-school graduate and Table A.1 lists all possible values of all CV elements.

All fictitious secondary-school graduates obtained an intermediate school degree (*Mittlere Reife*) after 10 years of schooling.[22] Because mobility is typically low among individuals with an apprenticeship education in Germany, all secondary-school graduates were born and attended school in the state of the HR manager's firm.[23] At the beginning of the online survey, HR managers are asked whether their firm offers predominantly technical or commercial apprenticeships. Depending on the answer to this question, the resumes include candidates who have completed an internship in the respective field - technical or commercial (technical internships differ by gender, whereas commercial internships do not, see Table A.1). To further increase realism, we ensure that HR managers receive female applicants only if the share of female employees in their industry is at least 20 percent.[24] As these gender-specific choices in our experimental design may affect gender-specific outcomes (which should be borne in mind when interpreting gender-specific findings), below we also report results for subsamples of sectors without gender differences in CV elements.

The resumes include the following specific signals of the two broad domains of skills that we focus on in this study.[25] *Cognitive skills* of secondary-school graduates are signaled by their final GPA in school, extended IT skills, English proficiency,

[18] As the CV elements are randomized, the (left or right) position of a given CV on the screen is also random. As the results below indicate, being shown on the left- vs. right-hand side does not predict whether a CV is chosen.

[19] HR managers are assigned to this group if their establishment either (i) does not offer apprentice positions, (ii) has a share of at least 25 percent of college-educated employees, or (iii) has a share of at least 5 percent college-educated employees *and* the majority of apprentices completed the academic high-school track *(Abitur)*.

[20] We did not include a cover letter or a photograph on the resume, which is standard in German applications, since HR managers in our study were fully aware that they face fictitious candidates.

[21] Firms typically receive many applications for apprenticeship positions. Therefore, in the first stage, HR managers pre-select appropriate candidates based on written applications, which include a cover letter, the resume, and various documents. Subsequently, large firms may conduct written tests and ask applicants to do some trial work, followed by job interviews. About 30–40 percent of applicants pass the first stage and only 10–15 percent are eventually invited to job interviews (Protsch and Solga, 2015).

[22] The German school system tracks students (in almost all states) after four years in primary school into three secondary-school tracks that differ in academic orientation: basic school (*Hauptschule*), intermediate school (*Realschule*), and high school (*Gymnasium*). Basic school is the least academic track and lasts until grade 9 or 10. It is typically followed by an apprenticeship in a firm that includes part-time attendance in a vocational school. Intermediate school usually lasts until grade 10 and is traditionally also followed by such an apprenticeship. High school is the most academic track and lasts until grade 12 or 13. It is meant to prepare students for college, with the high-school leaving certificate (*Abitur*) being a precondition for attending college.

[23] Fictitious candidates are born in the capital of the respective state (there are 16 states in Germany), where they have also attended an (existing) intermediate school and completed their internship.

[24] The share of female employees per industry is computed using data from the German Statistical Office from 2015. We distinguish between 62 industries based on the two-digit German Classification of Economic Activity, Version 2003. Kübler et al. (2018) show that female discrimination correlates with the female occupation share in a vignette study of fictitious apprenticeship applicants in Germany.

[25] The assignment of the specific signals to the skill domains serves to consolidate the presentation. We do not argue that each skill signal can be exclusively mapped to one domain. Instead, we categorize each skill signal according to the skill domain it most likely reflects, given all other signals. For example, GPAs likely reflect both cognitive components such as ability and non-cognitive components such as perseverance, but arguably most people would consider GPAs primarily as signals of cognitive skills. An alternative would have been to include information that more clearly reflects only one skill domain, such as Raven scores as reflecting only cognitive skills - but this information would never be reported on a CV. Similarly, engaging in volunteer activities or in team rather than single sports may reflect traits beyond sociability such as initiative or specific aspects of fitness. Continued involvement in

and proficiency in French or Spanish as a second language.[26] *Social skills* are signaled by social volunteering (neighborhood help such as youth work, elderly group, and offering German language courses)[27] and by reporting team sports (as opposed to single sports).[28]

To increase realism of the fictitious resumes, we also include information on month and year of birth, with an age difference of at most four months. The older candidate is born in the calendar year before the younger candidate but, given the year of school graduation, from the same regular school birth cohort. Finally, we include internship duration (two or four weeks).[29]

As HR managers have to select exactly one of the two candidates, we design resumes such that one resume does not clearly dominate the other resume within a CV pair to avoid obvious choices. To this end, we introduce a negative correlation between school GPA (likely an important skill signal) and the other skill signals in the CV. This means that the CV with the better GPA gets worse other skill signals, such as lower IT skills and no social volunteering (see Appendix A.1).

Finally, as the effects of innate characteristics have already been studied extensively in the literature, we intentionally keep these characteristics fixed within the choice sets in our experimental design. That is, we keep gender fixed within CV pairs (but the same HR manager could get a female CV pair in one round and a male CV pair in the other round) and use only fictitious candidates with German nationality and standard German-sounding names (see Appendix A.1).

College graduates

The setup of resumes of college graduates is similar to those of secondary-school graduates, with only few obvious differences. Appendix A2 describes the elements of the resumes of college graduates in detail. Table A.2 lists all values of all CV elements and Fig. A.2 presents the English translation of a sample resume for college graduates.

All fictitious college graduates completed upper-track high school (*Gymnasium*) after 12 years of schooling and obtained a four-year Bachelor's degree in business administration at a public German university. We chose business administration since this is by far the most common college major in Germany, with 15 percent of university students being enrolled in business administration during the academic year 2015/16 (Federal Statistical Office 2016). Because business administration is so pervasive, most firms likely hire college graduates with this major. This choice seems particularly appropriate for our context as we do not send applications to actual job advertisements. Instead, we ask HR managers to choose the better applicant for a hypothetical universal trainee position in their firm with a college graduate who has a business administration degree. We use five top-ranked and five lower-ranked universities to investigate whether the impact of college GPA varies with college quality (the category of top- vs. lower-ranked university is held constant within a CV pair; see Appendix A.2).

For college graduates, *cognitive skills* are signaled by their college GPA, the most recent productivity signal obtained just before entering the labor market. Further signals of cognitive skills again include extended IT skills, English proficiency (measured as 0=basic, 1=very good, and 2=fluent), and proficiency in French or Spanish as a second foreign language. *Social skills* are signaled by volunteering activities that involve intensive interactions with other people (neighborhood help or mobile care services) as opposed to volunteering activities that involve only limited social interactions (preservation of monuments or online IT work and translations for the United Nations). Again, social skills are also signaled by engaging in team sports as opposed to single sports. As for secondary-school graduates, we also include internship duration (one, three, or five months) and information on month and year of birth. Again, the maximum age difference is four months and both candidates are from the same regular school birth cohort. Finally, we also include high-school GPA since this is a standard information in job applications in Germany even among college graduates.

In contrast to secondary-school graduates who apply for an apprenticeship position in their region, college graduates are geographically more mobile. While the fictitious college graduates attended a high school in their city of birth (using schools that actually exist), they are completely mobile with respect to both the college location and the location of the HR manager's firm.

Each element on the resume is randomized independently of all other CV elements, except for one restriction on GPAs: while the first three GPAs within a CV pair (there are two high-school GPAs and two college GPAs) are randomized independently of each other, the fourth GPA, randomized last, is restricted such that no resume contains both a better high-school GPA *and* a better college GPA. We impose this restriction since HR managers may select the resume that dominates the other

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team sports in college may also reflect persistence, determination, and commitment, which may differ from single sports. Facing these trade-offs between conceptual sharpness and creating a realistic choice problem among actually used signals, we opt for the latter and only include important CV elements that are typically included in real applications in Germany, as elicited in our pre-study. While this comes at the cost of having to use a slightly ad-hoc categorization of skill domains, we believe that the proposed categorization is overall very reasonable. At the minimum, it allows for a more structured presentation of the results for the specific skill signals on a typical CV that should be of interest per se.

[26] Grades in Germany range from 1 (very good) to 6 (failed). For the empirical analysis, we recode all grades (GPAs) such that higher values mean better grades.

[27] These social volunteering activities meet the definition of social engagement used in Heinz and Schumacher (2017). They have been shown to be related to the actual willingness of individuals to cooperate as well as to HR managers' beliefs about the willingness of workers to cooperate.

[28] Existing studies show that team-sport athletes tend to be more agreeable and extraverted than individual-sport athletes (see the review by Allen et al., 2013).

[29] While these are short periods, it is uncommon for 17-year-old secondary-school graduates to have more labor-market experience. While a two-week internship may indicate a compulsory internship during the school year, a four-week internship rather indicates a voluntary labor-market experience obtained during vacations.

Table 1
Summary statistics: secondary-school graduate CVs.

	Mean	Std. Dev.
Job interview invitation	.500	
Cognitive Skills		
School GPA	1.460	.628
Extended IT skills	.491	
Fluent English	.516	
French as 2nd language	.237	
Spanish as 2nd language	.265	
Social Skills		
Social volunteering	.458	
Team sports	.500	
Additional CV Elements		
Age within school cohort	.416	
Long internship	.514	
Non-varying Characteristics		
Male	.568	
Technical internship	.477	
State		
Baden-Wuerttemberg	.160	
Bavaria	.254	
Berlin	.003	
Brandenburg	.023	
Bremen	.007	
Hamburg	.020	
Hesse	.072	
Lower Saxony	.088	
Mecklenburg-Vorpommern	.013	
North Rhine-Westphalia	.178	
Rhineland-Palatinate	.024	
Saarland	.007	
Saxony	.088	
Saxony-Anhalt	.010	
Schleswig-Holstein	.020	
Thuringia	.036	
N (CVs)	1228	

Note: Means of CV elements of secondary-school graduates. All variables except school GPA are binary. School GPA is recoded as "4 minus actual grade" such that higher values mean better grades.

resume with two better GPAs. As for the resumes of the secondary-school graduates, we keep gender constant within CV pairs (and, in this case, also within HR managers) and use only candidates with German nationality and German-sounding names.

