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Cognition, Personality, and Individual Response to Technological Change: The Case of Internet Adoption

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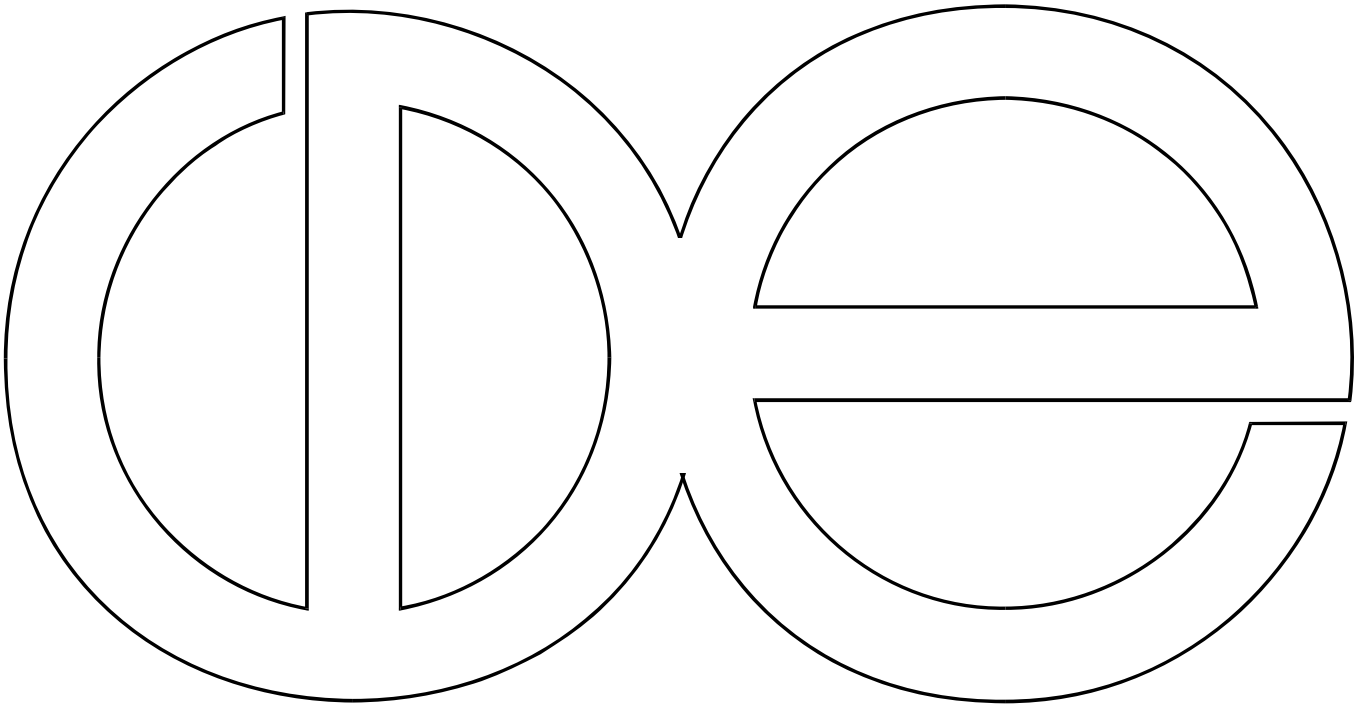

COGNITION, PERSONALITY, AND INDIVIDUAL RESPONSE TO TECHNOLOGICAL CHANGE: THE CASE OF INTERNET ADOPTION

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Abstract

Existing sociological and other literature on digital inequalities in the United States has given little specific attention to the potential roles of cognitive ability and personality, especially in terms of how effects of these variables may vary in predictable ways depending on individuals' social position. We consider the matter specifically with regard to whether late midlife adults have become Internet users. Consistent with our predictions, we find that cognitive ability and openness to experience are strongly and positively associated with Internet adoption in this cohort, and that neuroticism is inversely associated with adoption. Including these variables also attenuates the apparent causal effect of both education and income on Internet adoption. We also find that the effect of cognitive ability is smaller for those with more education, more wealth, and who have jobs that use the Internet. Openness and neuroticism are importantly also mediated by social circumstances, although the latter more ambiguously. The results underscore not only the importance of considering basic psychological characteristics in understanding why people in similar social positions respond differently to change, but also how social conditions create conditions under which psychological differences are more- or less-strongly implicated in behavioral differences.

A famous description of the sociological enterprise charges the discipline with understanding the interaction of history and biography, including how large-scale social changes are manifested in the everyday lives of individuals (Mills 1959). When discussing the individual consequences of social change, sociologists commonly emphasize that such consequences usually vary greatly depending on one's social position. Sociologists also generally acknowledge that psychological characteristics may have their own, autonomous influence on how people respond to change, although such characteristics are less often and less elaborately considered. An alternative position is that not only are the biographical consequences of basic psychological characteristics interesting and fundamental in their own right, but the failure to consider these characteristics can also limit and distort sociologists' understanding of how social position influences response to change. More importantly, whether and how much basic psychological characteristics influence behavior and outcomes in the face of social change might itself vary in systematic and sociologically explicable ways depending on individual circumstances.

We expand upon this orienting premise here with regard to social change brought about by technological change. In terms of technology transforming the character of everyday life in the United States, nothing has received as much scholarly and popular attention in the past two decades as has the spread of Internet into American homes (see DiMaggio, Hargittai, Neuman, Robinson 2001; DiMaggio, Hargittai, Celeste, and Shafer 2004; Boulianne 2005 for overviews). The Internet went quickly from a frontier inhabited by a relatively few professionals and hobbyists to a widely used sphere for a broad and expanding array of activities. Even if some of the headier claims about the changes the Internet would bring have not come to pass (as in, e.g., Negroponte 1995; Turkle 1995), it remains undeniable that, for many Americans, using the

Internet at home has become an important part of their lives. Yet there are also many Americans who never use the Internet and feel that they have no use for it. Why some people have become Internet users while others have not has been a topic of much speculation and research (e.g., de Haan 2004; DiMaggio et al. 2004; Boulianne 2005).

We are interested particularly in the case in which the historical phenomenon of the rapid diffusion of Internet into American homes intersected with the biographies of those in the most comfortable and settled segment of the life course. For Americans, one's fifties are a period marked by comparatively high residential, occupational, income, and marital stability, reduced childrearing responsibilities, and relatively good health. This is especially so for those who do not suffer the social disadvantages of being either non-white or without a high school education. Such individuals were typically quite settled into lives without the Internet as its rapid diffusion into homes began, but they were not yet elderly, either. How does this population respond to the widescale introduction of a new technology with potentially manifold personal implications? As it turns out, these cohorts evince some of the most dramatic variation in the home adoption of Internet technology, and, excepting those near the bottom of the socioeconomic distribution, this variation in Internet adoption is only modestly related to available financial resources (Fox 2004; Freese and Rivas 2005). Moreover, despite various predictions that Internet diffusion was on an S-curve toward relatively swift near-saturation (Leigh and Atkinson 2001), evidence indicates that intracohort rates of Internet adoption have largely stalled, suggesting that the mix of heavy users and complete non-users may well mark the remainder of the active lives of these cohorts (DiMaggio et al. 2004).

For reasons we describe, we believe response to the rapid rise of the Internet among late midlife adults represents exactly the response to social change that might be better understood by

sociologists than it has to date through a more detailed consideration of the potential interaction of basic psychological characteristics and social position. In pursuing this idea, we restrict attention here to one indicator of personal Internet adoption, whether one uses the Internet from home, and to two types of basic psychological characteristics: measures of cognitive ability and personality. We present conjectures about the relationship between individual psychological characteristics and household adoption, and we consider how we might expect the strength of these relationships to vary by one's familial, socioeconomic, and occupational circumstances. Then, we interrogate these conjectures using a large, longitudinal sample of adults in this cohort. Afterward, we discuss our findings in terms of what they might suggest more broadly about the interaction of personality and social structure in the unfolding of biography, as well as what they might signify for questions about the causes and meaning of digital inequality in the United States.

INTERNET ADOPTION

Between 1997 and 2001 alone, the percentage of American households with Internet service increased from 18.6% to 50.3% (NTIA 2004). Yet while Leigh and Atkinson (2001:6) projected 90% Internet penetration by 2003, the actual percentage of households with Internet by that year had increased only to 54.3% (NTIA 2004). The possible leveling off of household penetration has been observed in other studies (e.g., Lenhart et al. 2003), and the divergence from S-curve-based predictions of rapid saturation might reflect Internet access being a continuing expense rather than one-time purchase (Mueller and Schement 1996; DiMaggio et al. 2004). In any event, barring further changes in prices or modes of use, the best forecast appears to be a protracted future in which a majority of people have and use the Internet at home but a very substantial minority do not (Norris 2001; Martin 2003).

Sociologists and others have long worried about the possibility of exactly such a stagnant divide, especially if the result is users gaining considerable and varied benefits from the Internet that non-users do not (NTIA 1999; Harris 2000; Norris 2001). For this reason, there has been much interest in documenting the relationship between cleavages in Internet use and prominent lines of existing inequality in the United States. Recent studies find little gender difference in whether someone uses the Internet (NTIA 2002; Wasserman and Richmond-Abbott 2005; among older adults, Fox 2004), and there have been conflicting findings about the extent to which racial differences exist net of socioeconomic and other controls (see Rivas 2004). In contrast, existing studies are said to have "made it clear that [years of education and income] are the main ways in which Internet users differ from nonusers" (Robinson, Neustadtl, and Kestnbaum 2002: 285). In 2003, for American adults age 25 and above, 39% of those with only a high school diploma used the Internet from home, as compared to 12% of without a high school diploma and 77% of those with a college degree (authors' CPS analyses). About 15% of those living in households with annual incomes below $20,000 were Internet adopters, as opposed to almost 85% of those with household incomes over $75,000, with this gradient being much steeper below the median than above (authors' CPS analyses). For reasons elaborated below, this study focuses only on the matter of home Internet adoption, but many recent studies have also found considerable sociodemographic differences in what Internet users do on the Internet (e.g., Howard, Rainie, and Jones 2001; Loges and Jung 2001; Howard 2004).

