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Cognitive ability and Internet use among older adults

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Abstract

While previous work has found cognitive ability to be strongly associated with whether older adults use the Internet, we consider whether cognitive ability also differentiates basic aspects of use. Four measures of use are considered: having high-speed access, length of time since initial household adoption, self-reported time using the Internet, and whether any of the respondent's Internet use involves the Web in addition to e-mail. In all cases, we find associations with cognitive ability, although effects are sometimes mediated to nonsignificance by subsequent attainments, especially education. Given how central social support is to discussions of older adults navigating the Internet, we look also at reports of the availability of such support, and we find that cognition is positively related to respondents having someone available to help them with Internet problems. Taken together, our results suggest strongly that the already cognitively advantaged are much better positioned to reap the potential benefits of online tools to help older adults navigate social benefits and make complicated decisions.

1. Introduction

Early concerns about the digital divide focused more centrally on the issue of access to the Internet and the extent to which access was inhibited by the lack of resources (e.g., NTIA, 1999, 2000, 2002). In the last few years, scholars have begun looking more closely at predictors of use differences instead of focusing solely on questions about access (DiMaggio et al., 2004; van Dijk, 2005), referring to differences as ''digital inequality'' rather than a divide as a way of highlighting the complexity of divergent uses. Despite the increasingly refined measures of use, however, research has continued to focus on a relatively narrow set of predictors in explaining differential

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use. In particular, while theories have suggested the importance of ''cognitive resources'' for understanding differences (de Haan, 2004), little work has sought to explicitly examine the relationship between measured cognitive ability and variation in Internet use.

We think explicit consideration on the possible role of cognition in differentiated use may be important for considering the potential consequences of digital inequality. As many have anticipated, the Internet is becoming increasingly *proto-normative* in that more and more services are being moved online with the expectation that individuals (or surrogates) are informed Internet users. Governments across the globe are relying increasingly on information technologies to disseminate information and provide decision-support resources to citizens. In the realm of health care, both the European Union (Commission of the European Communities, 2004) and the United States are embracing digital technologies. A case in point that we will use throughout this piece has been implementation in the United States of a prescription drug benefit (Medicare Part D) for senior citizens. To help seniors figure out which of a wide variety of plans is best for them, the government has developed and promoted a tool available on Medicare's website (New York Times, 2005). Making optimal decisions about this benefit poses a complex cognitive task to seniors. If advanced Internet use was also associated with cognitive differences among older adults, it might suggest that the Internet may compound cognitive advantage, extending to benefits provision the same logic that has elsewhere animated concern about the role new media may play in widening ''knowledge gaps'' (Bonfadelli, 2002).

Among a cohort of older adults, we consider the relationship between measured cognitive ability and four measures that serve as proxies for being an advanced user. First, we consider *whether the respondent has broadband or dial-up access*. Many online services nowadays depend on complex underlying technologies that require high-speed connections for optimal use. Second, we look at *the amount of time users report spending online* per week. Experience online has been amply demonstrated to be an important predictor of skill, and so more frequent users are more likely to be more effective users (Hargittai, 2004). Following this same logic, we look at *the number of years the respondent reports having Internet access* at home, the most autonomous location of use. Fourth, we consider *the extent to which Internet use includes using the Web.* Those whose Internet use is vastly or entirely confined to e-mail would seem likely to be less effective at using new tools made available for use through the Web, and past research has noted that older Internet users are disproportionately likely to restrict their use to e-mail (Fox, 2004). Together, we take these general measures as suggestive of who will most readily make use of web-centered innovation in information provision.

In addition to looking at refined measures of Internet use, we also consider *the availability of social support* for problems individuals may encounter in using the Internet. Older adults are often presumed to have younger surrogates who can help them navigate new technologies as needed. While such help is undoubtedly available to some older users, we think it possible that those who we might expect to need the most support might actually have the least available. For this reason, we consider whether cognitive ability is related to the likelihood that users have significant informal support they can draw upon.