2.3. Descriptive statistics

We sent the online survey to HR managers in 1,496 firms (one HR manager per firm), of whom 579 HR managers participated. 307 respondents participated in the secondary-school-graduate sample and 272 in the college-graduate sample. Given that each HR manager was exposed to two pairs of resumes, we have a total of 1158 decisions and 2316 resumes.

Table 1 provides summary statistics of the resume characteristics for the secondary-school-graduate sample and Table 2 for the college-graduate sample. By construction, the mean of our outcome variable - the job interview invitation - is 0.5. The average school GPA (GPAs are recoded as "4 minus actual grade" such that higher values mean better grades) is 1.46 for secondary-school graduates and 1.68 for college graduates; average college GPA is 1.67. There are slightly more male applicants in the secondary-school-graduate sample (56.8 percent), reflecting our restriction of female applicants in male-dominated industries.[30]

The distribution of firms in the ifo Personnel Manager Survey is representative for firms in Germany. As shown in Table A.3 in the appendix, HR managers (and their firms) who participate in our study do not differ significantly from non-respondents of the ifo Personnel Manager Survey database in terms of location, industry, number of employees, and share of females in the industry.

A useful way to validate the randomization procedure is to test whether the randomized skill signals predict the characteristics of the HR managers to whom the CVs are assigned. As indicated by the results shown in Tables A.4 and A.5 in

[30] In contrast, the lower share of male applicants in the college-graduate sample arises due to chance in the randomization procedure.

Table 2
Summary statistics: college graduate CVs.

	Mean	Std. Dev.
Job interview invitation	.500	
Cognitive Skills		
College GPA	1.665	.683
Extended IT skills	.500	
Very good English	.367	
Fluent English	.318	
French as 2nd language	.267	
Spanish as 2nd language	.245	
Social Skills		
Social volunteering	.500	
Team sports	.500	
Additional CV Elements		
High-school GPA	1.677	.674
Age within school cohort	.380	
3-months internship	.275	
5-months internship	.330	
Non-varying Characteristics		
Male	.441	
Catholic school	.360	
Comprehensive secondary	.353	
Top-ranked university	.553	
Internship in sales	.232	
Internship in controlling	.395	
College		
University of Munich	.106	
RWTH Aachen	.092	
University of Frankfurt	.110	
University of Cologne	.132	
University Leuphana Lueneburg	.084	
University of Mannheim	.113	
University of Siegen	.098	
University of Trier	.107	
University of Bremen	.084	
High-school State		
Baden-Wuerttemberg	.066	
Bavaria	.202	
Hesse	.132	
Lower Saxony	.153	
North Rhine-Westphalia	.172	
Rhineland-Palatinate	.128	
Thuringia	.147	
N (CVs)	1088	

Note: Means of CV elements of college graduates. All variables except GPAs are binary. GPAs are recoded as "4 minus actual grade" such that higher values mean better grades.

the appendix, F-tests do not reject the null hypothesis that the skill signals are jointly insignificant in predicting the observed HR-manager characteristics, and the incidence of individually marginally significant coefficients is not larger than what would be expected by pure chance. These results speak in favor of a successful randomization that validates causal inference.

2.4. Empirical model

The randomization of the skill signals enables us to identify their causal effects on being invited for a job interview. Using individual resumes as the unit of observation, we model the probability y that the person with CV p ($p = 1,2$), which is part of CV pair i ($i = 1,2$), shown to HR manager j is invited for an interview as a function of a vector of skill signals, S_{pij}:

$$y_{pij} = \beta_0 + \beta_1' S_{pij} + \beta_2 l_{pij} + \mu_{ij} + \eta_{pij} \quad (1)$$

The model includes a full set of CV-pair fixed effects, μ_{ij}. With h_j indicating fixed effects for each HR manager j and r_i (equals 1 if i equals 1 and 0 otherwise) being an indicator for whether the CV pair was the first or second pair shown to the HR manager, these CV-pair fixed effects are equivalent to HR-manager by decision-round fixed effects ($\mu_{ij} = r_i * h_j$). In addition, the model controls for an indicator l_{pij} for the (left- vs. right-hand) side of the screen on which the respective CV

was shown (equals 1 if shown on left-hand side and 0 otherwise), and η_{pij} is an error term. Throughout, we cluster standard errors at the level of HR managers.

Our parameters of interest are given by the vector β_1. The elements of β_1 capture the impact of a one-unit change in the respective skill signal on the probability of being invited for an interview. Note, however, that the absolute magnitudes of the estimated effects of the skill signals do not have a straightforward interpretation in our setting because HR managers are forced to choose exactly one of the two applicants in each CV pair. This likely overemphasizes the importance of the skill signals as HR managers might choose both applicants or none when facing real applications, at least in the first stage of the application process. Therefore, we prefer to interpret *relative* effect sizes, comparing the importance of two different skill signals in our setting.[31]

The forced choice among two CVs and the design-induced similarity of overall applicant quality to avoid obviously dominant candidates might raise the concern that "weaker" signals, like sports participation, become tiebreakers in the comparison, whereas they would not be as important in other settings. One way to test this concern is to investigate whether these signals matter differently when applicants are similar as opposed to different on more salient characteristics. Thus, we test whether sports participation interacts with the GPA gap. Using either the absolute difference in GPAs or dummies that indicate an absolute GPA gap larger than 0.5 or 1 yields insignificant interactions with team sports in both the secondary-school-graduate and college-graduate sample (not shown). The same is true for interactions of social volunteering with GPA gaps. This suggests that the forced choice and CV design do not lead to artificial results that are restricted to specific settings where applicants are similar with respect to GPA.

To investigate heterogeneities in the effects of skill signals by HR managers' characteristics, we estimate models with interaction terms between the two:

$$y_{pij} = \gamma_0 + \gamma_1' S_{pij} + \gamma_2' \left(C_j * S_{pij}\right) + \gamma_3 l_{pij} + \mu_{ij} + \varepsilon_{pij}, \tag{2}$$

where C_i is a characteristic of HR manager j. In particular, we explore two dimensions of potential heterogeneity in the valuation of skill signals by HR managers. First, we study whether skill signal effects vary with HR managers' characteristics such as their age, gender, position, and responsibility in the firm, as well as size of their firm. Second, we test the consistency between HR managers' observed choices and the priorities they indicate for various skill signals (of actual applicants applying for jobs in their firm) in the subsequent questionnaire.

3. The impact of skill signals on job-interview invitations

We start by presenting the baseline results of the impact of different skill signals on job-interview invitations for secondary-school graduates and college graduates. In Section 4, we turn to effect heterogeneities for different HR managers.

3.1. Baseline results for secondary-school graduates

Table 3 reports baseline results of the choice experiment in the secondary-school-graduate sample. The baseline model, which includes CV-pair fixed effects, indicates significant effects of skill signals in both domains, cognitive and social skills (column 4). To (implicitly) document the randomization in our experimental design, column 1 shows results from regression models without any further covariates, column 2 with controls for observable HR-manager characteristics, and column 3 with HR-manager fixed effects. As would be expected with random allocation to treatments, qualitative results do not change across these three specifications. However, the magnitude of the significant coefficient estimates goes up when CV-pair fixed effects (which effectively interact HR-manager fixed effects with round fixed effects) are included, reflecting the built-in negative correlation between school GPA and the other CV elements. By ignoring this feature of our experimental design, the treatment effects in columns 1-3 are biased downwards, and only the estimates of column 4, by including CV-pair fixed effects, reflect consistent estimates.[32]

Focusing on the main specification in column 4, signals of cognitive skills strongly affect the invitation decision. In the given setting, an improvement in school GPA (which ranges between 1.3 and 3.3) by one grade level increases the probability of being invited for a job interview, ceteris paribus, by 22 percentage points. The point estimates do not differ significantly between female and male applicants (columns 5 and 6), although the coefficient is slightly smaller and less precisely estimated in the female sample. We tested for non-linearity in the effects of school GPA by adding two interaction terms: school GPA interacted with an indicator for whether both school GPAs in the CV pair are equal to or better than 2.3 (good GPAs) and school GPA interacted with an indicator for whether both school GPAs in the CV pair are equal to or worse than 2.7 (mediocre GPAs). The coefficients on both interaction terms are insignificant (not shown), indicating that the impact of school GPA is rather linear.[33]

[31] Since HR managers make relative decisions, comparing the two CVs within a CV pair, one can also transform Eq. (1) into a first-differenced model (left-hand minus right-hand CV), thus using a CV pair as the unit of observation. Such a first-differenced model, shown in Tables O.1 and O.2 in the online appendix, produces identical estimation results (see Piopiunik et al., 2018 for details).

[32] Note that the effect of a CV being shown on the left-hand (vs. right-hand) side of the screen is zero in all specifications, indicating that HR managers do not systematically favor CVs shown on a particular side of the screen.

[33] Similarly, we do not find evidence of non-linearity in the form of an additional effect of having a grade that starts with 1 (indicating top grades in Germany) when added to the linear grade effect (not shown).

Table 3
Skill signals and job-interview invitation: baseline results for secondary-school graduates.