While no one disputes the importance of documenting socioeconomic cleavages in adoption or use, de Haan (2004) complains that too much work has had a "descriptive tendency" focused mainly on documenting differences, perhaps taking their explanation as self-evident, rather than working to understanding better why cleavages exist. In this respect, for example,

education and income have been commonly discussed together as if they were two sides of the same coin of "socioeconomic status" or "privileged households" (see especially the NTIA reports, e.g., NTIA 2002). Separate education and income gaps are sometimes discussed as though they were an inevitable feature of the adoption of new technologies involving information, but analyses of the Current Population Survey indicate that there is no education gradient for adoption of either cable/satellite television or cellular telephones when income is held constant (Rogers 1995; Freese and Rivas 2005). de Haan (2004) elaborates what he calls a "resource theory" for understanding variation in technology adoption that posits the influence of different kinds of material, social, and psychological resources. For our purposes, the details of this theory are less important than that it calls attention to major themes suggested elsewhere in the literature: namely, the independent importance of money, motivation, and skill (e.g., Reddick and Boucher 2002; Nurmela and Viherä 2004). The importance of motivation is made plain from surveys showing that a large number of non-users cite a lack of interest rather than a lack of funds as the primary reason for non-adoption (NTIA 2002).[1] Skill has been emphasized because differences in what individuals are capable of doing with the Internet (or expect that they will be readily capable of learning to do) has been emphasized as a possibly important determinant of their adoption (Hargittai 2002; van Dijk and Hacker 2003; Kubicek 2004; regarding age differences in evinced skill, see also Hargittai 2004b).

One might consider Internet adoption decisions to be like many other prospective expenditures of money and time in being influenced importantly by both how much individuals have to spend and how much utility they expect to derive relative to other possible expenditures.

[1] This pattern becomes stronger with age. In 2001, more persons under 35 cited expense rather than non-interest as the reason for not having the Internet at home, while, for persons over 55, 69% cited non-interest and only 14% cited expense (NTIA 2002).

Financial resources would seem especially important for lowering the threshold of how much utility individuals must expect to derive from the Internet in order to become and remain adopters. "Motivation" might be recast as expectations about the utility available to one from Internet use, while "skills" might be considered to be expectations about one's capacity to actually extract available utility through use. In this view, even though education and income are so often considered together in discussions of digital inequality, we might imagine any causal role of income to be mainly as financial resources while any causal role of education net of income to operate mainly though motivation, skill (and expectations about the development of skill), or both. Importantly, emphasis on motivation and skill also raise the possibility that basic psychological characteristics might also be a separate, and still largely undocumented, "main way" that Internet users vary from nonusers, for reasons we develop further below.

One can easily find research about Internet adoption or use that has focused on children (e.g., Livingstone 2003), adolescents (e.g., Gross 2004), college students (e.g., Landers and Lounsbury in press), early midlife adults (e.g., Jackson et al. 2003), and the elderly (e.g., Fox 2004). Late midlife adults have received the least specific attention, which we regard as especially unfortunate because we think they provide an especially interesting age group for thinking about how psychological characteristics and social circumstances might interact in Internet adoption decisions. The group is in a better position than any other to have financial resources play a nondominant role in their adoption decision (NTIA 2002), and yet their adoption and use varies greatly. In terms of motivation, the group was already well into midlife when even personal computers became prominent, much less the Internet, but they are also sufficiently young as to have a prospectively quite long time horizon in which Internet use will presumably be a highly visible part of American culture. At the same time, very few had

children living with them during the sharp rise of the Internet, so that while children may have played an important role in some adoption decisions (i.e., as a source of communication and informal technical support), their obtaining Internet access would rarely be household adoption specifically for a child's use rather than their own. In terms of skill, they did not "grow up with the Internet" or have computers as part of their formal schooling, but they also have relatively low rates of the physical and cognitive infirmities that may inhibit Internet-specific skill acquisition in more elderly populations (NTIA 2000: 71). Apart from any such general characterizations of late-midlife adults, their social circumstances of course vary tremendously. Below we will develop predictions about how we expect this variation in circumstances to be related to the extent to which basic psychological characteristics differentiate Internet users from non-users, but first we briefly elaborate what we mean by basic psychological characteristics and the two types of characteristics we consider.

BASIC PSYCHOLOGICAL CHARACTERISTICS

As discussed above, studies of digital inequality have focused mostly on standard demographic cleavages and have given less consideration to psychology. As increasing interest in "skill" and "motivation" suggest, however, attention to psychological concepts seems indispensible for understanding variation in Internet adoption. Toward this end, we do not at all question the usefulness of concepts such as Internet skills (Hargittai 2002), computer or Internet anxiety (Marcoulides 1989; White and Scheb 2000), "informacy" (de Haan and Rijken 2002), technophobia (Brosnan 1998), or a "venturesome" disposition toward innovations (Rogers 1995), but we believe there is potential value for sociologists to think more in terms of basic psychological characteristics as well. Not only do we think basic psychological characteristics may contribute importantly to the development of domain-specific psychological constructs

(e.g., “Internet anxiety” might substantially reflect a more general disposition toward anxiety [Landers and Lounsbury in press]), but they may also influence adoption by influencing the circumstances of individuals’ lives (e.g., their occupations). Basic psychological characteristics also provide a better vocabulary for considering continuities and cross-influences in the importance of psychology across different life domains of sociological interest. Additionally, as opposed to the often haphazard work on the properties of domain-specific measures, basic psychological characteristics have highly studied measurement properties and have already been studied with regard to a plethora of other outcomes.

What we mean by “basic psychological characteristics” are those theoretically conceptualized as domain-general in their potential consequences and empirically indicated to have high rank-order stability over midlife, at least in populations under study. The domain-generality of these characteristics makes them potentially causally relevant for behaviors and outcomes across a variety of domains, and suggests that they may combine importantly with experience in the development of more domain-specific (“higher-order, “superstructural”) psychological constructs like skills or attitudes (see McCrae and Costa [2003: 184-205] for an appealing dynamic model of such psychological adaptation with regard to personality). In pointing also to high rank-order stability over midlife, we mean to highlight the empirical matter that for some psychological characteristics, there is a high correlation between one’s intracohort value on the construct at the start of midlife and one’s value at the end, regardless of how variation in the characteristics arises and how much it changes from infancy through adolescence. When a psychological characteristic has plausibly many consequences and also high rank-order stability, this creates a useful asymmetry in which the influence of basic psychological characteristics over midlife can be expected to be typically (and perhaps much)

greater than the influence of particular events on the intracohort rank-ordering of the psychological characteristics themselves.

The basic psychological characteristics considered in this paper are cognitive ability and personality. Our experience suggests that the study of the consequences of basic psychological characteristics is regarded with sufficient suspicion by enough sociologists as to require defense before proceeding. Cognitive ability especially is one of the most controversial constructs in the whole of behavioral science, as seen especially in the vigorous debates following publication of Jensen (1969) and Herrnstein and Murray (1994) (see Fischer et al. 1996; Devlin, Fienberg, Resnick, and Roeder 1997; Jacoby and Glauberman 1995; Gould 1996; Jencks and Phillips 1998). Central points of dispute in these debates have concerned why individual and group differences in cognitive abilities exist, the extent to which cognitive ability is changed by interventions, and the implications that particular views about the origins and malleability of cognitive ability would have for various efforts at redressing economic inequality.[2] Far less in dispute is that cognitive measures vary within populations and that this variation is potentially causally related to many life outcomes. Empirically, general measures of cognitive ability have been found to be perhaps the most stable of all psychological constructs over midlife (Schaie 1996).[3]

[2] Importantly contested matters also concern the conceptualization of cognitive ability and the validity of existing measures, especially for intergroup comparisons, both of which we discuss later in this paper.

[3] Kohn, Schooler, and colleagues have published several well-known studies on the dynamically reciprocal relationship between job characteristics and "intellectual flexibility" over the life course (e.g., Kohn & Schooler, 1978, 1983; Schooler et al., 1999). The relationship between their intellectual flexibility measure and more broadly deployed measures of cognitive ability remains unsatifactorily clarified, and making it hard to evaluate how their findings complement or contradict the broader literature on the rank-order stability of cognitive ability over midlife.

Importantly, belief that cognitive measures capture some psychological reality that is aptly characterized as an "ability" and that has subsequent life consequences does *not* commit one to any position *either* about how the variation in cognitive ability that exists by midlife originates *or* about how much cognitive ability can ultimately be changed by potential interventions (regardless of its stability in studied populations) (Wahlsten 1997; Freese, Li, and Wade 2003). Moreover, whatever the origins of cognitive and other psychological variation, central to the argument of this paper is that the consequences of that variation reflect the organization of societies and the positions of individuals within it. Social conditions create the contexts in which psychological characteristics are more or less influential for outcomes, and social processes also influence the development of new technologies and other innovations in ways that can influence the extent to which their adoption is associated with psychological characteristics. In short—and as we will emphasize again when we consider the policy implications of our findings later—greater attention to the consequences of basic psychological characteristics does not compel sociology onto some intellectual or ideological dark road down which the discipline should resist venturing even at the expense of more complete understanding of societal phenomena.