2. Cognition and explaining differential Internet use

Questions about the role of material constraints on Internet access differences remain important, but it has also become plain that the propensity to adopt and use the Internet varies greatly among those for whom the price of Internet access *per se* poses relatively little constraint. Indeed, about one-fifth of adults who do not use the Internet live in households with Internet

access, and, especially among older adults, the most-cited reason for not having the Internet is not expense but the belief that it would not be useful (NTIA, 2002, p. 83).

Simple comparisons of multiple regression coefficients of education and income on Internet adoption in the United States have typically found stronger associations for education, suggesting further the limits of finances per se for understanding digital inequality in the United States (DiMaggio et al., 2004). Moreover, once cohort differences in educational attainment are taken into account, the association between education and adoption is no smaller for older adults than younger adults, despite older adults generally not having exposure to computers in their formal schooling (Freese and Rivas, 2005). This would seem to suggest that, at least for older adults, much of the apparent education ''effect'' on adoption may actually reflect antecedents (like cognitive ability) and consequences (like occupation) of education, rather than any direct causal effect of schooling itself.

Theories of Internet adoption and use have recognized the limitations of any overemphasis on material resources, and various scholars have called attention to the importance of motivation and skill (de Haan, 2004; Reddick and Boucher, 2002; Nurmela and Viherä, 2004). The high literacy demands and text-based informational content of the Internet would seem to provide reason to suspect cognitive ability may be importantly related to motivation to become an Internet user (Freese and Rivas, 2005).[1] Meanwhile, literature on general cognitive ability and specific skill acquisition would strongly suggest cognition to be related to both expectations and reality about one's ability to use the Internet effectively (Schmidt and Hunter, 1998; Gottfredson, 2002).

In sum, there is much reason to expect cognitive ability to be related to Internet adoption, even when other variables are taken into account. While sociodemographic variables have dominated population-based studies of Internet adoption, Freese and Rivas (2005) found that scores on a general cognitive ability test administered decades earlier—when individuals were juniors in high school—strongly predicted whether they were Internet users. Those respondents with test scores in the top decile were more than 2.5 times more likely to be Internet users than those whose scores were in the lowest decile. Moreover, a substantial cognitive gradient on Internet adoption remained even after accounting for the intervening effects of adolescent cognitive differences on educational attainment, income, wealth, occupation, and several other measures. DiMaggio and Hargittai (2002) found a strong effect of a very crude measure of cognitive ability on adoption in a nationally representative sample of American adults.

As noted, however, digital inequality researchers have complained that research has focused too much on the binary outcome of whether one is an Internet user and not enough on differences among Internet users (DiMaggio et al., 2004; Lenhart and Horrigan, 2003). Hargittai (2002) underscores the importance of considering a ''second-order digital divide'' in which Internet users are differentiated by their capacity for efficient and effective use. For anticipating public capacity to utilize Internet tools to understand and navigate social benefits, in particular, it seems important to understand sources of cleavage not only in who is online but also the activities and capabilities of users (Robinson et al., 2003). Predictors of adoption may differ importantly from predictors of use (DiMaggio et al., 2004). In the case of cognitive ability, cognition may provide a ''hurdle'' to adoption but be of little relevance for differentiating users once the hurdle is passed.

[1] de Haan (2004, p. 78) discusses ''numeracy'' (quantitative reasoning ability) and ''informacy'' (''ability to handle information that becomes available through digital technologies'') as well as literacy in his model of ''cognitive resources'' and Internet use. Why ''numeracy'' should be independently related to the most common modes of Internet use is not elaborated, and ''informacy'' as a separate cognitive ability is highly intriguing but still not well developed.

Alternatively, unlike what Freese and Rivas (2005) found for adoption, it could be that apparent effects of cognition on effective use are mostly or fully mediated by subsequent educational, financial, or occupational attainments.

The Medicare Part D example illustrates why cognitive gradients in Internet use might be theoretically important for thinking about the broader implications of digital inequality. The complexity of the benefit is part of its design (HHS, 2005), and an important part of the government's response to complaints about its complexity has been to direct individuals to a tool on Medicare's website that helps individuals figure out which plan best matches their needs and budget. As put in an enthusiastic editorial in the *New York Times* (2005), "All elderly Americans can use software on the Medicare Web site to help pick the best plan for them."

