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RESEARCH ARTICLE

Brain Health Registry Study Partner Portal: Novel infrastructure for digital, dyadic data collection

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Abstract

BACKGROUND: In Alzheimer's disease (AD) research, subjective reports of cognitive and functional decline from participant–study partner dyads is an efficient method of assessing cognitive impairment and clinical progression.

METHODS: Demographics and subjective cognitive/functional decline (Everyday Cognition Scale [ECog]) scores from dyads enrolled in the Brain Health Registry (BHR) Study Partner Portal were analyzed. Associations between dyad characteristics and both ECog scores and study engagement were investigated.

RESULTS: A total of 10,494 BHR participants (mean age = 66.9 ± 12.16 standard deviations, 67.4% female) have enrolled study partners (mean age = 64.3 ± 14.3 standard deviations, 49.3% female), including 8987 dyads with a participant 55 years of age or

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older. Older and more educated study partners were more likely to complete tasks and return for follow-up. Twenty-five percent to 27% of older adult participants had self and study partner-report ECog scores indicating a possible cognitive impairment.

DISCUSSION: The BHR Study Partner Portal is a unique digital tool for capturing dyadic data, with high impact applications in the clinical neuroscience and AD fields.

KEYWORDS

aging research, Alzheimer's disease, Brain Health Registry, dementia, diversity, dyadic report, internet, internet registry, online, remote assessment, subjective cognitive decline

Highlights

- The Brain Health Registry (BHR) Study Partner Portal is a novel, digital platform of >10,000 dyads.
- Collection of dyadic online subjective cognitive and functional data is feasible.
- The portal has good usability as evidenced by positive study partner feedback.
- The portal is a potential scalable strategy for cognitive impairment screening in older adults.

1 | BACKGROUND

In cognitive aging and Alzheimer's disease and related dementias (ADRD) research, many clinical trials and observational studies require data collected from participant and study partner/informant pairs, also referred to as dyads. Study partners are often the participant's spouse, adult child, other family member, or close friend. Ideally the study partner knows the participant well enough to be able to provide insight into the current status of, and recent changes in, the participant's cognitive and functional abilities.[1,2] Advantages of involving dyads in research include (1) efficient, accurate, and reliable data for assessing ADRD risk[3,4]; (2) study partners may have insight into changes in complex activities of daily living, which are difficult to assess using neuropsychological tests[1,2,5]; (3) study partner report is less affected by the participant's mood and declining awareness of their own abilities associated with dementia[5,6]; (4) study partner involvement can help ensure participant safety and data integrity, and decrease study dropout.[7,8]

Although most dyadic data are collected in in-clinic studies, dyadic data collection has been adapted recently to remote, unsupervised settings.[5,9–12] The Brain Health Registry (BHR) Study Partner Portal is a novel and scalable platform to support remote collection of study partner data[10,13] within the University of California, San Francisco Brain Health Registry. BHR is an online cognitive aging and ADRD-related research registry and cohort (N > 92,000 participants). Previous results support the preliminary feasibility of the BHR Study Partner Portal, and the validity of data collected.[9,10,13,14] The goal of this exploratory study was to provide a detailed description of the dyads enrolled in the BHR Study Partner Portal, including their demographics, the subjective cognitive and functional data collected, and the dyad characteristics associated with study participation.

2 | METHODS

2.1 | Brain health registry (BHR)

The BHR is a public online registry. Adults (age 18+) can register, sign a digital informed consent, and complete online longitudinal tasks at 6-month intervals, including questionnaires and neuropsychological assessments.[10,13] The BHR study is approved by the University of California, San Francisco Internal Review Board.