"Cognitive" refers to information processing and "ability" refers to a capacity or skill at doing something, and so we use cognitive ability to refer to one's demonstrable and general internal capacity or skill at processing information.[4] The seemingly intrinsic vagueness of "processing information" suggests a wide range of diverse tasks might reflect cognitive

[4] Some use the word "ability" to refer to innate ability—itself not a straightforward concept—and thus take "cognitive ability" as providing assumptions about how differences in cognitive performance measures arise. We emphatically do not intend "ability" in this sense. Some literatures (e.g., Krosnick 1999) use "cognitive skills" with the same domain-general and developmentally-neutral meaning as our use of "cognitive ability" here.

performance. Considerable and continuing debate has been generated by the empirical demonstration that even ostensibly quite diverse cognitive tasks are often substantially correlated with one another, especially since this allows for the mathematical possibility that a single score can capture much shared variation across very diverse cognitive tasks (Carroll 1993). Although the data used in this study limits us to examining only such a summary score intended as a general characterization of ability, this should not be interpreted as denying that cognitive ability can be fruitfully divided into multiple measures of multiple abilities (Sternberg and Kaufman 1998). We would expect that multiple measures would likely be more illuminating than any single measure—no matter how intendedly general—and this implies that our use of a single score may systematically *underestimate* the ultimate causal effects of cognitive ability on Internet adoption. Concern has long been raised about comparing summary cognitive ability scores across cultural or ethnic groups; this may suggest the value of exploring effects of measured cognitive ability in relatively ethnically and culturally homogeneous samples, which is the approach of this study.

Like "cognitive ability," the history of "personality" has been characterized by considerable diversity of ideas about its proper conceptualization and measurement (Digman 1996). Personality is typically intended to encompass psychological characteristics that are not abilities but are reflected in abstract styles of thinking and feeling. Over at least the past two decades, however, personality psychology has gained increased vitality as a result of growing consensus about the usefulness of the Five-Factor Model (FFM) as a characterization of the structure of personality (Norman 1963; Borgatta 1964; John & Srivastava 1999; McCrae and Costa 2003). The premise of the FFM is that five independent, superordinate categories can be

used to reasonably collect the bulk of the concepts and measures that have been developed toward describing personality.

These "Big Five" factors of personality are commonly referred to as *Extraversion*, *Agreeableness*, *Conscientiousness*, *Neuroticism* (also sometimes referred to by its opposite, emotional stability), and *Openness to Experience*. How these dimensions are instantiated in the data used in this paper is presented in Table 1. As with cognitive ability, each of the factors of the FFM can be usefully divided into subscales, but subscale measures are not available in the data we use here.

TABLE 1 ABOUT HERE

Empirically, the premise that the FFM captures the main independent dimensions of personality seems to work reasonably well for adults in the United States, even if there is uncertainty about its replicability across cultures (De Raad, Perugini, Hrebickova, and Szarota 1998) or to children (John, Caspi, Robins, Moffitt, and Stouthamer-Loeber 1994; van Lieshout and Haselager 1994). Research also indicates that subscales from other common personality inventories do not measure major independent dimensions apart from those measured by the Big Five (McCrae and Costa 2003: 52-57). Studies have shown associations between personality and a wide array of psychological and social outcomes (see McCrae and Costa 2003: 216-233; Roberts et al. 2003: 580 for reviews and references). There has been considerable debate about the midlife stability of personality in various senses (see Costa and McCrae 1994; Roberts et al. 2003; Srivastava et al. 2003); important for our purposes is the intracohort rank-order stability of personality. For this, it should be noted that even a review that gives much attention to studies of effects of life course transitions on five-factor traits acknowledges that the "only psychological constructs more consistent [over midlife] than personality traits are measures of cognitive

ability" (Roberts et al. 2003). In other words, while studies have found some modest rank-order personality change in response to specific life circumstances, the main story of personality as observed over midlife for adults in the United States appears to be one of considerable stability.

DEVELOPING PREDICTIONS

The task of this paper is to consider when and how basic psychological characteristics might be relevant for which late midlife adults have adopted the Internet. We agree with the complaints of other Internet researchers that studies have focused too much on this binary outcome of whether or not someone uses the Internet from home, as opposed to broader measures differentiating use (see also Hargittai 2003, 2004a). However, we focus on it here precisely because we think attention to basic psychological characteristics can yield more to be said even about this well-studied and simple binary indicator of adoption. We also regard it as best single indicator of whether Internet technology has become part of the respondents' personal lives.

In developing predictions, we avail ourselves of a broad range of findings and thought both about psychological characteristics generally and about Internet adoption specifically. We do not enumerate these expectations as hypotheses to avoid suggesting that they are derived from some single theory or dueling set of competing theories. In this respect, we are less committed to whether favored predictions are borne out than whether the cumulative result is that combining basic psychological characteristics and indicators of social position results in a more satisfactory understanding of Internet adoption for this population than what is available from earlier studies. We describe first predictions regarding the main effects of basic psychological characteristics on Internet adoption, and then how we might expect the effect of basic

psychological characteristics to vary depending on respondents' familial, socioeconomic, and occupational circumstances.

Main effects of psychological characteristics on adoption. As noted, cognitive ability has been shown to have various educational, economic, and other social consequences, and the general expected direction of these associations and adoption would lead one to expect cognitive ability to be positively related to Internet adoption. Possibly, whatever effect cognitive ability has on Internet use could be entirely explained by its consequences for differential sorting into life circumstances that are then predictive of adoption. In that case, we would expect estimates of the effect of cognitive ability on Internet to be substantially or even entirely diminished when social circumstances are included as mediating variables in the model.

Discussions and research on the importance of "cognitive resources" for adoption, however, would lead us also to expect substantial cognitive selectivity in motivation to use the Internet (de Haan 2004). As an informational medium, Internet use typically involves much reading; as a communications medium, the Internet involves "writing" as well (de Haan 2004). There is ample reason to expect cognitive ability to be related to tasks that involve intensive literacy, even within populations (as in the WLS) for which practically all members can be presumed to have at least basic literacy (Gottfredson 2002: 359-367). Second, following Hargittai (2002) and others' emphasis on skills, it is important to keep in mind that for this population, Internet skills would have needed to be acquired in adulthood. Considerable research indicates that cognitive ability is related to more rapid and complete skill development in various domains, but especially those involving (as the Internet does) the manipulation and processing of information (Gettinger 1984; Schmidt and Hunter 1998). In other words, cognitive ability may be related to both expectations and reality about how easily the technology can be

effectively used. For these reasons, we might instead expect cognitive ability to remain significantly associated with adoption even when socioeconomic attainments are controlled, a possibility consistent with findings of DiMaggio and Hargittai (2002) using the rough indicator of ability provided by a 10-item vocabulary task on the General Social Survey.

Regarding personality traits, we think existing thought offers the most unequivocal predictions for the traits of Openness and Neuroticism. As Openness can be defined as "a receptiveness to new ideas, approaches, and experiences" (McCrae and Costa 2003:46), it seems resonant with notions both that a dispositional preference for novelty characterizes early adopters of new technologies and that a dispreference for novelty characterizes "laggards" (Rogers 1995). By contrast, given that a main facet of Neuroticism is anxiety, it would seem to be the basic psychological characteristic most implicated in "Internet anxiety" or "technophobia", which have been often discussed in explaining low motivation to Internet adoption, especially among older adults (Laguna and Babcock 1998). Accordingly, we would expect Openness to be positively and Neuroticism to be negatively associated with Internet adoption.

With respect to Agreeableness and Conscientiousness, we think implications for Internet adoption follow less obviously. However, Landers and Lounsbury (in press) found that both Agreeableness and Conscientiousness were inversely associated with use in a small and select sample of college students. Landers and Lounsbury speculate post-hoc that lower Agreeableness might be related to higher levels of Internet use because less agreeable persons might find the Internet an attractive refuge from face-to-face interaction. They also conjecture that, since Conscientiousness persons tend to be more time-conscious, they may be more averse to the Internet if perceived as a source of distraction.

Of the Big Five traits, Extraversion most readily lends itself to plausible contrary predictions. As a communications medium, we might imagine the Internet to be attractive to extraverted individuals as a way of providing them with another outlet (Kraut et al. 2002; Robinson et al. 2000; Robinson and Kestnbaum 1999). At the same time, however, discourse about the Internet has been long infused with the idea that the technology (and especially the Web) might offer a sanctuary for the introverted, while extroverted people might still be expected to maximize non-"virtual" interaction and to be less inclined toward the solitary possibilities of websurfing. Nie and Ebring (2000) find Internet use to be associated with less social interaction in cross-sectional data (but see Gershuny 2003), and Landers and Lounsbury (in press) found Extraversion to be negatively related with Internet use among college students.

Psychological characteristics and familial circumstances. The majority of late midlife adults are currently married and have lived with their spouses for a long time. Although whether one uses the Internet at home is an individual outcome, obtaining and maintaining access in the first place is a decision that is presumably made in different ways by different couples. Adoption may be prompted by the expected benefits of both spouses, or expected benefits to one may be enough. In the latter case, individuals who would not have the Internet but for their spouses' interest might still use it once it is obtained, although data make clear that there are many adults who have the Internet in their homes but do not use it (NTIA 2002).

At least among adults of the cohort we examine, we might expect a tendency toward asymmetric power in spousal relationships such that husbands have more influence over financial decisions than do wives (e.g., Denton 2004: 1164; Schaninger and Buss 1986: 132). If so, the motivation of husbands might be more consequential for adoption than the motivation of wives. Thus, if cognitive and personality characteristics influence motivation, then we might

expect the psychological characteristics of married men to be more consequential than the personality characteristics of married women in determining whether a household obtains Internet access.