The obvious counterpoints tempering such enthusiasm are that well under half of American over age 65 have the Internet in their homes, and a substantial portion have never used the Internet (Fox, 2004). Moreover, among the elderly as well as all other American adults, those with more education and income are more likely to be Internet users (Fox, 2004). However, the findings of Freese and Rivas (2005) suggest further that cognition is an independent source of cleavage between those who do and do not use the Internet. This, in turn, leads to the possible unfortunate irony that the cognitive assistance being provided by the Internet tool for the prescription drug benefit is disproportionately unavailable precisely to those Americans who would seem most in need of cognitive aids. Theories of knowledge gaps have proposed that improvements in the public distribution of information tend to increase disparities between those who would already be better and worse informed (Tichenor et al., 1970; Bonfadelli, 2002). The availability of decision-support tools online suggest that the Internet makes it imperative for researchers to expand their notion of "knowledge gaps" beyond just disparities of information to disparities in optimal decision-making in areas vital for individuals' physical and financial well-being.

Freese and Rivas (2005) examined only whether cognition was associated with respondents' being Internet users or not. In this study, we use the same data to examine whether cognition is also associated with aspects of Internet use and the provision of social support that could be expected to affect the capacity for respondents to utilize the Internet to take advantage of web-based tools provided by the government or other organizations to help utilize benefit programs. Specifically, the study will focus on whether respondents have a high-speed connection at home, how long they have had Internet access from home, how much time they spend online, and whether any of their Internet use includes the Web. In addition, when acknowledging that older adults may sometimes confront especial difficulties using online tools, commentators often suggest that problems are commonly resolved by help from others. For this reason, we also look at whether individuals have friends and family who can help with problems using the Internet.[2]

3. Data

3.1. Data

The Wisconsin Longitudinal Study (WLS) is based on a one-third sample of all Spring 1957 graduates from Wisconsin high schools (original $N = 10{,}317$). The WLS has gathered

[2] For example, the New York Times editorial quoted earlier notes that Medicare's Internet tool "may be daunting to those who are inexperienced with the Internet" but that it would still "offer their computer-savvy friends and advisers a valuable tool" (2005, p. 9).

information through several rounds of surveys, including in 1957 (in school), 1993 (telephone and mail), and 2003–2004 (telephone and mail, as well as telephone survey of spouses). Sample retention has remained high throughout: 76% of sample members who were alive in 2004 were successfully interviewed by telephone in 1993 and 2004 ($N = 6857$). About 67% of those interviewed in 2004 still lived in Wisconsin, which has had Internet penetration rates close to the median for all US states (NTIA, 2000). The WLS is the only data resource that combines a large population-based sample of older adults in the United States, detailed and longitudinal measurement of cognition, personality, financial and sociodemographic covariates, and several measures of Internet adoption and use.

The WLS is a unique data set well-suited for the purposes of this study so long as several limitations are kept in mind. First, as a cohort sample, WLS respondents were all approximately 65 years old when surveyed, and so findings cannot be generalized to other ages and cohorts. This age, however, is ideal for contemplating the possible implications of results for the potential use of the Internet to navigate benefits among those newly eligible for programs for the elderly, and signs of barriers in using public services among this age group suggest the possibility of more pronounced difficulties among the older elderly. Second, all WLS sample members are high school graduates, so findings cannot be generalized to those who did not complete high school [roughly 25–30% of adolescents in Wisconsin in 1957 (Sewell and Hauser, 1975)]. As noted, because cognitive test scores and completing high school are substantially correlated, the expected associations between test scores and Internet use will underestimate the association one would expect to observe in a fully representative population. This will also be so to whatever extent adolescent and contemporaneous cognitive ability diverge, although WLS respondents are sufficiently young that we would not expect substantial heterogeneity induced by differential rates of cognitive decline. Third, given the composition of Wisconsin and its patterns of high school completion in 1957, the WLS sample is almost entirely white. While this poses an obvious limitation for generalizability, the ethnic homogeneity of the sample may strengthen its internal validity given concerns about the comparison of cognitive test scores between white and nonwhite subpopulations in the United States (see, e.g., Fischer et al., 1996).