	All CVs			Female		Male
	No controls	HR- manager controls	HR-manager fixed effects	CV-pair fixed effects		
	(1)	(2)	(3)	(4)	(5)	(6)
Cognitive Skills						
School GPA	.04**	.04**	.08**	.22***	.17	.23**
	(.02)	(.02)	(.03)	(.08)	(.13)	(.10)
Extended IT skills	.12***	.11***	.13***	.18***	.22**	.13
	(.03)	(.03)	(.04)	(.06)	(.09)	(.09)
Fluent English	.09**	.09**	.09**	.12*	.12	.11
	(.03)	(.03)	(.04)	(.06)	(.10)	(.09)
2nd foreign language	.06**	.06*	.05	.05	–.06	.11
	(.03)	(.03)	(.04)	(.06)	(.10)	(.08)
Social Skills						
Social volunteering	.19***	.19***	.24***	.37***	.39***	.37***
	(.03)	(.03)	(.04)	(.06)	(.10)	(.08)
Team sports	.01	.01	.01	.01	.02	–.01
	(.04)	(.04)	(.04)	(.04)	(.06)	(.05)
Additional CV Elements						
Age within school cohort	.08***	.08**	.10***	.13***	–.01	.24***
	(.03)	(.03)	(.04)	(.05)	(.08)	(.06)
Long internship	.01	.02	.02	.03	.03	.03
	(.03)	(.03)	(.04)	(.06)	(.09)	(.08)
Left on screen	.01	.00	.01	.01	–.06	.06
	(.03)	(.03)	(.03)	(.03)	(.06)	(.05)
HR-manager controls	No	Yes	n/a	n/a	n/a	n/a
HR-manager fixed effects	No	No	Yes	n/a	n/a	n/a
CV-pair fixed effects	No	No	No	Yes	Yes	Yes
R^2	.089	.089	.099	.124	.147	.136
N	1228	1216	1228	1228	530	698

Note: OLS model with individual CVs as unit of observation. Dependent variable: invitation for job interview. HR-manager controls included in column 2: age, gender, managing director, hiring responsibility, education level, and number of interviews conducted during past 12 months. n/a = not available because controls are already absorbed by the fixed effects included in the model. Standard errors clustered at HR-manager level in parentheses. Significance level: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Extended IT skills also improve the odds of being invited to a job interview. This effect is more pronounced for female applicants, which might reflect implicit gender stereotypes among HR managers that males in general have (at least) reasonable IT skills (similar to math skills, e.g., Lummis and Stevenson 1990), so that returns to these skills are higher for females. Thus, HR managers may subconsciously not place a high value on IT skills signaled by males, but may reward female applicants with such a signal because it is less expected among this group.

Foreign language skills, another dimension of cognitive skills, seem to be less important in case of apprenticeship applications. The effect of being fluent (as opposed to basic) in English is marginally significant, whereas having a second foreign language (either French or Spanish) does not have a significant effect.

Signaling social skills by social volunteering has a considerable impact in the hiring process. Specifically, in our setting, applicants who report doing neighborhood help such as youth work, elderly group, or offering German language courses have a 37 percentage points higher probability of being invited for a job interview than identical applicants who have not volunteered. The effect size is almost equivalent to improving school GPA by two grade levels and is very similar for females and males. This indicates the importance of signaling social skills and commitment for young applicants who enter the labor market directly out of school.

A potential second signal of social skills is whether an applicant participates in team sports such as football (soccer) and basketball as opposed to single sports such as swimming and cycling. This signal, however, does not affect interview invitations among applicants for apprenticeship positions. This may reflect that social skills are predominantly signaled by social volunteering and that 17-year-olds commonly play team sports, which renders team sports a poor predictor for actual social skills at this age.

Finally, HR managers significantly prefer older applicants for apprenticeship positions, an effect entirely driven by male applicants. While all fictitious applicants are 17 years old and born within the same regular birth cohort (given the school graduation year), applicants born a couple of months earlier are more likely to get chosen. We do not find a significant effect of having completed a longer internship (four weeks rather than two weeks).

As mentioned above, some of the gender differences in the secondary-school-graduate sample may reflect differences in the industries and occupations that female and male apprenticeship applicants apply to rather than genuine differences of the relevance of skill signals by gender when applying to the same job. In our experimental setup, this is reflected by a restriction that a firm's industry must have at least a 20 percent female employment share to receive female CVs and

Table 4
Skill signals and job-interview invitation: baseline results for college graduates.

	All CVs			Female	Male
	No controls	HR- manager controls	HR-manager fixed effects	CV-pair fixed effects	
	(1)	(2)	(3)	(4)	(5)	(6)
Cognitive Skills						
College GPA	.10***	.10***	.14***	.38***	.33***	.42***
	(.02)	(.02)	(.02)	(.07)	(.10)	(.09)
Extended IT skills	–.04	–.04	–.04	–.03	–.01	–.05
	(.03)	(.03)	(.04)	(.06)	(.08)	(.09)
English level	–.01	–.01	–.01	–.03	–.06	.01
	(.02)	(.02)	(.02)	(.04)	(.05)	(.06)
2nd foreign language	.07**	.07**	.09**	.11*	.27***	–.06
	(.03)	(.03)	(.04)	(.06)	(.08)	(.08)
Social Skills						
Social volunteering	.07	.07	.07	.07	.10*	.01
	(.05)	(.05)	(.05)	(.05)	(.06)	(.07)
Team sports	.10**	.10**	.09**	.10**	.11*	.09
	(.04)	(.04)	(.04)	(.04)	(.07)	(.09)
Additional CV Elements						
High-school GPA	–.04*	–.04*	–.04	.05	–.00	.12
	(.02)	(.02)	(.03)	(.05)	(.07)	(.08)
Age within school cohort	.01	.01	.02	.00	.11	–.09
	(.04)	(.04)	(.04)	(.06)	(.08)	(.08)
Internship length	.07***	.07***	.09***	.12***	.12***	.15***
	(.02)	(.02)	(.02)	(.03)	(.05)	(.05)
Left on screen	.01	.01	.01	.00	–.02	.05
	(.04)	(.04)	(.04)	(.04)	(.06)	(.08)
HR-manager controls	No	Yes	n/a	n/a	n/a	n/a
HR-manager fixed effects	No	No	Yes	n/a	n/a	n/a
CV-pair fixed effects	No	No	No	Yes	Yes	Yes
R^2	.076	.077	.090	.139	.163	.160
N	1088	1088	1088	1088	608	480

Note: OLS model with individual CVs as unit of observation. Dependent variable: invitation for job interview. HR-manager controls included in column 2: age, gender, managing director, hiring responsibility, education level, and number of interviews conducted during past 12 months. n/a = not available because controls are already absorbed by the fixed effects included in the model. Standard errors clustered at HR-manager level in parentheses. Significance level: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

that the types of internships differ by gender when they apply in the technical sector. Therefore, Table A.6 in the appendix restricts the analysis to applications in the commercial (as opposed to technical) sector in industries with at least 20 percent female employment share. In this subsample, there is no built-in difference between female and male applications in our experimental setup. Qualitative results in this subsample do not differ from the full sample. In particular, the age effect is also restricted to male applicants in this subsample. Thus, the main gender patterns do not appear to be mainly driven by gender differences in the industries or occupations which they apply to.

3.2. Baseline results for college graduates

Table 4 presents baseline results of the choice experiment in the college-graduate sample. Again, we find significant effects of skill signals in both skill domains. However, the specific signals that affect job-interview invitations for college graduates partly differ from the specific signals relevant for secondary-school graduates.[34] The first three columns are again presented to highlight the characteristics of our randomization process. The only significant difference between the first three columns - which have no controls, controls for HR manager characteristics, and HR-manager fixed effects, respectively - and the main specification in column 4, which includes CV-pair fixed effects, is that the coefficients on both college GPA and high-school GPA become more positive, reflecting the fact that within-pair randomization ensured that no CV dominates the other CV in terms of both GPAs within a CV pair. By including CV-pair fixed effects, column 4 provides consistent estimates.

The results indicate that college grades, one signal of cognitive skills, are an important determinant in the first stage of the hiring decision of HR managers. A better college GPA significantly increases the probability of being invited to a job interview for both females and males. In the given setting, an improvement in college GPA by one grade level (on a range from 1.3 to 3.3) increases the likelihood of a job-interview invitation by 38 percentage points. Again, we do not find evidence of non-linearity in the GPA effects among college graduates (not shown).

[34] We replicated all results from Tables 3 and 4 in specifications that weight HR managers by (log) firm size to account for the relative overrepresentation of small firms in the German economy. These results (not shown) are very similar to the unweighted results.

Results for other cognitive-skill signals are mixed. Extended IT skills and English proficiency do not affect the interview decision in the college-graduate sample. One possible explanation is that firms expect that German college graduates possess reasonably decent IT skills and English proficiency anyways. By contrast, being very proficient in a second foreign language (French or Spanish), which is less common, does improve the probability of an interview invitation. This effect is entirely driven by female college graduates, whereas no such effect is observed for males, possibly reflecting the types of occupations or tasks that HR managers expect females to perform.[35] The effect is very similar for whether the second foreign language is French or Spanish (not shown).

Signals of social skills also matter for the employability of college graduates, although to a substantially lesser extent than the cognitive-skill signals in our setting. Among females, volunteering work that is characterized by intensive social interactions (such as neighborhood help or mobile care services) is an advantage over volunteering work that involves less social interactions (such as monument preservation or online office work for the UN). No such effect is found for males. Note that the treatment here is different from the secondary-school-graduate sample, where applicants do or do not report volunteering work; by contrast, all college graduates report some sort of volunteering, but with varying intensity of social interactions.

Interestingly, participation in team sports such as football and basketball, as opposed to single sports such as swimming and cycling, increases the probability of a job interview in the college-graduate sample. This contrasts with the lack of such an effect in the secondary-school sample. Potentially, at the age of 17, the type of sport that an applicant does may be conceived as being primarily determined by family and friends rather than being a personal choice, such that type of sport is a poor signal of social skills. By contrast, at the age of 24 in the college-graduate sample, the type of sports that a person decides to (continue to) participate in may be more likely perceived as a personal choice and thus a better signal of social skills. In addition, HR managers may be wary of strategic behavior among applicants who have reached the stage of finishing college. This could account for the fact that reporting social volunteering work has a much smaller effect in the college sample than in the secondary-school sample (besides reflecting a somewhat weaker variation in the signal), whereas it is the other way around for team sports. Knowing that firms value social volunteering (Baert and Vujić, 2018), even persons with limited social skills may do some voluntary social work only to have the signal. With limited credibility of volunteering as a signal of actual social skills, HR managers may revert to the type of sports as an alternative signal that is less obvious to applicants and may thus be less subject to strategic manipulation.