Social support has been commonly emphasized as important to Internet adoption (DiMaggio et al. 2004). For adults in late midlife and older, children have been thought to play an important role as sources of motivation—via direct encouragement and the prospect of being able to communication with them online—as well as a source of assistance in developing skills (Fox et al. 2001). We might expect the support of children to lessen the influence of psychological factors in Internet adoption, especially any effect of Neuroticism and perhaps more for mothers than fathers.

Psychological characteristics and socioeconomic circumstances. Educational attainment, meanwhile, is strongly related to earlier measures of cognitive ability, including in older cohorts for whom standardized tests did not play as strong a gatekeeping role (Sewell and Hauser 1975; Snow and Yalow 1982). Toward this end, it seems possible that cognitive ability measured prior to sample differentiation in educational attainment (i.e., adolescence) might explain some of the "education effect" estimated by models in which cognitive measures are excluded. This might be especially so for older cohorts that did not have computers (much less the Internet) as part of their formal schooling.[5]

Even if this is the case, we might expect to observe also that any effect of cognitive ability will be largest among those with the least education. For if at least part of the effect of cognitive ability on later outcomes is the result of sorting into later-life outcomes, we can

[5] A curious feature of the education gradient in Internet adoption in the Current Population Survey is that, adjusting for cohort differences in the marginal distribution of education, the effects of education on adoption do not diminish for older cohorts despite the lack of computers in formal schooling (CPS analyses by authors).

imagine the possibility of education plausibly providing a "substitution" or "compensatory" effect on unmeasured components of social position that, in turn, attenuates the effect of cognitive ability. For that matter, the same prediction would be implied to whatever extent that continued education makes a lasting contribution to the realized abilities that are relevant for adoption.

Quite apart from education, we might expect psychological characteristics to matter most for those with the least wealth. For one, financial resources could be expected to diminish at least the relevance of cognitive ability by increasing the capacity to afford compensatory training, support, or software in the acquisition of skill. Additionally, one might conjecture that motivation and skill differences—and any of their psychological correlates—will matter most for those whose financial situation puts them closer to the margin of affordability. This last argument should be regarded cautiously, however, for if the role of some psychological characteristics is more in creating an active *aversion* for adoption, then we might imagine effects will show up as largest precisely among those for whom the expense of the Internet would be *least* at issue.

Psychological characteristics and occupational circumstances. The percentage of American adults who used e-mail/Internet at work increased from 9.3% in 1993 to 42.2% in 2003 (authors' CPS analyses). At younger ages, we would expect considerable active sorting of individuals into jobs with varying degrees of Internet use. However, late midlife, until retirement, tends to be a period of comparatively high occupational stability. Consequently, although some Internet-related occupational sorting presumably has occurred in late-midlife cohorts, it is presumably much more the case that the rise of the Internet in the workplace intersected an established career trajectory. While there has been much concern that introducing

computers imposed new skill demands on older workers that they could not meet, these fears are now thought to have been overstated, in part because so many older workers were indeed able to adapt to the introduction of new technologies into their jobs (Friedberg 2003). Importantly for our purposes, not only may workers have been able to adapt to the Internet at work, but this might also have increased their desire and facility for having the Internet at home (de Haan 2004).

Should we expect that the same psychological characteristics that predict Internet adoption at home to also affect Internet use at work? We would under at least two quite distinct conditions. First, to whatever extent individuals have influence over whether their jobs involve using the Internet or not (whether by control over job conditions or by job switching), we would expect that many of the same arguments for why cognitive and personality characteristics might motivate home adoption would also apply to discretionary adoption in one's workplace. Second, psychological characteristics might actually be strongly predictive of career trajectories that subsequently have been highly penetrated by Internet technology and, in turn, using the Internet at work might be such a strong predictor of subsequent home adoption that this is actually the primary reason for any relationship between psychological characteristics and home Internet adoption in this cohort. In this second scenario (but not the first), the effect of psychological characteristics on home adoption would mostly diminish when the use of the Internet at work is taken into account.

Should we expect the effect of basic psychological characteristics to differ between those who do and do not use the Internet at work? As noted, one possibility is that effects of psychological characteristics in the full sample largely disappear for both groups when those who do and do not use the Internet at work are treated separately, and this would suggest that the

story of psychological characteristics affecting Internet adoption is really a story about sorting into Internet-using jobs and the dominant effect of these jobs on home adoption. A reason to think use at work could have such a dominant effect is that it would seem an obvious route to gaining the familiarity with the Internet that would make its home use more appealing (not to mention useful, perhaps for work but other purposes as well). If that is the case, however, a separate possibility is that basic psychological characteristics would predict Internet use much more strongly for those who do not use it at work than those who do. Use at work, in other words, may importantly facilitate home adoption (especially by surmounting the skills hurdle), and it may be that psychological characteristics especially matter when one does not have this experience.

DATA AND MEASURES

Data We use data from the Wisconsin Longitudinal Study (WLS), whose participants comprise a 1/3 sample of all Spring 1957 graduates from high schools in Wisconsin (original N = 10317). The WLS has gathered information through surveys in 1957 (in school), 1964 (mail survey of parents), 1975 (telephone), 1993 (telephone and mail), and 2003-4 (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).[6] The WLS is the only data resource that combines a large population-based sample, detailed and longitudinal measurement of cognition, personality, and financial and sociodemographic covariates, and extensive measurement of Internet adoption and use.

As such, the WLS would seem almost ideally suited for the purposes of this study, so long as key limitations of the sample are kept in mind. First, as a cohort sample, WLS

[6] About 67% of those interviewed in 2004 still lived in Wisconsin, which has had Internet penetration rates close to the median for all states (NTIA 2000).

respondents are all approximately the same age, and so findings from the study cannot be generalized to other ages and cohorts. For the theoretical purpose of looking at response to change among individuals who are well entrenched in midlife when the change occurs, WLS respondents would seem almost exactly the right age, and a cohort sample allows for within-cohort exploration of the interaction of social structural and psychological variables with statistical power that would require many times more cases in an age-diverse sample.

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]). Because cognitive test scores and completing high school are substantially related in the WLS cohort, the expectation would be that any observed association between test scores and Internet adoption will be *less* than the association if non-truncated data were available. Inclusion only of high school graduates presumably means that there are fewer respondents for whom finances directly preclude adoption, making the sample perhaps better for considering why so many for whom Internet adoption is plausibly affordable still do not use it.

Finally, given the composition of Wisconsin and patterns of high school completion in 1957, the WLS sample is almost entirely white. As such, our study will not contribute to the debate over how much racial and ethnic disparities in Internet use can be resolved by other variables, especially as the relevant interaction terms and statistical power for addressing the issue might not even be available if the WLS did reflect the nationwide ethnic distribution of 1957 high school graduates (see Rivas 2004). As mentioned earlier, the relative homogeneity of the WLS may actually be desirable in first explorations of effects of cognitive ability given concerns about comparisons of ability measures across cultural/ethnic groups.

Internet Adoption The primary outcome considered in this paper is whether the respondent has the Internet in their home and uses it. We construct this binary variable from a nested series of telephone survey items asking whether respondents (1) have a computer in their home [74% of respondents], (2) have Internet access from their home computer [67% of respondents, and 91% of those with a computer at home], (3) themselves access the Internet from their home computer [57% of respondents, and 84% of those with household Internet access].[7] The WLS does not specifically ask about WebTV and related devices, as these were expected to be a very small percentage (< 1%) of sample members, but respondents were coded as having Internet access from home when the use of these devices was volunteered.[8]

Cognitive Ability All 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 percentile rank for all Wisconsin high school students. As already noted, the H-N was intended as a general measure of ability and includes no subtests, which implies that it may underestimate the total effective of cognitive abilities as measurable in adolescence on later-life Internet adoption.[9] We emphasize again that our analyses make no assumptions about the developmental origins of measured cognitive ability.[10]

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[7] Supplementary analyses considering adoption in terms of transitions through these constituent items do not yield results that add substantively to the conclusions presented here.

[8] The WLS contains additional information about respondent Internet adoption, but interrogation of these other measures is postponed to a subsequent study.

[9] For a small subset of respondents (N=108), scores were obtained from archives on subtests of Iowa Tests of Basic Skills. Analyses indicate that the quantitative skills, vocabulary, and verbal

Personality In the WLS, personality was measured using a 39-item scale administered across the 1993 telephone (10 items) and mail (29) surveys. Items are a subset of the BFI-54 (John & Srivastava 1999). Separate scales were intended to measure the five primary factors prevailing in personality psychology: Extraversion (8 items), Agreeableness (8), Conscientiousness (8), Neuroticism (7), and Openness to Experience (8) (see Table 1). Principal factor analyses yield factors consistent with the intended scale structure. Multiple imputations from other personality items, H-N test scores, and gender were used to account for nonresponse to the mail survey as well as to individual items on either survey.[11] All scales were standardized. Personality measures derived from self-reports show substantial agreement with measures derived from ratings by spouses and friends (see McCrae and Costa 2003: 37-51 for review).

That personality was not measured until 1993, when respondents were ~54 years old, poses an obvious problem for treating personality as exogenous to educational, occupational, or other attainments, as measured effects of personality may actually reflect the indirect effects of the attainments through effects of the attainments on personality. Available research, however, provides good reason to believe that personality selection into these attainments is high relative to any long-term effect of attainments on variation in these traits (see Srivastava et al. 2003, Roberts et al. 2003). For example, given the results that follow, the most obvious concern might be the effect of educational attainment on Openness. A longitudinal study covering the college

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expression subtests predict H-N scores to a roughly equal degree and together predict performance as well or better than does an earlier administration of the H-N (Freese 2005).