3.2. Cognitive ability

Wisconsin high school students in the WLS cohort were administered the Henmon–Nelson test of Mental Ability (hereafter H–N) at least once during high school. Scores for WLS respondents were obtained from the Wisconsin State Testing Archive. The measure we use here is based on respondents' junior-year score if available and freshman-year score otherwise. Scores were converted to standardized (z) scores based on the corresponding Wisconsin percentile rank. Regrettably, the H–N was intended as a general measure of ability and includes no subtests, which implies that it may *underestimate* the total effect of cognitive abilities as measurable in adolescence on later-life Internet adoption.[3] The lack of subtests also makes it impossible to evaluate the relative importance of "literacy" or "numeracy" of cognitive resources (as suggested by de Haan, 2004).

[3] For various reasons, such attenuation might be less in this study, which is conditional on being an Internet user, than a study of Internet adoption itself.

3.3. Covariates

The study employs many of the same model covariates as Freese and Rivas (2005). The study includes a number of measures drawn from the 1993 survey and thus presumably preceded Internet adoption for the vast majority of respondents, reducing the possibility of biased estimates due to endogeneity. These measures are: gender, educational attainment, income, spouse's income, net worth (from asset reports), occupational education (based on percentage with same title according to 1990 Census classification who had at least one year of college, and thus can be considered a measure of the typical education for someone with the same occupation), occupational income (based on the percentage with same title earning more than $14.30/h), and whether respondent lives in rural area (defined as an area without a Census place code). Spouse's educational attainment is based on the 2004 spouse survey if available and on respondent's own report otherwise. Whether respondent is currently married and currently working is based on the 2004 survey. Multiple imputations based on an expectation-maximization algorithm were used to impute missing values on wealth (King et al., 2001).

3.4. Internet use

WLS respondents who reported having Internet access at home on the telephone survey were asked when they first obtained access at home and whether they had broadband or dial-up access (connectivity speed was asked only to a 50% random subsample of respondents). WLS respondents who reported using the Internet from home were also asked how many minutes per week they estimated that they used the Internet for all purposes. On the WLS mail survey, respondents were asked about the amount of time they used the Internet at home for e-mail and for the web separately, from which we construct our measure of whether respondents use the web at all.[4] Mail survey respondents were also asked "Suppose you had a problem setting up or using your computer that you couldn't figure out. Who could you ask for help?" and asked to check all that apply from a set of categories that included "friends, neighbors, and coworkers" and several categories of nonspouse relatives (children, grandchildren, siblings, and other relatives).

4. Results

Table 1 presents results for the four Internet adoption and use outcomes: whether the respondent has a high-speed Internet connection, how many minutes per week the respondent reports using the Internet, how many months the respondent has had Internet access from home, and whether the respondent uses the Web (versus using the Internet for e-mail only). For each outcome, coefficients for the H–N measure are presented for men and women separately for (1) the bivariate regression, (2) a model that adds just education, (3) a model that adds also income and wealth measures, and (4) a model including all controls. Combined results for the full model are also shown.[5]

If we look first to the logistic regression for having a high-speed connection at home, we observe a significant effect of cognition in the bivariate regression, although the relationship is

[4] For the overall measure of time use, the telephone measure is used because not all telephone respondents completed the mail survey.

[5] Supplemental tables with results for all covariates are available on the first author's webpage (http://www.ssc.wisc.edu/~jfreese/).