Finally, a longer internship increases the probability of being invited to a job interview. In contrast to secondary-school graduates, we do not find an advantage for applicants who are older within their school cohort, presumably because small age differences (at most four months) are less relevant for applicants aged 24 than for applicants during their adolescence (aged 17 in the secondary-school-graduate sample). For male college-graduate applicants, we find a positive effect of a better high-school GPA that is just shy of statistical significance at conventional levels in this specification. Holding constant college GPA, we interpret a good high-school GPA as a signal that the applicant focused on school work already during adolescence.[36] No such effect is found for female college-graduate applicants.[37]

Although our experiment was not designed for deeper investigation of the importance of complementarities among different skills or different packages of skills, we also experimented with adding interaction terms between different skill signals to our baseline model (not shown). There are virtually no significant interaction effects among the different randomized skill signals, possibly due to limited statistical power in these models. In particular, we do not find significant interactions between GPAs and social skills. Similarly, there is no consistent pattern of effect heterogeneities by the four high-school types used on the college-graduate resumes or by whether the college is top-ranked or not.

In sum, signals in both domains - cognitive and social skills - have a causal impact on the decisions of HR managers whom to invite for a job interview among both secondary-school and college graduates. In general, cognitive skills as signaled by school GPA for secondary-school graduates and college GPA for college graduates play a consistently important role. In our setting, cognitive skills tend to be relatively more relevant than social skills among college graduates, whereas social skills seem to be more relevant for young school graduates applying for an apprenticeship. In contrast, IT skills tend to be more important for female secondary-school graduates, possibly because of common gender stereotypes that boys have an affinity to computers. Overall, the observed effect heterogeneities across entry ages and genders appear consistent with differences in the relevance, expectedness, and credibility of specific signals in different settings.

4. Heterogeneous effects for different HR managers

In this section, we turn to effect heterogeneities with respect to HR manager characteristics. Furthermore, we investigate whether decisions in the choice experiment are consistent with HR managers' answers to survey questions regarding the importance of various skill signals of applicants in their firm.

[35] The difference between the estimate for females and males is statistically highly significant (see Table O.3 in the online appendix).

[36] Additionally controlling for whether the GPA has improved from school to college does not change the coefficient on high-school GPA and increases the coefficient on college GPA only slightly (not shown).

[37] In robustness analyses, our baseline results hold when excluding one explanatory variable at a time or when excluding all insignificant variables simultaneously from the specification in Table 4 (see Table O.4 in the online appendix).

Table 5
Summary statistics: HR manager and firm characteristics.

	Secondary-school graduates		College graduates	
	Mean	Std. Dev.	Mean	Std. Dev.
HR Manager Characteristics				
Age	49.593	9.9	49.664	9.8
Male	.658		.651	
Managing director	.437		.288	
Hiring responsibility	.875		.871	
Professional education level				
Vocational education degree	.309		.217	
University of applied sciences degree	.250		.258	
University degree	.411		.472	
None/Other	.026		.051	
Firm Characteristics				
Number of employees	331	1286.7	442	1817.9
Industry share female employees $\leq$ 20%	.239		.118	
Industry				
Manufacturing	.534		.360	
Trade, maintenance and reparations	.182		.136	
Hospitality	.032		.025	
Transport and communication	.072		.074	
Real estate	.162		.341	
Other public services	.016		.062	
N (HR-managers)	307		272	

Note: Means (and standard deviations for continuous variables) reported. HR manager characteristics come from the survey questionnaire and firm characteristics come from the ifo Personnel Manager Survey Database. "Industry share female employees $\leq$ 20%" refers to the share of firms in industries with less than 20 % female employment. Indicated industries refer to the 1-digit German Classification of Economic Activity, Version 2003.

4.1. Heterogeneity by HR manager characteristics

In contrast to most existing CV studies, we have information about the characteristics of the HR managers who make the decisions in our setting. After the choice experiments, we provided the HR managers with a short survey questionnaire that included questions on their personal characteristics and on the importance they assign to different skill signals in actual applications to their firm (see Appendix A3). The information on HR managers' personal characteristics includes age, gender, educational attainment, whether they are responsible for hiring decisions in their firm, whether they are the managing director of the firm (more likely in smaller firms), and how many job interviews they have conducted during the past 12 months. This information allows us to investigate whether the effects of the different skill signals differ across different types of HR managers.

Table 5 provides summary statistics of the characteristics of HR managers and firms, separately for the secondary-school-graduate and college-graduate samples. In both samples, HR managers are on average 50 years old, and about two thirds are male. HR managers in the secondary-school-graduate sample are more likely to be managing directors of their firms, presumably because apprenticeship-offering firms tend to be smaller than those in the college sample. Most HR managers (87–88 percent) are responsible for the actual final hiring decisions in their firm. HR managers are rather similarly divided between the three types of professional degrees - vocational education, university of applied sciences, and university - in the two samples. Firms in the secondary-school-graduate sample, all of which employ apprentices, are more likely to be in the manufacturing sector, whereas firms in the college-graduate sample are more likely to be in the real estate sector. Furthermore, firms in the secondary-school-graduate sample are more likely to be in industries where the share of women is below 20 percent. This is likely due to the fact that many apprenticeship positions are technical jobs.

Tables 6 and 7 report estimated coefficients on interaction terms between the various skill signals (indicated in the first column) and selected characteristics of the HR managers and firms (indicated in the column headers) for the secondary-school-graduate and the college-graduate sample, respectively. Each cell stems from a separate regression.

For apprenticeship positions, we find substantial effect heterogeneity with respect to HR manager characteristics (Table 6). Older HR managers (split at median age 51) put less weight on school grades and more weight on IT skills. Older managers also appreciate social volunteering more, but consider team sports to be less important for the decision whom to invite for a job interview. These differences between younger and older HR managers might indicate that older HR managers have gained the experience that school grades predict the workplace performance of apprentices less well than signals of specific abilities such as IT skills. Similarly, experienced HR managers might have experienced that social volunteering is indeed a good signal for social skills that are important on the labor market. Interestingly, the focus of HR managers who are also the managing directors of their firm goes in the same direction as that of older HR managers, partly reflecting the fact that the majority of managing directors (59.5 percent) are also in the subgroup of older HR managers.

Table 6
Interactions of skill signals with HR manager and firm characteristics: secondary-school graduates.

	(1) HR age above median	(2) Male	(3) Managing director	(4) Hiring responsibility	(5) Technical sector	(6) Firm size ≥ 250 employees
Cognitive Skills						
School GPA	−.19**	.03	−.33***	−.24	.14*	.01
	(.10)	(.11)	(.09)	(.16)	(.10)	(.12)
Extended IT skills	.17**	.16	.26***	.21	−.20**	−.00
	(.10)	(.10)	(.10)	(.15)	(.10)	(.13)
Fluent English	.10	−.07	.10	.12	−.11	.11
	(.10)	(.10)	(.10)	(.15)	(.10)	(.13)
2nd foreign language	.11	.19*	.24**	.21	−.22**	−.02
	(.10)	(.11)	(.10)	(.15)	(.10)	(.12)
Social Skills						
Social volunteering	.19**	.07	.24**	.20	−.19*	−.10
	(.11)	(.12)	(.11)	(.18)	(.11)	(.13)
Team sports	−.17**	.07	−.06	.12	.03	.13
	(.08)	(.08)	(.08)	(.12)	(.08)	(.09)
Additional CV Elements						
Age within school cohort	−.01	.03	−.02	.07	−.14	.02
	(.10)	(.11)	(.1)	(.16)	(.10)	(.12)
Long internship	.11	.04	.21**	.27*	−.21**	.14
	(.10)	(.11)	(.10)	(.16)	(.10)	(.13)

Note: Each cell stems from a separate OLS regression with CV-pair fixed effects. The reported coefficients are the interaction terms between the two elements indicated in the header and first column. Dependent variable: invitation for job interview. Controls for other CV elements as in Table 3 included throughout. Standard errors clustered at HR-manager level in parentheses. Significance level: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 7
Interactions of skill signals with HR manager and firm characteristics: college graduates.

	(1) HR age above median	(2) Male	(3) Managing director	(4) Hiring responsibility	(5) Vocational degree	(6) Technical college degree	(7) Firm size ≥ 250 employees
Cognitive Skills							
College GPA	−.06	−.13	−.17	−.06	.20*	−.30***	.23**
	(.11)	(.10)	(.13)	(.12)	(.11)	(.11)	(.10)
Extended IT skills	.16	.08	−.02	.18	.13	.00	.19
	(.12)	(.13)	(.13)	(.18)	(.16)	(.14)	(.14)
English level	−.03	−.07	−.13*	.04	.01	.06	.08
	(.07)	(.07)	(.08)	(.10)	(.08)	(.08)	(.08)
2nd foreign language	.25**	.26**	.19	.29**	−.18	−.16	−.31**
	(.12)	(.12)	(.13)	(.14)	(.15)	(.14)	(.13)
Social Skills							
Social volunteering	−.04	.04	−.14	.16	−.10	.22**	−.10
	(.09)	(.09)	(.10)	(.12)	(.10)	(.10)	(.10)
Team sports	.10	.00	−.02	−.08	.00	.27***	.07
	(.08)	(.09)	(.09)	(.12)	(.10)	(.09)	(.10)
High-school GPA	.05	.11	−.05	−.11	−.22**	.13	.00
	(.08)	(.08)	(.10)	(.10)	(.09)	(.10)	(.11)
Additional CV Elements							
Age within school cohort	.01	.00	.00	.03	−.10	.03	.02
	(.11)	(.11)	(.14)	(.14)	(.12)	(.13)	(.13)
Internship length	−.06	−.07	−.17**	−.14*	.10	−.05	.02
	(.06)	(.07)	(.07)	(.07)	(.07)	(.07)	(.07)

Note: Each cell stems from a separate OLS regression with CV-pair fixed effects. The reported coefficients are the interaction terms between the two elements indicated in the header and first column. Dependent variable: invitation for job interview. Controls for other CV elements as in Table 4 included throughout. Standard errors clustered at HR-manager level in parentheses. Significance level: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Furthermore, managing directors, as well as HR managers who are responsible for hiring decisions in their firm, place more weight on work experience through long internships.