[10] Supplementary analyses examined models in which adolescent socioeconomic status measures (parental education and income) were included as predictors of adoption, but these were not significant when the cognitive ability and subsequent attainment measures were included. Such a result has no implications for the developmental origins of ability but does imply that adolescent status does not influence Internet adoption *beyond* its influence on cognitive ability and later attainments.

[11] Multiple imputations for this paper were done using the Amelia software package (see King, Honaker, Joseph, and Scheve 2001).

years, however, finds a corrected rank-order stability coefficient over the four years that is very high (.90) and actually higher than the other Big Five traits (Robins et al. 2001).

Potential mediators and controls *Educational attainment* is based on 1993 self-report. In the presented analyses, education is specified as a pair of dummy variables indicating some college (13-15 years of education) and completed college (16+ years). Alternative specifications fit no better and yield substantively similar results. *Spouse educational attainment* is taken from the 2004 spouse survey when available (78% of cases in estimation sample) and from the WLS respondent report otherwise.[12]

Income and *wealth* are based on individual reports and measured in logged dollars for the models presented. In cases of refused or don't know responses to individual reports, multiple imputations were made using available financial and sociodemographic information.

Rural household is determined using the 1993 mailing address. Those households designated as rural were located outside a census metropolitan statistical area.

Occupational education and *occupational income* for both the respondent and spouse are based on the 1993 reported current/last occupation and on 1990 Census occupation information. The occupational education score is derived from the percentage of Census respondents in the occupational category who completed one year of college or more, while the occupational earnings score is derived from the percentage of those in the category who earned at least $14.30 per hour in 1989. Both variables are standardized, with a constant imputed and dummy indicator variable used for missing cases.

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[12] The latter is problematic because the WLS asks for spouse educational attainment *at the time of the marriage*. While it might seem advisable to therefore provide some adjusted imputation based on at least gender and spouse's age at marriage, inspection of data suggest that this is only one source of discrepant reporting between respondents and spouses about the spouse's education and that the consequence of such an adjustment would be minor and not necessarily superior.

Probability of a child online. The WLS does not measure whether children are online or whether children directly provide support for respondents being online. We use information about the number of respondents children and their education, along with estimates from 2003 CPS data, to create a proxy measure of the probability of a respondent having at least one child who is online. Specifically, based on the October 2003 CPS, we used probabilities of .3 for a child with a high school education or less, .6 with some college, or .8 with a college degree or higher, and for the purposes of creating the proxy measure we assumed that childrens' probabilities of being Internet users were independent. Attempting to refine probabilities by adjusting further for the age of children did not improve ultimate results.

Job with Internet. Respondents were asked whether they used the Internet on their current/last job; for respondents who had retired from a job that could be regarded as their "career" job since 1993 and taken other employment, the question asked about the earlier job. We do not know whether Internet use at work preceded Internet use at home for individuals, and thus we cannot make decisive statements about work-to-home diffusion. Problems with trying to measure reciprocal influence in cross-sectional data are well-known and are even less tractable when one is talking about binary outcomes. Side information about the occupational stability (excepting retirements) of this cohort, as well as the general rate of diffusion into workplaces versus the home, would lead us to strongly expect that the extent to which respondents have the Internet at work *because of* their experience using the Internet first at home is quite low compared to the reverse. (That the item asks about one's earlier job in the case of recent post-retirement employment changes also likely reduces the magnitude of any endogeneity bias in this regard.) Even so, while consider having a job with the Internet as a potential mediator of home adoption, we emphasize caution in interpreting results.

RESULTS

Main effects. Table 2 presents results from our key main effects models of Internet use at home. Model 1 includes our cognitive and personality measures and only a control for gender. Model 2 includes only sociodemographic characteristics; as such, it presents the estimates that one would obtain from these data if, as in most previous studies of Internet adoption, basic psychological characteristics were not considered at all. Model 3 includes both basic psychological and sociodemographic characteristics, and Model 4 adds contemporaneous measures of work status and whether the respondent uses the Internet in his or her current/last job.

TABLE 2 ABOUT HERE

Looking first to Model 1, we observe a large effect of cognitive ability on Internet adoption. We also observe significant effects in the expected direction for the two personality traits we most expected to matter: Openness and Neuroticism, with the effect of Openness being especially strong. Less expectedly, we also observed significant effects for Conscientiousness and Agreeableness consistent with those found by Landers and Lounsbury (in press) among college students. The trait for which would could most readily derive competing expectations, Extraversion, was the only one not significantly related to adoption. In terms of predicted probabilities, if we hold all variables to their means, then a standard deviation change in cognitive ability centered on its mean is associated with a .124 increase in the predicted probability of adoption (from .520 to .644); for the significant personality traits, the correspondent effect of Openness = .092, Neuroticism = -.024, Agreeableness = -.016, and Conscientiousness = -.014.

The results of Model 2 largely affirm the extant literature about what sociodemographic variables predict Internet adoption, although a few results merit highlighting. First, net worth has a significant effect on adoption net of income. If true beyond this sample, this would indicate that caution is well warranted in studies that wish to consider the effect of circumstances or characteristics on adoption "controlling for socioeconomic status" but have only income and education measures at their disposal.[13] Second, occupational education has a significant independent association with adoption but occupational income does not. As with wealth, this speaks to the importance of a broader set of socioeconomic status measures in studies of adoption for which SES is either the focus or a control. Third, our measure of the probability of having a child online, despite its seemingly obvious shortcomings, has a strong significant association, and, in ancillary analyses, fits better than number of children or number of college-educated children (not shown). Even so, this can be taken as only weak but suggestive evidence of child-to-parent diffusion without better measures, and the measure could be a proxy for other aspects of social advantage not resolved by other measures.

Model 3 results indicate that all of the cognitive and psychological characteristics that were predictors of adoption in Model 1 remain significant with the addition of the sociodemographic controls. The effect of cognitive ability, however, is attenuated by 45% and the effect of Openness is attenuated by 30%. By contrast, the effect size of the other significant personality characteristics—although not large to begin with—are not diminished by the inclusion of these other variables. The resulting estimates of the unmediated effects of cognitive ability and Openness are much closer to being equal. Models adding sociodemographic

[13] Given findings on where the difference between income and the concentration of wealth is most pronounced (Conley 1999; Oliver and Shapiro 1995), the difference between the effects of income and wealth might be an especially important distinction to pursue in samples less affluent and more racially diverse than the WLS.

characteristics sequentially reveal that 61% of the attenuation in the cognitive ability coefficient can be accounted for by adding education alone, and 93% by education, income, net worth, and occupational education and income. For the attenuation in Openness, these percentages are 75% and 100%, respectively.

Excepting marital status, all regressors in Models 1-3 are measures in 1993 or before and so presumably predate Internet adoption for all but a handful of the cohort. Model 4, on the other hand, includes current work status and whether respondents used the Internet in their current/last job. Because potential bias due to endogeneity is more of a concern for these variables, we exclude them from the earlier specifications. However, one can see by comparing the Model 3 and Model 4 results that their inclusion does not make much difference for the estimation of the effect of psychological characteristics, other than reducing Agreeableness to marginal significance.[14]

Taken together, these results lend support to the conclusion that an important part of why cognitive ability is strongly related to Internet adoption is that it determines later-life attainments and concomitant sorting that influences adoption. Even so, however, a substantial effect of cognitive ability remains even after controlling for a more extensive range of sociodemographic characteristics than most studies of Internet adoption. This is consistent with the conjecture that the skill and literacy demands of the Internet provide an independent means of cognitive selectivity. A smaller portion of Openness to Experience is attenuated by attainments, and the effects of other personality characteristics are not attenuated at all. The ultimate result is strong

[14] The reduction in sample size in Model 4 is due to the job characteristics items being asked of only a 75% random subsample of WLS respondents. We do not limit the estimation samples for Models 1-3 to this random subsample only because the Model 3 specification serves as the baseline for later analyses, but supplementary analyses that do restrict the sample confirm that it makes no practical difference for the magnitude of coefficients.

evidence that heterogeneity in basic personality characteristics is important to understanding variation in Internet adoption for this population of late midlife adults. Comparing Models 2 and 3, we see that the magnitude of the estimated effects of most sociodemographic characteristics is not much changed with the exception of education and income, with the change in the education coefficient being relatively larger even though the income coefficient is reduced to nonsignficance. While we will consider the attenuation of the estimated education effect again shortly, we note here that considering psychological characteristics indeed does reduce the apparent influence of what have been regarded elsewhere as the two main cleavages in Internet adoption.

Familial circumstances. We proposed that psychological characteristics might be more strongly related to Internet adoption for men than women, if men in this cohort have relatively more power over household financial decisions. Table 3 shows estimates of the effect of cognitive and personality measures on Internet adoption for married men and married women. Model 1 includes only the basic psychological characteristics, while Model 2 adds all the sociodemographic variables (except sex) as in the full model of Table 3. In Model 1, we can see the effect of H-N score on the log odds of adoption is about 26% larger for men than for women (p = .06) and the effect of Openness is about 21% larger (p = .30).

TABLE 3 ABOUT HERE

While this result is consistent with what we would expect if husbands had more power than wives in familial purchasing decisions (even if not to conventional standards of statistical significance), we can see when we look to Model 2 that the cognitive ability effect difference between the sexes is entirely accounted for by other sociodemographic variables. Further analysis shows specifically that the differences are accounted for by the inclusion of the

occupational measures, suggesting the importance of our closer consideration of occupation below. There are also no significant differences in the estimated effects of basic psychological characteristics between married and unmarried members of either sex (not shown). Taken together, this would suggest that while sex differences in sorting into careers may be important for understanding the role of psychological characteristics in Internet adoption, as we will explore further below, we do not have reason to think that systematic differences in relative household decision-making power between husbands and wives are important.