Table 1
Regression coefficients for effect of cognitive ability (Henmon–Nelson score) on Internet adoption and use outcomes

	Has high-speed connection[a]		Months since household first obtained access[b]		Minutes per week of Internet use[b]		Uses Web[a]	
	Males	Females	Males	Females	Males	Females	Males	Females
Bivariate	0.316*** (0.065)	0.169* (0.070)	0.133*** (0.022)	0.125*** (0.025)	0.139 (0.322)	0.067* (0.032)	0.441*** (0.117)	0.231* (0.100)
Model adding education	0.224*** (0.073)	0.057 (0.076)	0.059* (0.024)	0.056* (0.026)	0.106** (0.036)	0.061 (0.034)	0.261* (0.129)	0.126 (0.107)
Model adding income and net worth	0.190* (0.075)	0.033 (0.077)	0.045 (0.024)	0.047 (0.026)	0.105** (0.036)	0.064 (0.034)	0.260* (0.130)	0.116 (0.107)
Full model (adds all controls and mediators)	0.191* (0.078)	0.000 (0.079)	0.027 (0.024)	0.041 (0.026)	0.095** (0.036)	0.064 (0.034)	0.275* (0.134)	0.099 (0.109)
Full model combined sample	0.089 (0.077)		0.035 (0.018)		0.083*** (0.025)		0.168* (0.084)	
N	6853		6853		6853		6853	

* $p < 0.01$, ** $p < 0.05$, *** $p < 0.001$. Standard errors in parentheses.
[a] Logistic regression for binary dependent variable.
[b] OLS regression for logged dependent variable.

stronger for men than for women. In terms of the bivariate distribution, the percentage of men having a high-speed connection increases from 25.8% to 43.8% (18.0 points) between the lowest and highest test score deciles, while the comparable increase for women is from 21.2% to 35.3% (14.1 points). The effect on log odds for both men and women are attenuated by ~0.13 when education and income are controlled, but the implication of the change means the effect remains significant for men but is reduced to nearly zero for women. The implied predicted probabilities for men in the full model correspond to an increase from 0.286 to 0.339 as one moves from the bottom H–N quintile to the top quintile.[6] In sum, the results indicate a substantial effect of cognitive ability on having high-speed access, but, for women, this effect is nearly fully mediated by the influence of cognition on educational and financial attainments.

We might expect that the same patterns observed for having high-speed access at home would be also observed for how early respondents obtained Internet access in the first place. As it happens, however, we do not observe much difference in coefficients between men and women. The exponentiated average implies that those in the top test score quintile have had the Internet for approximately 65 months, compared to only 45 months for respondents in the bottom quintile.[7] Also, for both men and women, results are reduced to nonsignificance by controls for education and income. In our sample, then, users with higher test scores did adopt the Internet earlier than those with lower test scores, but this gradient is mostly the consequence of the effect of cognition on later education and income. While mediation should not be misinterpreted as meaning that cognition is unimportant for this outcome, the result is different from the strong effect of cognition *net* of potential mediators found for the simple binary measure of adoption by Freese and Rivas (2005). Early adoption of Internet for this cohort is importantly related to use of Internet at work (a finding reinforced by de Haan, 2004), and this likely explains why the effect of cognition on earliness of adoption is strongly mediated by attainment measures closely associated with one's career.

Looking next to the effect of cognition on self-reported time use, we can see again a stronger bivariate effect for men than for women. Exponentiating the logged measure indicates an increase in average time online from 161 to 235 min for men between the bottom and top H–N quintiles (74 min difference in use per week), compared to only an increase from 187 to 217 min (30 min difference) for women. Unlike what we have observed for high-speed access, however, neither is much reduced in magnitude by the inclusion of other controls, although the effect for women is no longer significant at the $p < 0.05$ level ($p = 0.06$). Cognitive ability thus appears substantially and positively related to the amount of time online in this sample—more so for men than for women—and the effect is not resolved by any of the potential intervening variables we examine.[8] Meanwhile, our analyses indicate that neither education nor income significantly

[6] Predicted probabilities based on mean Henmon–Nelson score for respondents in quintile with all other regressors held to their respective means.

[7] Because of concerns about the accuracy of recollected dates, we explored the possibility of incorporating reports from the spouse survey and using the wife's report of time access was first obtained whenever possible (based on evidence that women recollect dates more accuracy than men; see Skowronski and Thompson, 1990). This did not substantively affect our results.