We also find substantial and intuitive differences between apprenticeship positions in the technical sector and in the commercial area. Concerning signals of cognitive skills, the priorities of HR managers in the technical sector are more strongly focused on school GPA and less on specific skills in IT and second foreign languages, which might be particularly relevant for apprenticeship positions in the commercial area. Similarly, social volunteering is more important in the commercial area, likely reflecting higher relevance of social skills in commercial jobs than in technical jobs. Longer internship duration is also more important for HR managers in the commercial area than in the technical sector. By contrast, effects

Table 8
HR managers' stated priorities: survey results.

	HR manager sample			
	Secondary-school graduates (1)	College graduates (2)	Difference (1)-(2) (3)	p-value (4)
School GPA	0.674	0.471	0.204	0.000
College GPA	n/a	.809	n/a	n/a
German grade	.808	n/a	n/a	n/a
Math grade	.886	n/a	n/a	n/a
IT skills	0.860	0.956	−0.096	0.000
Language skills	0.661	0.831	−0.170	0.000
Professional experience through internships	0.739	0.941	−0.202	0.000
Hobbies	.483	.472	.011	.593
N (HR managers)	307	272		

Note: Shares of HR managers stating to find the indicated characteristic "very important" or "rather important" (as opposed to "rather unimportant" or "very unimportant"). p-values in column (4) stem from a two-sided t-test.

of the different skill signals in the secondary-school-graduate sample hardly differ between female and male HR managers, and they do not vary significantly with firm size.

Overall, there is less effect heterogeneity with respect to HR manager characteristics in the college-graduate sample (Table 7). Interestingly, HR managers in larger firms place more weight on college GPA, possibly reflecting a more standardized and automated screening process in larger firms with a particular focus on formal signals or with applicants having to pass a specific GPA threshold. Easy verifiability of signals may thus be particularly important for large firms in the first hiring stage. Older HR managers, males, and those with hiring responsibility place more weight on proficiency in a second foreign language. Internship duration seems less important for managing directors and HR managers with hiring responsibility. HR managers who obtained an apprenticeship degree care less about high- school GPA than HR managers with a college degree; HR managers with a technical college degree put less weight on college GPA and more weight on social skills.

4.2. Consistency with stated priorities in survey questions

At the end of the questionnaire, HR managers also indicate their priorities for various skill signals of actual applicants applying for jobs in their firm. Table 8 shows that 67 percent of HR managers in the secondary-school-graduate sample report that school GPAs are either "rather important" or "very important" (as opposed to "rather unimportant" or "very unimportant"). An even larger share of HR managers states that school grades in specific main subjects are important: 89 percent in math and 81 percent in German. IT skills are considered important by 86 percent of HR managers, language skills by 66 percent, and professional experience through internships by 74 percent. In the college-graduate sample, only 47 percent of HR managers view high-school GPA as important, but 81 percent college GPA, the more recently acquired skill signal. The shares of HR managers who view IT skills (96 percent), language skills (83 percent), and professional experience through internships (94 percent) as important are all higher in the college-graduate sample than in the secondary-school-graduate sample. The only dimension without a significant difference between the two samples is hobbies (47 vs. 48 percent).

The priorities reported by HR managers in the questionnaire allow us to investigate whether answers to survey questions are consistent with choices between the fictitious applicants in the choice experiment. This yields insights into whether HR managers' answers in survey questionnaires are in line with their decisions when comparing entire resumes of applicants. To investigate this question, we add to our baseline model an interaction term between a skill signal in our fictitious resumes and the degree of importance that the HR manager assigns to that specific skill signal in the questionnaire (using the original four-point scale). We estimate models with interaction terms separately for each skill signal that is included both in the questionnaire and in the fictitious resumes.

For HR managers in the secondary-school-graduate sample, all interaction terms are positive and statistically significant (Table 9). This implies that HR managers who indicate in the questionnaire that a certain skill signal is important for them in real hiring situations in their firm also put more weight on that signal when choosing between the fictitious resumes. This is the case for school GPA, IT skills, language proficiency (English and second foreign language), and internship duration.

Similar positive interactions are found for HR managers in the college-graduate sample, with the interactions with college GPA, IT skills, and English language proficiency reaching statistical significance at conventional levels (Table 10). The results again indicate that the experimental choices are consistent with the self-reported priorities in the questionnaire. Interestingly, statistical significance is reached by the three signals of cognitive skills, which is the most important domain of signals among college graduates, whereas the coefficients on high-school GPA and internship duration, which are in general less important for decisions among college graduates, are statistically insignificant.

Note, however, that we only observe self-reported priorities *after* the choice experiment. Thus, we cannot rule out that the positive correlation between stated priorities and experimental choices partly reflects ex-post rationalization of choices with respect to some CV characteristics. This seems to be more likely in case of HR managers with weak priorities. However, as participants in this choice experiment are HR managers who are used to making similar choices based on these CV

Table 9
Interactions of skill signals with HR manager priorities: secondary-school graduates.

	(1) School GPA	(2) Extended IT skills	(3) Fluent English	(4) 2nd foreign language	(5) Long internship
CV element	.22***	.16***	.13**	.05	.04
	(.07)	(.06)	(.06)	(.06)	(.06)
Interaction with HR priority	.36***	.27***	.32***	.27***	.17**
	(.07)	(.07)	(.06)	(.06)	(.08)
Controls for other CV elements	Yes	Yes	Yes	Yes	Yes
CV-pair fixed effects	Yes	Yes	Yes	Yes	Yes
R^2	.166	.146	.169	.157	.137
N	1202	1210	1210	1210	1210

Note: OLS model with CV-pair fixed effects. Dependent variable: invitation for job interview. Controls for other CV elements as in Table 3 included throughout. HR priority refers to importance given to the respective CV element (on a 4-point scale) by the HR manager in the questionnaire (1 = very unimportant, 2 = rather unimportant, 3 = rather important, 4 = very important). In columns 3 and 4, this importance refers to "language skills", in column 5 to "professional experience through internships." Standard errors clustered at HR-manager level in parentheses. Significance level: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 10
Interactions of skill signals with HR manager priorities: college graduates.

	(1) College GPA	(2) Extended IT skills	(3) English level	(4) 2nd foreign language	(5) High-school GPA	(6) Long internship
CV element	.40***	–.03	–.03	.11*	.06	.23***
	(.07)	(.06)	(.04)	(.06)	(.05)	(.05)
Interaction with HR priority	.26***	.22*	.18**	.09	.09	.06
	(.08)	(.11)	(.09)	(.08)	(.07)	(.05)
Controls for other CV elements	Yes	Yes	Yes	Yes	Yes	Yes
CV-pair fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
R^2	.151	.146	.151	.15	.14	.139
N	1084	1084	1072	1072	1084	1084

Note: OLS model with CV-pair fixed effects. Dependent variable: invitation for job interview. Controls for other CV elements as in Table 4 included throughout. HR priority refers to importance given to the respective CV element (on a 4-point scale) by the HR manager in the questionnaire (1 = very unimportant, 2 = rather unimportant, 3 = rather important, 4 = very important). In columns 3 and 4, this importance refers to "language skills", in column 5 to "professional experience through internships." Standard errors clustered at HR-manager level in parentheses. Significance level: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

characteristics, we argue that it is unlikely that the entire correlation between priorities and choices is driven by ex-post rationalization.

5. Conclusion

We conduct a randomized lab-in-the-field experiment among HR managers to investigate how acquired signals of a broad range of cognitive and social skills are valued by employers. We find evidence that signals in both domains increase the probability of being invited for a job interview. Given our factorial design, these are separate and independent effects of signals in the two skill domains, with little evidence of strong complementarities between cognitive and social skills. The results indicate at least three conclusions on how labor markets function. First, skills in both domains matter on the labor market. Second, applicants can effectively signal these skills to employers before career start with information contained on their CVs. Third, associations of labor-market outcomes with skill indicators such as school or college grades in observational data do in fact have a causal interpretation in the sense that employers observe and react to them during the application process.

Furthermore, the importance of the specific signals differs depending on the respective relevance, stereotypical expectedness, and credibility of the signal in different contexts. Important effect heterogeneities exist between secondary-school graduates applying for an apprentice position and college graduates. While in our setting, signals of cognitive skills (particularly college GPA) seem to be more important than signals of social skills among college graduates, this is not true for secondary-school graduates. School GPA of secondary-school graduates and college GPA of college graduates - signals of cognitive skills - are important for both genders, but other signals matter more for one gender than the other: IT and second language skills - and, to a lesser extent, social skills - are particularly relevant for females. These differences might reflect gender stereotypes in relevance (with stronger effects for the gender which is expected to perform the respective tasks) and in expectedness (with stronger effects for the gender for which the skill is less expected). Social volunteering is a strong signal of social skills among secondary-school graduates. Among college graduates, however, social skills appear to be more effectively signaled by engaging in team sports, consistent with reduced credibility of social volunteering as a signal of actual social skills due to potential strategic behavior at older ages.

We also find differences in the impact of skill signals across different groups of HR managers. For secondary-school graduates, older HR managers and managing directors put less weight on school GPA and more weight on IT skills, social

volunteering, and internship duration. Among college graduates, HR managers in larger firms place more weight on college GPA than those in smaller firms, which might reflect more standardized procedures of hiring applicants in larger firms that attach more importance to easily verifiable skill signals. Using a questionnaire that asks HR managers to indicate their priorities of skill signals of actual applicants applying for jobs in their firm, we find that the decisions in the choice experiments are consistent with HR managers' self-reported hiring priorities. Together, the effect heterogeneities by entry age, gender, and HR managers reveal important aspects about how signals of skills are processed and utilized in the labor market.

Appendix A

A1. Resumes of secondary-school graduates

Each secondary-school graduate applying for an apprenticeship position is represented by a one-page CV. Fig. A.1 shows an example CV of a secondary-school graduate. Table A.1 lists all possible values of all CV elements that are randomly attributed to the secondary-school-graduate resumes. Elements marked with a star - gender and apprenticeship area (commercial or technical) - do not vary within a CV pair shown to an HR manager. The other elements — name, date of birth, school GPA, internship duration, English proficiency, 2nd foreign language, IT skills, voluntary work, and sports — vary randomly within CV pairs.