We also speculated that the effect of psychological characteristics on adoption (especially, perhaps, that of Neuroticism) may be smaller for those with a higher probability of a child online. Despite a relatively strong main effect of the probability of a child online and adoption, our analyses found no evidence of a significant interaction between this probability and any of the basic psychological characteristics (not shown). This may well indicate that the relevance of psychological characteristics is not mediated by processes of child-to-parent diffusion, but, as already noted, the indirectness of the child online measure would seem to preclude the possibility of any decisive conclusion.

Socioeconomic circumstances. In the main effects models presented in Table 3, the estimated effect of education was substantially attenuated by the inclusion of cognitive and personality characteristics in the full model. This seemed the clearest example in which the failure to consider basic psychological characteristics would actually distort our understanding of the importance of the role of some particular sociodemographic characteristic in Internet adoption. Because cognitive ability was measured prior to differentiation of educational attainment in this sample, the reduction of the education coefficient can be regarded straightforwardly as a correction for spuriousness, presumably of cognitive selectivity into

education. Personality was not measured until the respondents' mid-fifties, but the midlife stability in personality found in other studies would seem to warrant strong suspicion that attenuation due to the inclusion of personality measures may substantially indicate spuriousness as well.

Table 4 examines the extent to which measured sources of spuriousness, potential spuriousness, and mediation resolve the estimated education effect on adoption in this sample. While 47% of women with only high school diplomas in this sample are Internet adopters, 74% of the female college graduates are, and the difference is even larger among men (41% vs. 81%). Over half this effect for women, and a quarter of the effect for men, is resolved by inclusion of basic psychological characteristics. Virtually all of the remainder of the estimated effect, but only 62% of the effect for men, is resolved by the mediating variables of income, wealth, occupational characteristics, and spousal characteristics. Indeed, for women, there is no significant effect of education on Internet adoption once these different variables are controlled. Studies that have emphasized the importance of differences in education in models of Internet adoption, even in samples that include older adults whose education predates the personal computer, typically have only controlled for income among these various covariates. Our results suggest that, especially for women, education cleavages in this cohort might be mostly or entirely attributable to a combination of the spurious influence of cognitive and personality characteristics and the consequences that education has for one's finances, occupation, and spouse characteristics.

TABLE 4 ABOUT HERE

We proposed that the effect of cognitive ability may be largest for those with the least education, for a variety of reasons. We show the difference here in Table 5 by presenting results

separately for respondents with different levels of education. Model 1 includes only basic psychological characteristics and gender, while Model 2 includes all the same sociodemographic characteristics (except education) as Model 3 of Table 2. The results show that the strongest effects of cognitive ability are observed among those with only a high school education, while the weakest effects are observed for those with a college degree. Against the possibility that this difference reflects just a mismatch between the log odds metric of logistic regression and the actual responsiveness of Internet adoption at different baseline probabilities, one can see that the effect of Openness is not attenuated as education increases, and Neuroticism, Agreeableness, and Conscientiousness have, if anything, larger coefficients as education increases. In terms of the change in predicted probabilities, if we hold all other variables to their means, a standard deviation change in cognitive ability centered on the mean is associated with an increase from .399 to .467 for high school graduates, but only from .821 to .836 for those with a college degree.

TABLE 5 ABOUT HERE

We also conjectured that the effect of psychological characteristics on adoption might be larger for individuals with less financial resources. Table 6 presents the effect of basic psychological characteristics on Internet adoption as analyzed separately for respondents with household net worth below and above the sample median (substantively similar results are obtained if income is used instead of net worth). Model 1 includes the basic psychological characteristics, gender, education, job status (working or not), and whether one's job uses the Internet, while Model 2 adds all sociodemographic characteristics included as Model 3 in Table 2.[15] We can see that the estimated effect of cognitive ability is less for those with household

[15] We include education and job variables in the first model here because of the significant interactions we observe for these variables in the analyses of interactions of education earlier and occupation later.

wealth above the median than for those with wealth below the median. We can also see, however, that this expected pattern is not observed for any of the personality measures. Indeed, the results indicate that the entire effect of Conscientiousness on adoption observed in the full sample is actually confined only to those with wealth above the median. The results would thus seem inconsistent with the conjecture that motivation, broadly speaking, figures more importantly in Internet adoption decisions for less wealthy individuals than more wealthy individuals (or that variation in motivation is not importantly associated with variation in personality measures). We cannot determine whether the interaction of wealth and cognitive ability reflects aspects of motivation related to cognition but not personality or, as proposed, the possibility that financial resources recompense for skill.

TABLE 6 ABOUT HERE

Occupational circumstances. We posited that the same psychological characteristics that predict using the Internet at home might also predict using the Internet at work. Table 7 presents estimates of logistic regression models for whether the respondent uses the Internet at work. Model 1 includes only the basic psychological characteristics, while Model 2 adds whether respondents are married, their education, and whether they live in a rural area.[16] We present results for Model 2 for both all respondents and for only those who are currently working.

TABLE 7 ABOUT HERE

The results indicate that Internet use at work is positively associated with both cognitive ability and Openness. The differences are substantially reduced but not eliminated by the

[16] As this is an outcome about the characteristic of the respondents' employment, we include only respondent characteristics and not spouse or household characteristics, or other characteristics of their jobs. In supplemental analyses, including other job characteristics or all sociodemographic characteristics does not change the conclusions of our results.

addition of controls. The results indicate the importance of earlier sorting on cognitive ability and personality into different careers but also the presence of additional psychological selectivity into using computers with Internet at work.

The effects for both cognitive ability and Openness are stronger for women than for men, although these differences are much reduced in Model 2, mainly as the result of the inclusion of the additional controls for education. Unexpectedly, we also find that Conscientiousness is positively associated with Internet use at work among women, even though it is negatively associated with home use and is not associated with Internet use at work among men. The differences seem likely to reflect the disproportionate sorting of women into administrative or clerical jobs that have a relatively high proportion of computer or Internet use relative to the average education of workers (see Losh 2004).[17]

Table 8 shows how the effects of basic psychological characteristics vary for those who have jobs using the Internet, those currently working at jobs that do not use the Internet, and those retired or otherwise not currently working. Consistent with expectations, the effects of both cognitive ability and Openness are less for those with jobs that use the Internet. Keeping in mind our earlier caveat about home and workplace Internet being cross-sectional measures, the finding is consistent with the interpretation that having the Internet at work introduces individuals to skills and benefits of Internet use that then diminish the relevance of cognitive ability and Openness for adoption at home.

TABLE 8 ABOUT HERE

[17] Even so, supplementary analyses indicate that the positive relationship between Conscientiousness and Internet use is not confined to any one of the broad 1990 census occupational categories (e.g., those classified as clerical jobs). As is well known, however, the heterogeneity of job characteristics within those broad classifications is very large.

At the same time, we also note that the effects of Conscientiousness, Neuroticism, and Agreeableness are stronger for those using the Internet at work than for others (although these differences vary in magnitude and statistical significance). This supports the idea that the findings of attenuation for cognitive ability and Openness are not somehow artifacts of the higher baseline probability of adoption for those who use the Internet at work. For Agreeableness and Conscientiousness, the difference was not predicted but would not seem to contradict the earlier conjectures about why these variables might be expected to affect Internet adoption, especially since the workplace might provide a venue where the benefits of the solitary character of the Internet (for those low in Agreeableness) or its potential for distraction (for those low in Conscientiousness) are revealed. The same *cannot* be said for Neuroticism: if the inverse relationship between Neuroticism and Internet adoption reflects "technophobia" or anxiety about new technology, then we would expect the effect to be less for those with a potentially compulsory workplace introduction. The difference in coefficients is not significant, but if it does reflect a real difference in the circumstances when Neuroticism affects adoption, it suggests that further work to understand why Neuroticism is inversely related to adoption is needed.

DISCUSSION

Even as technologies like the Internet may be regularly hailed for revolutionizing aspects of everyday life, people vary considerably in the extent to which they are active participants in the revolution. Social scientists have approached variation in Internet adoption in studies that have relied heavily on sociodemographic characteristics, and their recognition of the need for more attention to the psychology of adoption has been evinced mostly in highly domain-specific concepts like Internet anxiety and Internet skill. Our study is not intended to question the importance of such work, but rather we proposed that a fuller understanding of adoption might

be achieved by also giving attention to aspects of psychology that are both substantively general and relatively robust to changes in social circumstances over midlife. Basic psychological characteristics, we believe, may hold much unfulfilled promise toward providing a common, parsimonious, and interdisciplinary vocabulary in considering how psychological heterogeneity and social position influence responses to change. We thought an especially interesting case for Internet adoption was provided by those whose biographies intersected the rise of the technology at a comparatively settled point in the life course.

We focused here on cognitive ability and personality for a sample of relatively privileged late-midlife adults, and the predictions we developed worked out most cleanly for the former. Even though cognitive ability in this sample was measured before the Internet was invented and before any sample members had likely ever seen a computer, the measure very strongly predicts whether respondents were Internet users almost fifty years later. Some of the effect of cognitive ability is attributable to the consequences of cognitive ability for sorting into later life circumstances, but much seems to reflect more direct cognitive selectivity into adoption, perhaps due to the literacy and information-processing skill demands of the technology as it has developed. Including our measure of cognitive ability from high school also diminishes the extent to which Internet adoption appears to be causally affected by whether respondents attended or completed college. Importantly, however, we also found that the influence of cognitive ability is itself moderated by social position. Three separate dimensions of social position that put one in a more privileged position in terms of the likelihood of adoption—higher education, more wealth, and a job in which one uses the Internet—are all associated with a reduced association between cognitive ability and Internet adoption.