[8] Of our controls, we note that not having a spouse is strongly associated with logged minutes of use (logit $\beta = 0.427$ in the full model, $p < 0.001$), but not with any other measures of connectivity or use. Our interpretation is just that, for married couples, household Internet adoption reflects joint preferences of partner and spouse; as such, there are some married respondents with low minutes of use who would not have the Internet if they were unmarried. None of our results regarding cognition change substantively if the sample is restricted to married individuals.

influences time online. These results are consistent with the interpretation that while socioeconomic factors strongly influence whether to obtain access, cognitive resources may be presently more strongly associated than socioeconomic factors with finding Internet use enjoyable or rewarding.

When we look specifically at whether respondents report using the Web as opposed to going online for email use only, we can note first that relatively few users (7.4%) limit their online time in this way. Once again, however, we do observe a bivariate relationship with cognitive ability that is stronger for men than for women. Men in the lowest quintile of cognitive ability are more than three times more likely to report not using the Web than men in the highest quintile (11.6% versus 3.6%), while for women the difference between extreme quintiles is less dramatic (12.3% versus 6.7%). For both men and women, the cognitive gradient is substantially reduced by the addition of other controls, although the effect of cognitive ability remains significant in the full model for men. For men, the reduction in the cognitive ability coefficient is entirely accounted for by education, and education also accounts for the vast majority of the attenuation for women. The education coefficient itself is not much attenuated by the addition of further variables to the model. In other words, important to why those of lower general cognitive ability are more likely to use the Internet for e-mail is that they have lower educational attainment, and the reason why less education is associated with not using the Web is not much resolved by subsequent measures in the study. One possibility is that educational attainment influences social networks or leisure time preferences in ways that are not otherwise much associated with the other potential mediating variables we examine.

Turning now from individual use to social support, Table 2 presents results for the reported availability of a friend or family member who could help with an Internet problem. We also present results for reporting no one who could help, which is equivalent to reporting no friend or family member. As in Table 1, analyses are conducted separately for men and women and results are presented for the bivariate regression, a model adding education, a model adding income and wealth, and a model including all controls.

We find that Internet users with higher cognitive ability are more likely to report having a friend who could help them with an Internet problem. The difference between the lowest and highest test score quintiles is about 18 percentage points for both men and women (42.7–64.2% for men, 34.5–52.5% for women). When controls are added, the coefficients are reduced to nonsignificance for women ($p = 0.17$), but remain significant for men. Supplementary analyses indicate that the bulk of the attenuation is due to the inclusion of education and occupational education, suggesting that much (but not all) of why cognitive ability is positively associated with having Internet-savvy friends is accounted for by the implications for social networks of cognitive sorting into education first and occupation later.

Meanwhile, for women, education suppresses the relationship between cognitive ability and reporting a child or grandchild who can help. For both men and women, the bivariate relationship between cognitive ability and help from a descendant is nonsignificant. For women, however, the relationship becomes significant once education is controlled ($p < 0.001$), and remains significant when other variables are added to the model. The effect implies an increase in the predicted probability of support from 0.736 to 0.793 as one moves from the lowest to highest quintile of ability. Analyses indicate that, for women, finishing college (versus not attending college) has a strong negative effect on the log odds of having a child or grandchild who can help with an Internet problem (-0.607, $p < 0.001$), when the model includes only cognitive ability as a control. However, this difference is strongly attenuated by the inclusion of the covariates from the full model of Table 2 (to -402, $p < 0.01$), and it is reduced substantially and to

Table 2
Logistic regression coefficients for effect of cognitive ability (Henmon–Nelson score) on measures of Internet social support