We use five different first names for each gender and five different last names. The last names are the most common family names in Germany, while the first names are among the ten most common names of boys and girls of the birth cohort of the fictitious candidates (1998/1999).[38] Table A.7 indicates that HR managers do not strongly prefer specific first names or specific family names. Invitation rates for the job interview differ statistically significantly from 0.5 (at the 5 percent level) in only two of 30 cases. Candidates are born within a four-month period between 15 November 1998 and 10 March 1999 in the capital of the respective state in which the firm is located.

Table A.1
Values of all CV elements of secondary-school graduates.

Gender*	Female	Male			
Male first name	Alexander	Christian	Patrick	Daniel	Tobias
Female first name	Sarah	Laura	Anna	Katharina	Julia
Last name	Becker	Fischer	Mayer	Schneider	Weber
Date of birth	15-Nov-98	2-Dec-98	22-Jan-99	12-Feb-99	10-Mar-99
School GPA	1.3; 1.7; 2.0; 2.3; 2.7; 3.0;3.3				
Apprentice area*	commercial	technical			
Commercial internship	at Sparkasse (savings bank)	at carhouse	in bookstore	in hotel	in supermarket
Technical internship f	at hairdresser salon	at cosmetic studio	at bakery	at jeweller	at photographic shop
Technical internship m	with floortiler craftsman	at bakery	at locksmith	with carpenter	at painter
Internship length	4 weeks	2 weeks			
English	fluent	basic			
2nd foreign language	French	Spanish			
IT skills	Microsoft Office	Microsoft Office, HTML and Dreamweaver			
Sports	single	team			
Single sports	swimming	cycling	running		
Team sports	handball	volleyball	basketball	football	
Social volunteering	neighborhood help: youth and senior group, German language classes (social)				

Note: This table shows all values of all CV elements that were randomized. * denotes elements that are fixed within CV pairs. School GPAs range from 1.3 (very good) to 3.3 (satisfactory); for the empirical analysis, grades are reversed such that higher values mean better grades (see notes of Table 1). Technical internships vary for male and female candidates to ensure credibility. Each resume contains either two single sports or two team sports. In half of the resumes, there is no social volunteering.

Grades in Germany, both in school and in college, range from 1 (very good) to 6 (failed). A grade of 4 (adequate) is typically the passing grade and GPAs typically involve decimal places. The school GPAs in our resumes range from 1.3 to 3.3, that is, between very good and satisfactory. Each resume includes two sports disciplines, either two team sports or two single sports.

The secondary-school graduates do their internships either in a "technical" or "commercial" job at a local craft or retail company. Technical internships differ across gender and involve, e.g., carpenter for males and hairdresser for females. Commercial internships are the same for both genders and include, e.g., positions in banks or supermarkets.

To obtain a negative correlation between the school GPA and the other skill signals on the resume, we construct a point index for the other skill signals, with each skill signal receiving 1 point if the signal is positive (and 0 otherwise). In particular, the following signals receive 1 point: fluent English proficiency (vs. basic), basic French or Spanish proficiency (vs. no second foreign language), extended IT skills (Microsoft Office plus HTML plus Dreamweaver vs. only Microsoft Office),

[38] Family names are chosen from the ten most common family names in Germany according to Wikipedia (https://de.wikipedia.org/wiki/Liste_der_h%C3%A4ufigsten_Familiennamen_in_Deutschland). First names are taken from the German "popular first names" database (http://www.beliebte-vornamen.de/jahrgang/j1998).

Curriculum Vitae

Name:	Daniel Fischer
Nationality:	German
Date of birth:	15.11.1998
Place of birth:	Dresden

School education

2008 - 2015	32. Oberschule "Sieben Schwaben", Dresden
2015	Intermediate school degree Average grade: 3,3

Professional experience

July 2014	Internship at Savings Bank in Dresden 4 weeks

Languages

- English (fluent)
- Spanish (basic knowledge)

IT skills

- Microsoft Office
- HTML + Dreamweaver

Interests and social engagement

- Swimming
- Biking
- Neighbourhood assistance: youth work, senior citizens' group, implementation of German courses

Fig. A.1. Example CV of a secondary-school graduate. *Note*: Own translation of German original, which is provided in Fig. O.1 in the online appendix.

Table A.2
Values of all CV elements of college graduates.

Gender*	Female	Male					
Male first name	Alexander	Christian	Patrick	Daniel	Tobias		
Female first name	Sarah	Laura	Anna	Katharina	Julia		
Last name	Becker	Fischer	Mayer	Schneider	Weber		
Date of birth	15-Nov-91	2-Dec-91	22-Jan-92	12-Feb-92	10-Mar-92		
Place of birth	Wiesbaden	Erfurt	Mainz	Hannover	Düsseldorf	München	Stuttgart
Type of secondary school*	catholic	integrated comprehensive	neutral				
Catholic	Bishop-Naumann-School Königstein	Edith-Stein-School Erfurt	Theresianum, Mainz	Gymnasium St.-Ursula-School Hannover	Archiebiscopal Suitbertus-Gymnasium, Düsseldorf	Archiebiscopal Maria-Ward-Gymnasium München	Sankt-Meinrad-Gymnasium
Integrated comprehensive	Helene Lange Gesamtschule Wiesbaden	Comprehensive secondary Erfurt	Comprehensive secondary Mainz-Bretzenheim	Comprehensive secondary Linden, Hannover	Heinrich-Heine Gesamtschule, Düsseldorf	Willy-Brandt Gesamtschule München	Elise von König Gemeinschaftsschule
Neutral	Gymnasium Leibniz School Wiesbaden	Albert-Schweizer Gymnasium Erfurt	Gymnasium Mainz-Oberstadt	Gymmasium Schillerschule Hannover	Max-Planck Gymnasium Düsseldorf	Oskar-von-Miller Gymnasium München	Karl-Gymnasium Stuttgart
High-school GPA	1.3	1.7	2.0	2.3	2.7	3.0	3.3
College type*	Top-ranked	Non top-ranked					
Top-ranked universities	University of Mannheim	RWTH Aachen	University of Munich	University of Cologne	University of Frankfurt		
Non top-ranked universities	University of Trier	University of Greifswald	University of Siegen	University Leuphana Lüneburg	University of Bremen		
College GPA	1.3	1.7	2.0	2.3	2.7	3.0	3.3
Internship firm	Windmöller & Hölscher, Lengerich	Amann Group, Bönnigheim	FACT, Münster	MVI Proplant, Wolfsburg	Astaro GmbH & Co. KG, Karlsruhe		
Internship business area*	Accounting	Controlling	Sales				
Internship length	1 month	3 months	5 months				
English	fluent	very good	basic				
2nd foreign language	Spanish (basic)	French (basic)					
IT skills	Microsoft Office	Microsoft Office, HTML and Dreamweaver					
Sports	single	team					
Single sports	swimming	cycling	running				
Team sports	handball	volleyball	basketball	football			
Volunteering: "social"	neighborhood help: youth and senior group, German language classes			mobile care services: senior and domestic care			
Volunteering: "non-social"	volunteering preservation of monuments work			online volunteering at UN: IT work and translations			

Note: This table shows all values of all CV elements that were randomized. * denotes elements that are fixed within CV pairs. School and college GPAs range from 1.3 (very good) to 3.3 (satisfactory); for the empirical analysis, grades are reversed such that higher values mean better grades (see notes of Table 2). Top-ranked universities according to the "2015 CHE Hochschulranking" in Undergraduate Business Administration. Each resume contains either two single sports or two team sports. In half of the resumes, there is socially-interactive volunteering, in the other half, there is non-socially-interactive volunteering.

Table A.3
Sample representativeness: comparing respondents and non-respondents from the ifo personnel manager survey database.

	Respondents	Non-respondents	p-value
Assigned sample (secondary school = 1 / college = 2)	1.472	1.469	.932
Share female ≤ 20	.185	.187	.930
Industry			.680
Employees	383.02	424.22	.725
State			.578
Baden-Württemberg	.145	.150	
Bavaria	.242	.195	
Berlin	.009	.023	
Brandenburg	.019	.023	
Bremen	.007	.011	
Hamburg	.021	.024	
Hesse	.073	.079	
Mecklenburg-West Pomerania	.019	.013	
Lower Saxony	.083	.095	
North Rhine-Westphalia	.181	.178	
Rhineland-Palatinate	.043	.040	
Saarland	.012	.009	
Saxony	.074	.066	
Saxony Anhalt	.021	.028	
Schleswig-Holstein	.026	.032	
Thuringia	.026	.036	
N (HR managers)	579	927	Total: 1506

Note: Means and p-values from two-sided t-tests comparing respondents and non-respondents from the ifo Personnel Manager Survey Database. For "industry" and "state" distributions, both groups are compared using a two-sample Kolmogorov-Smirnov test (means are not reported for these categorical variables). Numbers for the German states represent the shares of firms from the respective state.

Table A.4
Independence of randomized skill signals of assigned HR managers: secondary-school graduates.