Meanwhile, of the Big Five personality traits, Openness is most strongly associated with adoption and is moderated by having a job that uses the Internet (but not wealth or education) similar to what was observed for cognitive ability. Neuroticism was inversely related to adoption as predicted, but the stronger relationship between Neuroticism and adoption among those with exposure to the Internet at work seems inconsistent with the idea that the relationship reflects anxiety toward new technology. Conscientiousness and Agreeableness show results consistent with other work, but Conscientiousness also shows interactions with some measures of social position that are not obviously explained. Personality was also measured later in this sample, so it does not have the epistemic luxury of temporal priority over the attainment variables, and it is measured by relatively few items and thus has lower reliability than cognitive ability. Whether better measures would have resulted in a more unambiguous picture is uncertain, but, even with the observed ambiguities, the study does provide strong evidence for the relevance of basic personality traits for Internet adoption. In sum, the findings for cognitive ability and Openness especially emphasize not just that these characteristics are pertinent for understanding adoption but that an appropriately nuanced account of their influence requires sociological thinking about the kinds of social circumstances that make cognition and personality more or less influential.

As such, we hope our study suggests the potential value of greater effort to include measures of basic psychological characteristics in longitudinal surveys, as well as more attention to those data sources that contain such measures. As things stand, our inquiry raises many more questions than it answers. For one, of course, we do not know how far our findings extend beyond the narrow outcome of Internet adoption and for the narrow population represented by a sample of almost-entirely-white, late midlife adults with high school degrees. Our findings do

lend themselves to further conjectures: for example, just as having a job that uses the Internet is associated with a sharp reduction in the cognitive gradient of adoption, we might expect this gradient to be less in younger cohorts that have exposure through schools. We also know very little about the relationship between basic psychological characteristics and the more domain-specific psychological characteristics that have been more commonly invoked in the literature. For that matter, more detailed information about social circumstances might further elaborate our understanding of when psychological characteristics matter more or less. As a notable example, specific information on the psychological characteristics of both spouses would allow more specific examination of how the psychological characteristics of each partner are implicated in the household decision to obtain Internet access.

With these limitations, what might our findings imply for current debates and research about digital inequality? Numerous researchers have rightly complained about the impoverished picture of technology cleavages one gets from a focus on a narrow outcome rather than the variegated spectrum of use (e.g., Hargittai 2003, 2004a). By focusing precisely on a narrow outcome, however, we hope to show also the impoverished view that results from an *overly narrow consideration of explanatory variables*. Even apart from our consideration of psychological characteristics, we hope our study also underscores the potential value of considering wealth alongside income, and occupational measures alongside educational attainment. We recognize that many surveys do not collect information to construct these measures, either, but, at the least, the practical absence of additional measures should cause greater tentativeness in conclusions. While our own study finds the estimated education effect on adoption is mostly accounted for by selection and posteducational sorting, rather than formal schooling *per se*, the narrowness of our sample means the generalizability of the result is an open

question—but we do emphasize that it is, truly, an open question. If digital inequalities are to be redressed, then more complete knowledge of their causes would seem desirable, and such knowledge will require more elaborate measures of both psychological *and* social characteristics.

The importance of redressing digital inequalities has been itself a matter of considerable and much-politicized debate (Compaine 2001; Warschauer 2003). Such debates turn on the consequences of non-adoption for non-adopters, which is outside the scope of this inquiry. What is plain from looking at the recent course of Internet diffusion is that we are not presently on some S-curve toward full saturation, even in younger cohorts. While many Americans do lack the resources to affordably obtain the Internet in their homes (for that matter, many Americans do not even have homes), it is also plain that for many Americans, not using the Internet is mainly a matter of choice, a choice driven as much by their perceptions of it not being useful as by constraints imposed by its expense. Changes in skill and the opportunity to acquire skill may well change some choices. To whatever extent motivation is at issue, this still does not reduce the imperative to motivate non-users if the consequences of non-use are negative. This point may be especially important for Internet adoption, as its possible usefulness might not be as apparent to individuals and one's being online may have positive social externalities in addition to whatever individual benefits of use. Such implications are not at all affected by findings of an important role of basic psychological characteristics in understanding differences in technology adoption choices, even as it may prove helpful in understanding how choices may be changed if socially desirable. For that matter, the benefits of Internet use may themselves vary by basic psychological characteristics (see, e.g., Kraut et al. 2002 regarding extraversion).

One reason basic psychological characteristics are often resisted in studies of inequalities is that their relevance, when demonstrated, is often taken as implying the inevitability of the

inequality. Not only does the observed midlife stability of psychological characteristics in populations not imply some ultimate "natural" immutability of the characteristic (Freese, Li, and Wade 2003), but, as our results suggest, the consequences of psychological characteristics can also vary and so should not be construed as inevitable anyway. As for the case of Internet adoption, sociology should resist thinking of technological evolution as an asocial phenomenon, but instead as a matter open to investigation. Technologies co-evolve with the needs and demands of users (DiMaggio et al. 2004), with the variously disadvantaged often providing the least incentive for the expansion of markets. Home computers were once a paradigmatic example of how the complexity of innovations could inhibit adoption (Rogers 1995: 243), and the rise of the Internet is not just a story about a change of technical capacity but about making the technology more "user-friendly." If a new technology is cognitively selective in problematic ways, one job for the sociologist may be to interrogate how and why the technology has come to be as cognitively inclusive as it is and *yet not more so*. What we have found here is not some natural relationship between mind and technology, but a socially contingent one. We demonstrate social contingency here just in the sense of showing that the relevance of psychological characteristics varies by social position. In closing, however, we wish to encourage more thinking about the social contingencies of technological development in ways that create, sustain, and reduce the relevance of basic psychological characteristics for a technology's adoption and use.

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Table 1. Dimensions of the Five-Factor Model of Personality and Their Measurement in the Wisconsin Longitudinal Study (1993 wave)

Dimension	**Items**
Openness	prefers work that is routine and simple*; inventive; prefers the conventional, traditional*; values artistic, aesthetic experiences; has an active imagination; wants things to be simple and clear-cut*; sophisticated in art, music, and literature
Neuroticism	worries a lot; relaxed and handles stress well*; can be tense; emotionally stable, not easily upset*; remains calm in tense situations*; gets nervous easily
Agreeableness	tends to find fault with others*; has a forgiving nature; sometimes rude to others*; generally trusting; can be cold and aloof*; considerate to almost everyone; likes to cooperate with others
Conscientiousness	easily distracted*; can be somewhat careless*; does a thorough job; a reliable worker; tends to be disorganized*; lazy at times*; does things efficiently
Extraversion	tends to be quiet*; outgoing and sociable; talkative; reserved*; full of energy; shy or inhibited*; generates a lot of enthusiasm

Asterisks denote items to be reverse scored for scaling. All items use stem "I see myself as a person who (is)" and have six response categories ranging from "agree strongly" to "disagree strongly." First item in list was administered on both phone and mail survey, second item administered on phone only, the rest were administered on mail only. Summated scales standardized for all analyses. Lower-bound reliability estimates (Cronbach's α): Openness = .69, Neuroticism = .83, Agreeableness = .74, Conscientiousness = .70, Extraversion = .82. The greater homogeneity of the WLS sample implies lower reliabilities than would be expected for nationally representative samples.

Table 2. Estimated Effects of Psychological and Sociodemographic Characteristics on Internet Adoption

	Model 1	Model 2	Model 3	Model 4
HN score	0.529***		0.294***	0.277***
	(0.030)		(0.033)	(0.038)
Openness	0.383***		0.265***	0.249***
	(0.031)		(0.033)	(0.039)
Neuroticism	-0.100***		-0.103***	-0.110**
	(0.029)		(0.031)	(0.036)
Agreeableness	-0.068*		-0.067*	-0.060
	(0.029)		(0.031)	(0.035)
Conscientiousness	-0.063*		-0.076*	-0.102**
	(0.028)		(0.030)	(0.035)
Extraversion	0.009		-0.048	-0.067
	(0.028)		(0.030)	(0.034)
Female	-0.041	0.237**	0.236**	0.211*
	(0.055)	(0.083)	(0.085)	(0.099)
No spouse		-0.406***	-0.442***	-0.437***
		(0.089)	(0.090)	(0.108)
Some college		0.489***	0.321***	0.323***
		(0.077)	(0.079)	(0.092)
College degree		0.685***	0.375***	0.385***
		(0.084)	(0.088)	(0.103)
Household income		0.107*	0.083	0.080
		(0.045)	(0.045)	(0.050)
Net worth		0.092***	0.088**	0.079*
		(0.027)	(0.028)	(0.031)
Occupational education		0.466***	0.394***	0.259***
		(0.059)	(0.060)	(0.070)
Occupational income		0.036	-0.023	0.052
		(0.072)	(0.074)	(0.087)
Rural residence		-0.382***	-0.349***	-0.242***
		(0.060)	(0.061)	(0.071)
Online child		0.545***	0.497***	0.507***
		(0.104)	(0.106)	(0.123)
Spouse age		-0.001*	-0.001*	-0.001
		(0.001)	(0.001)	(0.001)
Spouse no hs diploma		-0.055	-0.037	-0.053
		(0.110)	(0.113)	(0.134)
Spouse some college		0.254**	0.241*	0.220*
		(0.093)	(0.094)	(0.109)
Spouse college		0.128	0.095	0.085
		(0.095)	(0.097)	(0.111)
Spouse occupational education		0.221***	0.179**	0.144*
		(0.060)	(0.061)	(0.070)
Spouse occupational income		-0.036	-0.006	0.053
		(0.074)	(0.076)	(0.089)
Currently working				-0.288***
				(0.066)
Uses net at work				1.071***
				(0.076)
N	6849	6849	6849	5281
bic	8604.428	8315.810	8156.083	6107.782

* $p < .05$, ** $p < .01$, *** $p < .001$ (two-tailed). Standard errors in parentheses. Models also include terms for missing values on occupation, spouse occupation, or spouse education.