	Has friend who can help		Has family member who can help		Reports no one who can help	
	Males	Females	Males	Females	Males	Females
Bivariate	0.300*** (0.047)	0.227*** (0.047)	−0.100 (0.055)	0.041 (0.062)	−0.174 (0.112)	−0.322** (0.118)
Model adding education	0.176*** (0.052)	0.119* (0.050)	−0.030 (0.063)	0.151* (0.067)	−0.172 (0.126)	−0.400*** (0.128)
Model adding income and net worth	0.173*** (0.053)	0.104* (0.051)	−0.050 (0.063)	0.137* (0.067)	−0.147 (0.125)	−0.365** (0.129)
Full model (adds all controls and mediators)	0.135* (0.054)	0.071 (0.052)	−0.044 (0.065)	0.172* (0.069)	−0.107 (0.129)	−0.334* (0.131)
Full model combined sample	0.103** (0.037)		0.058 (0.047)		−0.222* (0.091)	
N	6853		6853		6853	

* $p < 0.01$, ** $p < 0.05$, *** $p < 0.001$. Standard errors in parentheses.

nonsignificance when measures of the number of children and the woman's age at first birth are added (to −0.231, $p = 0.15$). The implication is that, the reduced or delayed childbearing by women with higher education offsets the otherwise positive effect of cognitive ability through its negative effects on the number or age of descendants who can help. Another way of saying this is that, at least for women, cognitive ability may simultaneously be associated with a reduced number of family members available to provide support for Internet problems and an increased likelihood that any particular member will be able to provide support.

In contrast to the patterns reported for family or friends, there is no relationship between cognitive ability and the probability of having a sibling or other nonoffspring relative who can help with an Internet problem, for either gender in any model. In all, when possible help from either family or friends is considered, only 4.2% of respondents report having no one who could help them with an Internet problem. That said, among women, the percentage reporting having no one who could help is more than twice as large for those in the lowest test score quintile than the highest quintile (6.6% versus 2.4%). The magnitude of the cognitive gradient for women is not much changed by the addition of controls. This is not surprising given the analyses above, in which the inclusion of education in the model had opposite consequences for the estimated cognitive ability effect on having friends who could help versus offspring who could help. In sum, cognitive ability may ultimately be positively related to having any social support for Internet problems, at least among women, and it is more plainly related to the availability of such support from friends, neighbors, or co-workers than from family.

5. Conclusion

Freese and Rivas (2005) documented the importance of cognitive differences in whether members of this cohort sample of older adults were Internet users. Taking the agenda further, the present study finds that cognition also importantly differentiates Internet users regarding intensity and context of use in this cohort. The relationship between cognition and Internet behavior is not simply that of a ''hurdle'' in which cognitive differences become irrelevant once barriers to adoption *per se* are surmounted. The study provides strong support for theories that give prominent place to ''cognitive resources'' alongside other resources in understanding Internet use (de Haan, 2004), and it suggests psychological measures may figure importantly in both understanding digital inequalities and in anticipating their potential consequences.

Specifically, we find that those with higher cognitive ability are more likely to have broadband access and more likely to have Web use—as opposed to e-mail use only—as part of their online experience. They also tend to have adopted the Internet earlier and use the Internet more. All of these outcomes seem likely associated with the practical ability to use the Web efficiently and effectively (Hargittai, 2002). We also find cognition to be related to having friends who can provide help with Internet problems and, at least for women, we find cognition related to whether one ultimately has anyone available to help. In short, while we may well expect cognition to be related to how readily individuals may develop skills for using the Internet, it is also associated with the experiences that facilitate effective use and with the availability of support that can compensate for deficiencies of skill that may inhibit effective use.

We can consider the implications of these findings further with reference to the example of the Medicare prescription drug benefit program discussed earlier. As noted, the benefit itself puts a cognitively complicated task to millions of older Americans, and an Internet-based tool has been widely touted as providing valuable cognitive assistance with this task. While one might expect those with lower cognitive ability to have greater need for cognitive assistance, they are also less

likely to be Internet users and presumably less likely to realize the benefits of the Internet tool. As we find, even among those who are Internet users, we have every reason to expect lower capacity for effective use among those with lower cognitive ability, as they would appear less experienced with the Internet generally (having had access from home for a shorter time and currently using it less) and with the Web specifically.