	Age (1)	Male (2)	Managing director (3)	Hiring responsibility (4)	University (5)	Number interviews (6)
Cognitive Skills						
School GPA	−.78	−.02	−.05	−.03	−.04	.06
	(.67)	(.03)	(.03)	(.02)	(.03)	(.05)
Extended IT skills	−.27	.01	−.02	−.01	−.03	−.05
	(.65)	(.03)	(.03)	(.02)	(.03)	(.04)
Fluent English	−.68	.02	−.04	.01	.01	.07*
	(.63)	(.03)	(.03)	(.02)	(.03)	(.04)
2nd foreign language	.35	−.03	.00	.01	.02	.04
	(.59)	(.03)	(.03)	(.02)	(.03)	(.05)
Social Skills						
Social volunteering	.08	−.00	.03	−.03	−.05	−.05
	(.56)	(.03)	(.03)	(.02)	(.03)	(.05)
Team sports	−.01	−.00	.00	−.00	−.00	−.00
	(.05)	(.00)	(.00)	(.00)	(.00)	(.00)
Additional CV Elements						
Age within school cohort	.57	.02	.01	−.02	−.02	.01
	(.46)	(.02)	(.02)	(.02)	(.02)	(.03)
Long internship	−.74	−.04	−.04	−.01	.00	.04
	(.58)	(.03)	(.03)	(.02)	(.03)	(.05)
R^2	.004	.003	.006	.006	.005	.006
N	1228	1228	1228	1228	1216	1228
F	.753	.562	.714	1.035	.736	.673

Note: Dependent variables, indicated in table headers, are HR manager characteristics (see Table 5 for details), explanatory variables are the same CV elements as in our baseline model (see Table 3 for details). Standard errors clustered at HR-manager level in parentheses. Significance level: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

social volunteering (vs. no volunteering), and four weeks of internship (vs. two weeks). Within each CV pair, the resume with the worse school GPA includes other skill signals with an index that is 2, 3, or 4 points higher.

A2. Resumes of college graduates

Each college graduate applying for a business trainee position is represented by a one-page CV. Fig. A.2 shows an example CV of a college graduate. Table A.2 lists all possible values of all CV elements that are randomly attributed to the

Table A.5
Independence of randomized skill signals of assigned HR managers: college graduates.

	Age (1)	Male (2)	Managing director (3)	Hiring responsibility (4)	University (5)	Number interviews (6)
Cognitive Skills						
College GPA	.19	.02	−.04*	.02	−.02	.03
	(.52)	(.03)	(.02)	(.02)	(.02)	(.04)
Extended IT skills	−.17	.01	−.04	−.01	−.01	−.09*
	(.61)	(.03)	(.03)	(.02)	(.03)	(.05)
English level	.18	.00	.01	.02	−.03	.01
	(.36)	(.02)	(.02)	(.01)	(.02)	(.03)
2nd foreign languagee	−.72	−.03	−.01	−.01	−.05**	.07*
	(.48)	(.03)	(.03)	(.02)	(.03)	(.04)
Social Skills						
Social volunteering	.17*	.00	.00	.00	−.00	−.01
	(.10)	(.00)	(.00)	(.00)	(.00)	(.01)
Team sports	.02	.00	.00	−.00	.01	−.00
	(.11)	(.01)	(.01)	(.00)	(.01)	(.01)
Additional CV Elements						
High-school GPA	−.25	.02	.00	.00	−.01	−.02
	(.42)	(.02)	(.02)	(.02)	(.02)	(.03)
Age within school cohort	.31	.02	−.03	.00	−.02	.03
	(.50)	(.03)	(.03)	(.02)	(.02)	(.04)
Internship length	−.61*	−.01	−.02	−.00	.01	.00
	(.35)	(.02)	(.02)	(.01)	(.01)	(.02)
R^2	.005	.003	.008	.003	.008	.007
N	1088	1088	1088	1088	1088	1088
F	.698	.402	.978	.396	1.084	.810

Note: Dependent variables, indicated in table headers, are HR manager characteristics (see Table 5 for details), explanatory variables are the same CV elements as in our baseline model (see Table 4 for details). Standard errors clustered at HR-manager level in parentheses. Significance level: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A.6
Secondary-school analysis in subsample of commercial apprenticeships in non-male-dominated industries.

	All (1)	Female (2)	Male (3)
Cognitive Skills			
School GPA	.29**	.14	.35**
	(.12)	(.16)	(.15)
Extended IT skills	.19**	.24**	.17
	(.09)	(.11)	(.15)
Fluent English	.12	.19	.03
	(.08)	(.12)	(.12)
2nd foreign language	.13	−.08	.30**
	(.09)	(.13)	(.13)
Social Skills			
Social volunteering	.40***	.44***	.37***
	(.08)	(.11)	(.13)
Team sports	−.01	.07	−.15*
	(.05)	(.07)	(.08)
Additional CV Elements			
Age within school cohort	.21***	.08	.32***
	(.07)	(.10)	(.10)
Long internship	.11	.09	.09
	(.09)	(.10)	(.14)
Left on screen	−.05	−.08	.01
	(.05)	(.08)	(.08)
CV-pair fixed effects	Yes	Yes	Yes
R^2	.182	.226	.218
N	624	350	274

Note: Same specification as in columns 4-6 of Table 3. Sample includes only commercial (rather than technical) apprenticeships in industries with a female employment share of at least 20 percent. Standard errors clustered at HR-manager level in parentheses. Significance level: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Curriculum Vitae

Name:	Sarah Becker
Nationality:	German
Date of birth:	15.11.1991
Place of birth:	Mainz

School education

2003 - 2011	Integrated Comprehensive School Mainz-Bretzenheim
2011	High school degree, average grade: 3,3

College education

2011 - 20115	Business administration University Siegen
2015	Degree: Bachelor of Science in Business administration Final grade: 3,0

Professional experience

2014	Internship in the Sales division MVI Proplant, Wolfsburg 3 months

Languages

- English (fluent)
- French (good knowledge)

IT skills

- Microsoft Office (advanced)
- HTML and Adobe Dreamweaver

Interests and social engagement

- Handball
- Volleyball
- Neighbourhood assistance: youth work, senior citizens' group, implementation of German courses

Fig. A.2. Example CV of a college graduate. *Note*: Own translation of German original, which is provided in Fig. O.2 in the online appendix.

Table A.7
Invitation rate by first and last names.

	Secondary-school graduate sample			College-graduate sample		
	mean	p-value	N (CVs)	mean	p-value	N (CVs)
Male first names						
Alexander	0.416	0.060	125	0.558	0.241	104
Christian	0.487	0.750	156	0.439	0.272	82
Daniel	0.561	0.227	98	0.582	0.106	98
Patrick	0.504	0.931	133	0.461	0.431	102
Tobias	0.532	0.380	186	0.447	0.305	94
Female first names						
Anna	0.455	0.397	88	0.531	0.454	143
Julia	0.562	0.174	121	0.463	0.419	123
Katharina	0.480	0.657	125	0.510	0.844	102
Laura	0.495	0.918	93	0.547	0.272	139
Sarah	0.495	0.922	103	0.426	0.136	101
Last names						
Becker	0.484	0.611	246	0.463	0.275	214
Fischer	0.482	0.554	284	0.559	0.091	202
Mayer	0.542	0.175	262	0.589	0.005	241
Schneider	0.474	0.428	228	0.403	0.003	226
Weber	0.519	0.580	208	0.483	0.626	205

Note: Mean represents the share of CVs chosen for an interview. P-values stem from two-sided tests whether the mean equals 0.5.

college-graduate resumes. Elements marked with a star - gender, type of secondary school, college type, and business area of the internship - do not vary within a CV pair shown to an HR manager. The other elements — name, date of birth, place of birth, high-school GPA, college GPA, internship firm and duration, English proficiency, 2nd foreign language, IT skills, volunteering, and sports — vary randomly within CV pairs.

College-graduate resumes have the same five first names and five last names as the secondary-school graduates. The first names are again among the ten most common names in the year the candidates were born. Candidates are born within a four-month period between 15 November 1991 and 10 March 1992 in the capital in one of six states.

The applicants went to one of three high-school types, which are held constant within CV pairs: a regular high school (Gymnasium), a private catholic school, or a comprehensive school. All schools in the fictitious resumes actually exist in the respective city of birth. All candidates obtained their high-school leaving certificate (Abitur) in 2011. Resumes include the high-school GPA (Abiturnote).

All applicants have obtained a four-year Bachelor's degree in business administration at a public German university. The degrees are from universities ranked either in the top five or bottom five in the category undergraduate business degree of the CHE University Ranking 2015. Note that there are no tuition fees and typically no entrance exams for public colleges in Germany. Resumes include the college GPA.

High-school GPA and college GPA range from 1.3 to 3.3, that is, between very good and satisfactory. We do not use the best and worst possible grades to avoid very large (and quite uncommon) performance changes from high school to college. To avoid that one CV in a pair dominates on both GPAs, we randomize three of the four GPAs in each CV pair independently, but restrict the fourth GPA in a way that ensures that no CV contains better GPAs at both levels.

The area of the internship (sales, accounting, or controlling) is held constant within CV pairs in order not to give one candidate a particular advantage in case that the HR manager's firm happens to specialize in that area. Fictitious candidates have completed their internship at one of four existing mid-size firms that offer student internships on an online job portal.

All candidates have English language skills, but the level of proficiency varies between basic, very good, and fluent. Candidates may or may not have a second foreign language, either French or Spanish (basic level). All candidates are proficient in Microsoft Office, whereas some candidates have additional IT skills in both HTML and Dreamweaver.

A3. HR-manager questionnaire

HR managers are given the following questionnaire (translated from the original German version) after they have selected their preferred fictitious applicants.