Table 3. Logistic regression estimates of the effect of psychological characteristics on Internet adoption, by sex

	WLS Females		**WLS Males**	
	Model 1	Model 2	Model 1	Model 2
HN score	0.471***	0.295***	0.595***	0.262***
	(0.049)	(0.053)	(0.048)	(0.055)
Openness	0.367***	0.241***	0.443***	0.281***
	(0.049)	(0.053)	(0.054)	(0.059)
Neuroticism	-0.104*	-0.091	-0.133**	-0.146**
	(0.046)	(0.048)	(0.050)	(0.053)
Agreeableness	-0.067	-0.060	-0.103*	-0.082
	(0.049)	(0.050)	(0.047)	(0.050)
Conscientiousness	-0.084	-0.118*	-0.073	-0.088
	(0.045)	(0.048)	(0.047)	(0.050)
Extraversion	0.008	-0.010	-0.010	-0.060
	(0.044)	(0.045)	(0.047)	(0.050)
N	3687	3687	3161	3161
BIC	4754.020	4631.907	3886.901	3653.655

* $p < .05$, ** $p < .01$, *** $p < .001$ (two-tailed). Standard errors in parentheses. Model 2 includes all regressors (except sex) from Model 3 in Table 2.

Table 4. Logistic regression estimates of effect of educational attainment on log odds of home Internet adoption

WLS females (N = 3687)

	some college	college graduates
bivariate	.652*** (0%)	1.163*** (0%)
adding HN score	.496*** (24%)	.770*** (34%)
adding personality variables	.363*** (44%)	.545*** (53%)
adding income and wealth	.297*** (54%)	.446*** (62%)
adding occupational measures	.196* (70%)	.158* (86%)
adding spousal characteristics	.148* (77%)	.053 (95%)

WLS males (N = 3161)

	some college	college graduates
bivariate	1.086*** (0%)	1.810*** (0%)
adding HN score	.914*** (16%)	1.413*** (22%)
adding personality variables	.819*** (25%)	1.302*** (28%)
adding income and wealth	.738*** (32%)	1.133*** (37%)
adding occupational measures	.611*** (44%)	.770*** (57%)
adding spousal characteristics	.575*** (47%)	.683*** (62%)

* $p < .05$, ** $p < .01$, *** $p < .001$ (two-tailed). Percentage attenuation from bivariate regression in parentheses. Respondents with high school diploma only are reference category for estimates.

Table 5. Logistic regression coefficients of psychological and sociodemographic characteristics on whether respondent used Internet at current/last job

	High school only		**Some college**		**College degree**	
	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2
HN score	0.433***§	0.306***§	0.302***	0.225*	0.248**	0.124
	(0.048)	(0.052)	(0.090)	(0.095)	(0.079)	(0.086)
Openness	0.330***	0.258***	0.350***	0.302**	0.287***	0.274**
	(0.049)	(0.052)	(0.094)	(0.098)	(0.082)	(0.087)
Neuroticism	-0.086	-0.085	-0.086	-0.070	-0.250**	-0.204*
	(0.044)	(0.047)	(0.087)	(0.092)	(0.077)	(0.083)
Agreeableness	-0.000	-0.005	-0.106	-0.126	-0.121	-0.113
	(0.045)	(0.048)	(0.085)	(0.088)	(0.072)	(0.077)
Conscientiousness	-0.022	-0.064	-0.179*	-0.214*	-0.032	-0.090
	(0.044)	(0.047)	(0.082)	(0.087)	(0.069)	(0.075)
Extraversion	-0.020	-0.067	-0.031	-0.082	0.056	-0.058
	(0.043)	(0.046)	(0.079)	(0.084)	(0.066)	(0.074)
Female	0.233**	0.278	-0.058	0.242	-0.373**	0.045
	(0.085)	(0.142)	(0.160)	(0.250)	(0.136)	(0.188)
N	2777	2777	818	818	1439	1439
BIC	3680.433	3524.548	1066.457	1106.388	1506.493	1464.691

* $p < .05$, ** $p < .01$, *** $p < .001$ (two-tailed). §Indicates $p < .05$ for interactions across categories. Standard errors in parentheses. Model 2 includes all controls from Model 4 in Table 2.

Table 6. Logistic Regression Estimates of the Effects of Basic Psychological Characteristics and Gender on Home Internet Adoption, by Wealth

	Below median wealth		**Above median wealth**	
	Model 1	Model 2	Model 1	Model 2
HN score	0.406***§	0.335***	0.250***§	0.193**
	(0.058)	(0.060)	(0.061)	(0.063)
Openness	0.260***	0.265***	0.279***	0.258***
	(0.053)	(0.056)	(0.057)	(0.059)
Neuroticism	-0.093	-0.098	-0.114*	-0.117*
	(0.051)	(0.052)	(0.054)	(0.055)
Agreeableness	-0.032	-0.042	-0.055	-0.074
	(0.051)	(0.052)	(0.053)	(0.054)
Conscientiousness	0.003§	-0.006§	-0.180***§	-0.193***§
	(0.050)	(0.051)	(0.053)	(0.054)
Extraversion	-0.036	-0.094	0.004	-0.045
	(0.049)	(0.052)	(0.053)	(0.055)
Female	0.101	0.296*	0.046	0.146
	(0.098)	(0.144)	(0.104)	(0.151)
N	2497	2497	2537	2537
BIC	3108.347	3082.386	2887.639	2925.896

* $p < .05$, ** $p < .01$, *** $p < .005$ (one-tailed). §Indicates $p < .05$ for interactions across categories. Standard errors in parentheses. Model 1 includes education, job status, and Internet at work as additional controls. Model 2 includes all controls from Model 4 in Table 2.

Table 7. Logistic regression coefficients of psychological and sociodemographic characteristics on whether respondent used Internet at current or last job

	WLS Females			WLS Males		
	Model 1 (full sample)	Model 2 (full sample)	Model 2 (current workers)	Model 1 (full sample)	Model 2 (full sample)	Model 2 (current workers)
HN score	0.287***§	0.154**	0.211**	0.553***	0.240***	0.179*
	(0.047)	(0.052)	(0.076)	(0.049)	(0.056)	(0.079)
Openness	0.278***§	0.187***	0.218**	0.453***	0.329***	0.359***
	(0.050)	(0.055)	(0.077)	(0.057)	(0.060)	(0.080)
Neuroticism	-0.132**	-0.107*	-0.046	-0.082	-0.079	-0.088
	(0.048)	(0.049)	(0.073)	(0.052)	(0.055)	(0.077)
Agreeableness	-0.043	-0.012	0.066	0.048	0.085	0.010
	(0.048)	(0.050)	(0.071)	(0.047)	(0.050)	(0.070)
Conscientiousness	0.143**	0.114*	0.217**	0.035	0.019	0.105
	(0.046)	(0.049)	(0.071)	(0.048)	(0.050)	(0.070)
Extraversion	0.035	0.040	-0.023	0.055	0.036	-0.004
	(0.045)	(0.047)	(0.068)	(0.047)	(0.049)	(0.069)
No spouse		0.231*	0.047		-0.289*	-0.270
		(0.097)	(0.136)		(0.142)	(0.208)
Some college		0.154§	0.174§		0.792***	0.968***
		(0.122)	(0.175)		(0.131)	(0.184)
College degree		0.158§	0.265§		1.132***	1.198***
		(0.118)	(0.170)		(0.119)	(0.168)
Rural residence		-0.330**§	-0.460**		-0.482***	-0.501**
		(0.103)	(0.145)		(0.111)	(0.155)
N	2820	2820	1156	2464	2464	1222
BIC	3363.605	3208.590	1529.779	3013.352	2841.271	1477.085

* $p < .05$, ** $p < .01$, *** $p < .001$ (two-tailed).). §Indicates $p < .05$ for difference between females and males. Standard errors in parentheses.

Table 8. Logistic Regression Estimates of the Effects of Basic Psychological Characteristics and Gender on Home Internet Adoption, by Whether Internet is Used at Work

	Currently working		**Not currently working**	
	Uses Internet at work	No Internet at work	Used Internet at last job	No Internet at last job
HN score	0.080[§]	0.395***[§]	0.220	0.299***
	(0.100)	(0.073)	(0.114)	(0.059)
Openness	0.113	0.382***	0.400**	0.174**
	(0.106)	(0.075)	(0.131)	(0.058)
Neuroticism	-0.229*	-0.082	-0.050	-0.126*
	(0.095)	(0.069)	(0.115)	(0.053)
Agreeableness	-0.214*[§]	-0.045[§]	-0.076	-0.011
	(0.093)	(0.066)	(0.115)	(0.055)
Conscientiousness	-0.226*	0.018	-0.142	-0.129*
	(0.093)	(0.067)	(0.118)	(0.052)
Extraversion	0.015	-0.144*	-0.242*	-0.022
	(0.084)	(0.068)	(0.109)	(0.052)
N	1026	1351	775	2129
BIC	1128.104	1771.990	816.935	2776.005

* $p < .05$, ** $p < .01$, *** $p < .001$ (two-tailed).). [§]Indicates $p < .05$ for interactions across categories. Standard errors in parentheses. Model 1 includes education, job status, and internet at work as additional controls. Model 2 includes all controls from Model 4 in Table 2.

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