Although a tutorial is available to help confused users figure out how to use the drug benefit tool, the tutorial works far better if one has a high-speed connection, and users with lower cognitive ability are less likely to have quick connectivity. Users might also seek the help of others in using the tool, but we find that those with lower cognitive ability are less likely to have such support. In sum, then, cognitive ability poses several distinct disadvantages that inhibit the capacity for those who may benefit most from the drug benefit tool from being able to use it effectively. Additionally, one might also note that the negative consequences of making a bad decision about one's drug benefit plan are less severe the more wealthy one is, but cognitive ability has a substantial association with wealth.

In considering the implications of this study, of course, one must remain mindful of its limitations. The sample is ethnically homogeneous, and thus the study does not speak to cultural or language barriers to effective use of Web-based tools. As a sample for cohorts that are at the earliest ages of being eligible for social programs for the elderly, the sample cannot speak to the role of cognition in Internet use among the ''older old''; of especial importance, the study cannot speak to the implications of cognitive decline for continued effective use of the Internet. Because sample members all graduated from high school, the sample contains disproportionately few of those with the lowest levels of cognitive ability. This may cause us to underestimate the relationship between cognition and use that we might observe in an untruncated sample.[9]

In calling specific attention to the role of cognition, the study underscores the value of data resources that contain cognitive measures for studies of digital inequalities. Educational attainment is often taken as a quasi-proxy for cognition, which is unfortunate given the many noncognitive causes and consequences of education and the enormous heterogeneity of measured cognition within any level of educational attainment. The findings for family support among women in this study show that education and cognition can have opposite effects, in this case seemingly because the otherwise favorable consequences of higher cognitive ability for support networks is offset by the implications of continued education for childbearing. Cognitive measures are sometimes eschewed by those interested in policy because of a sense that, compared to educational attainment, estimated effects of cognition offer less hope for change than effects attributed to schooling. Yet we cannot easily go back and change the formal schooling attainment of the elderly; the finding of a cognitive gradient implies the possibility of skills-focused intervention no less strongly than education effects do; and interventions are most promising when based on as precise an understanding of causes as possible. Understanding the role of cognition in digital inequality can prompt more attention to considering what about the Internet (e.g., the literacy demands, the cultural and occupational networks over by which knowledge about it diffuses) makes it cognitively selective.

Cognitive effects were stronger for men than women both in broadband use and time use. Freese and Rivas (2005) likewise find stronger cognitive effects for men than women for

[9] Freese (2006) uses centile rank information from the freshman administration of the Henmon–Nelson test to estimate the cognitive distribution of high school drop-outs in the WLS cohort and finds the expected strong inverse relationship between test scores and probability of dropping out of school.

adoption. We posit that this difference reflects men being relatively less attracted than women to using e-mail versus the web (e.g., Wasserman and Richmond-Abbott, 2005) and to the web being more cognitively selective (for both men and women) than e-mail.[10] If modes of web use more attractive to men are also more cognitively selective, then it follows that cognitive gradients for adoption and use will be stronger for men.

For some outcomes in this study, the effects of cognition were substantially mediated by education, while for others it was not. Education seemed more consequential for the measures associated with obtaining access (i.e., early adoption of Internet or adoption at time-of-interview of broadband), which may reflect the effects of education on cultural capital and its implications for diffusion of knowledge of benefits (as would be similar for other innovations, see Rogers, 1995). That said, the causal effect of education on Internet adoption or use remains poorly understood, especially for older adults whose formal education did not include computers or the Internet. As Internet studies continue to move beyond binary indicators of access or adoption to studies of differential use, we hope this expansion is accompanied by a greater effort to articulate the specifics behind the large cleavages by education and other sociodemographic variables that are observed. Basic psychological variables like cognition can be expected to have an important role in this task, but they are also plainly only part of a still much incomplete story. As the Internet comes increasingly to be used to augment the capacities of users to make informed decisions among vast arrays of choices, understanding the true causes of inequality in who uses the Internet and does so effectively will become ever more undeniably important.

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