1. How old are you? (drop down menu, 18–100 years)
2. You are: (male, female)
3. Which professional qualification do you have? (vocational degree, university of applied sciences degree, university degree, no professional degree, other degree)
4. Are you responsible for hiring decisions in your establishment? (yes, no)
5. Are you the managing director of the firm? (yes, no)

6. How many job interviews have you approximately conducted during the previous 12 months? (0, 1-9, 10-50, more than 50)
7. How important are for you the following characteristics of applicants in your firm? (very important, rather important, rather unimportant, very unimportant)

All HR managers

- IT skills
- Language skills
- Professional experience through internships
- Hobbies

Only HR managers in secondary-school-graduate sample

- GPA of school-leaving degree
- German grade
- Math grade

Only HR managers in college-graduate sample

- High-school GPA (Abiturnote)
- College GPA

References

Abeler, J., Becker, A., Falk, A., 2014. Representative evidence on lying costs. J. Public Econ. 113, 96–104.
Agan, A., Starr, S., 2018. Ban the box, criminal records, and racial discrimination: a field experiment. Q. J. Econ. 133 (1), 191–235.
Alesina, A., Miano, A., Stantcheva, S., 2018. Immigration and Redistribution. NBER Working Paper No. 24733.
Allen, M.S., Greenlees, I., Jones, M., 2013. Personality in sport: a comprehensive review. Int. Rev. Sport Exerc. Psychol. 6 (1), 184–208.
Altonji, J.G., Pierret, C.R., 2001. Employer learning and statistical discrimination. Q. J. Econ. 116 (1), 313–350.
Arcidiacono, P., Bayer, P., Hizmo, A., 2010. Beyond signaling and human capital: education and the revelation of ability. Am. Econ. J. Appl. Econ. 2 (4), 76–104.
Arrow, K.J., 1973. Higher education as a filter. J. Public Econ. 2 (3), 193–216.
Baert, S., 2018. Hiring Discrimination: An Overview of (Almost) All Correspondence Experiments since 2005. In: Gaddis, Michael S. (Ed.), Audit Studies: Behind the Scenes with Theory, Method, and Nuance. Springer, Cham, pp. 63–77.
Baert, S., Rotsaert, O., Verhaest, D., Omey, E., 2016. Student employment and later labour market success: no evidence for higher employment chances. Kyklos 69 (3), 401–425. doi:10.1111/kykl.12115.
Baert, S., Verhaest, D., 2018. Work Hard or Play Hard? Degree Class, Student Leadership and Employment Opportunities. GLO Discussion Paper 276. Global Labor Organization, Essen.
Baert, S., Verhaest, D., 2019. Unemployment or overeducation: which is a worse signal to employers? De Econ. 167 (1), 1–21.
Baert, S., Vujić, S., 2018. Does it pay to care? Volunteering and employment opportunities. J. Popul. Econ. 31 (3), 819–836.
Beam, E.A., Theoharides, C., Hyman, J., 2020. The Relative Returns to Education, Experience, and Attractiveness for Young Workers. Econ. Dev. Cult. Change forthcoming.
Bertrand, M., Duflo, E., 2017. Field experiments on discrimination. In: Banerjee, A.V., Duflo, E. (Eds.), Handbook of Field Experiments. Handbook of Economic Field Experiments, 1. North-Holland, pp. 309–393.
Boyd-Swan, C., Herbst, C.M., 2018. The demand for teacher characteristics in the market for child care: evidence from a field experiment. J. Public Econ. 159, 183–202.
Chetty, R., Friedman, J.N., Hilger, N., Saez, E., Schanzenbach, D.W., Yagan, D., 2011. How does your kindergarten classroom affect your earnings? Evidence from project star. Q. J. Econ. 126 (4), 1593–1660.
Clark, D., Martorell, P., 2014. The signaling value of a high school diploma. J. Polit. Econ. 122 (2), 282–318.
Darolia, R., Koedel, C., Martorell, P., Wilson, K., Perez-Arce, F., 2015. Do employers prefer workers who attend for-profit colleges? Evidence from a field experiment. J. Policy Anal. Manag. 34 (4), 881–903.
Deming, D.J., 2017. The growing importance of social skills in the labor market. Q. J. Econ. 132 (4), 1593–1640.
Deming, D.J., Yuchtman, N., Abulafi, A., Goldin, C., Katz, L.F., 2016. The value of postsecondary credentials in the labor market: an experimental study. Am. Econ. Rev. 106 (3), 778–806.
Eriksson, S., Rooth, D.-O., 2014. Do employers use unemployment as a sorting criterion when hiring? Evidence from a field experiment. Am. Econ. Rev. 104 (3), 1014–1039.
Falk, A., Becker, A., Dohmen, T., Enke, B., Huffman, D., Sunde, U., 2018. Global evidence on economic preferences. Q. J. Econ. 133 (4), 1645–1692.
Falk, A., Lalive, R., Zweimueller, J., 2005. The success of job applications: a new approach to program evaluation. Labour Econ. 12 (6), 739–748.
Farber, H.S., Silverman, D., Von Wachter, T., 2016. Determinants of callbacks to job applications: an audit study. Am. Econ. Rev. 106 (5), 314–318.
Federal Statistical Office 2016. Studierende an Hochschulen, Fachserie 11, Reihe 4.1, WS 2015/2016. https://www.destatis.de/GPStatistik/servlets/MCRFileNodeServlet/DEHeft_derivate_00035247/2110410177314.pdf.
Gorman, E.H., 2005. Gender stereotypes, same-gender preferences, and organizational variation in the hiring of women: evidence from law firms. Am. Sociol. Rev. 70 (4), 702–728.
Grigorieff, A., Roth, C., Ubfal, D., 2016. Does Information Change Attitudes Towards Immigrants? Representative Evidence from Survey Experiments. IZA Discussion Papers, 10419. Institute for the Study of Labor (IZA).
Haaland, I., Roth, C., 2017. Labor Market Concerns and Support for Immigration. Technical Report.
Hamermesh, D., 2012. Are Fake Resumes Ethical For Academic Research? Freakonomics Blog, http://freakonomics.com/2012/03/15/are-fake-resumes-ethical-for-academic-research.

Hanushek, E.A., Schwerdt, G., Wiederhold, S., Woessmann, L., 2015. Returns to skills around the world: evidence from PIAAC. Eur. Econ. Rev. 73 (C), 103–130.
Hanushek, E.A., Schwerdt, G., Wiederhold, S., Woessmann, L., 2017. Coping with change: International differences in the returns to skills. Econ. Lett. 153, 15–19.
Hanushek, E.A., Woessmann, L., 2008. The role of cognitive skills in economic development. J. Econ. Lit. 46 (3), 607–668.
Heckman, J.J., Stixrud, J., Urzua, S., 2006a. The Effects of Cognitive and Noncognitive Abilities on Labor Market Outcomes and Social Behavior. J. Labor Econ. 24 (3), 441–482.
Heckman, J.J., Lochner, L.J., Todd, P.E., 20006b. Earnings functions, rates of return and treatment effects: the mincer equation and beyond. In: Handbook of the Economics of Education, 1, pp. 307–458.
Heinz, M., Schumacher, H., 2017. Signaling cooperation. Eur. Econ. Rev. 98, 199–216.
Humburg, M., Van der Velden, R., 2015. Skills and the graduate recruitment process: evidence from two discrete choice experiments. Econ. Educ. Rev. 49, 24–41.
Koedel, C., Tyhurst, E., 2012. Math skills and labor-market outcomes: evidence from a resume-based field experiment. Econ. Educ. Rev. 31 (1), 131–140.
Kroft, K., Lange, F., Notowidigdo, M.J., 2013. Duration dependence and labor market conditions: evidence from a field experiment. Q. J. Econ. 128 (3), 1123–1167.
Kübler, D., Schmid, J., Stüber, R., 2018. Gender discrimination in hiring across occupations: a nationally-representative vignette study. Labour Econ. 55, 215–229.
Kübler, D., Stüber, R., Schmid, J., 2019. Take your time to grow: A field experiment on the hiring of youths. Ger. Econ. Rev. 20 (4), e706–e729.
Lahey, J.N., Oxley, D.R., 2018. Discrimination at the Intersection of Age, Race, and Gender: Evidence from a Lab-in-the-Field Experiment. NBER Working Paper No. 25357.
Lang, K., Manove, M., 2011. Education and labor market discrimination. Am. Econ. Rev. 101 (4), 1467–1496.
Lummis, M., Stevenson, H.W., 1990. Gender differences in beliefs and achievement: a cross-cultural study.. Dev. Psychol. 26 (2), 254.
MacLeod, W.B., Riehl, E., Saavedra, J.E., Urquiola, M., 2017. The big sort: college reputation and labor market outcomes. Am. Econ. J. Appl. Econ. 9 (3), 223–261.
Neumark, D., 2018. Experimental research on labor market discrimination. J. Econ. Lit. 56 (3), 799–866.
Nunley, J.M., Pugh, A., Romero, N., Seals Jr, R.A., 2016. College major, internship experience, and employment opportunities: estimates from a résumé audit. Labour Econ. 38, 37–46.
Oreopoulos, P., 2011. Why do skilled immigrants struggle in the labor market? A field experiment with thirteen thousand resumes. Am. Econ. J. Econ. Policy 3 (4), 148–171.
Piopiunik, M., Schwerdt, G., Simon, L., Woessmann, L., 2018. Skills, Signals, and Employability: An Experimental Investigation. CESifo Working Paper 6858. CESifo, Munich.
Protsch, P., Solga, H., 2015. How employers use signals of cognitive and noncognitive skills at labour market entry: insights from field experiments. Eur. Sociol. Rev. 31 (5), 521–532.
Rich, J., 2014. What Do Field Experiments of Discrimination in Markets Tell Us? A Meta Analysis of Studies Conducted since 2000. IZA Discussion Papers, 8584. Institute for the Study of Labor (IZA).
Riley, J.G., 2001. Silver signals: Twenty-five years of screening and signaling. J. Econ. Lit. 39 (2), 432–478.
Roemer, J.E., 1998. Equality of Opportunity. Harvard University Press, Cambridge, MA.
Rooth, D.-O., 2011. Work out or out of work: The labor market return to physical fitness and leisure sports activities. Labour Econ. 18 (3), 399–409.
Sauer, S., Wohlrabe, K., 2020. ifo Handbuch der Konjunkturumfragen. ifo Beiträge zur Wirtschaftsforschung 88 Munich: ifo Institute.
Schwerdt, G., Woessmann, L., 2017. The information value of central school exams. Econ. Educ. Rev. 56, 65–79.
Spence, M., 1973. Job market signaling. Q. J. Econ. 87 (3), 355–374.
Stiglitz, J.E., 1975. The theory of screening, education, and the distribution of income. Am. Econ. Rev. 65 (3), 283–300.
Verhaest, D., Bogaert, E., Dereymaeker, J., Mestdagh, L., Baert, S., 2018. Do employers prefer overqualified graduates? A field experiment. Ind. Relat. J. Econ. Soc. 57 (3), 361–388.
Weinberger, C.J., 2014. The increasing complementarity between cognitive and social skills. Rev. Econ. Stat. 96 (4), 849–861.