The BHR Study Partner Portal[9,10] was launched in 2016 and is a novel, scalable, remote, online portal within the BHR. All enrolled BHR participants are presented with a "My Study Partner" questionnaire, which describes what a study partner is, and asks whether they have someone who could serve as their study partner. If a BHR participant indicates that they have one potential study partner, they are asked to enter this person's name and contact information. BHR then automatically sends the potential study partner an email describing the Study Partner Portal and asking them to join as the study partner for their associated BHR participant by following an email link. Potential study partners who click the link are directed to a page with more information about the Study Partner Portal and can register and sign an online informed consent. Consented study partners are considered enrolled. If the study partner does not respond to the initial invitation, three additional email invitations are sent 8, 11, and 21 days after the initial invitation. Participants are given an opportunity to confirm or change their study partner in annual follow-up visits to the BHR website. Study partners answer online questionnaires about the BHR participant and the study partner themselves, which take ≈30 minutes to complete. Questionnaires about the associated participant include a short health screener, and the following scales adapted for online use[9]: Everyday Cognition Scale (ECog),[15] Functional Activities

Questionnaire (FAQ),[16,17] Cognitive Function Instrument (CFI),[18,19] and Mild Behavioral Impairment Checklist (MBI-C).[20,21] Questions about the study partners themselves include demographics, relationship to BHR participants, and a short health screener. A unique identification code links data between the study partner and participant. Study partners and participants receive automated reminder emails to finish tasks, and to return for follow-up visits at 6-month intervals. Participants are not informed about the information that study partners provide.

For this study, study partners and BHR participants came from two sources: (1) enrolled in the BHR from the general public (April 2014 to September 2022; N = 10,113); or (2) first enrolled in the Imaging Dementia-Evidence for Amyloid Scanning (IDEAS) study[9,22] and then invited to join BHR via email (February 2017 to February 2018; N = 381). IDEAS is a study with more than 18,000 participants age 65 years and older with Mild Cognitive Impairment (MCI) or dementia of uncertain etiology, with the goal to establish the clinical utility of a brain amyloid beta (Aβ) positron emission tomography (PET) scan. This analysis included all study partners and participants from both sources with data necessary to perform analyses.

RESEARCH IN CONTEXT

1. **Systematic review**: A review of the literature on dyadic subjective cognitive decline was conducted using electronic databases. Previous studies supported preliminary feasibility of the Brain Health Registry (BHR) Study Partner Portal, and the validity of the data collected.
2. **Interpretation**: Collection of remote, unsupervised, digital, online longitudinal subjective cognitive/functional data from a large cohort of dyads (participant, study partner pairs) is feasible. Dyads had high task completion and retention rates. However, characteristics associated with study partner enrollment, engagement, and retention levels highlighted selection biases for older and highly educated dyads. The BHR Study Partner Portal has good usability, as demonstrated by positive study partner feedback about their experience.
3. **Future directions**: Much needed efforts are underway and planned to increase the ethnocultural and socioeconomic diversity of dyads enrolled in the BHR. Important next steps are to look at the relationship between subjective and objective cognitive measures, and the contributions of dyad demographics to this relationship.

2.2 | Participant metrics

2.2.1 | Demographic information

These analyses used the following study partner- and participant-reported demographic information: current age (continuous), gender (male, female, other, prefer not to say), years of educational attainment (continuous), ethnicity (Latino, non-Latino, declined to state), and race (Asian, African American/Black, Native American, Pacific Islander, Other, White, Multiple, and declined to state).

2.2.2 | Medical history

The following participant-reported medical history variables were included in the analysis: history of Alzheimer's disease (AD) ("Do you have any biological parents, full siblings, or biological children who have been diagnosed with AD?"), self-report of MCI ("Please indicate whether you currently have or have had any of the following conditions in the past: Mild Cognitive Impairment"), AD ("Please indicate whether you currently have or have had any of the following conditions in the past: Alzheimer's Disease"), dementia ("Please indicate whether you currently have or have had any of the following conditions in the past: Dementia").

2.2.3 | Self-reported memory concern

The analysis used both participant- and study partner–reported memory concern ("Are you concerned that you/[associated participant name] have/has a memory problem?")

2.2.4 | Everyday Cognition Scale (ECog)

The ECog measures change in instrumental activities of daily living compared to 10 years before.[15] ECog is completed separately by the participant and study partner, and includes questions related to six cognitive domains: Everyday Memory (e.g., remembering a few shopping items without a list), Everyday Language (e.g., forgetting the names of objects), Everyday Visuospatial Abilities (e.g., following a map to find a new location), Everyday Planning (e.g., thinking things through before acting), Everyday Organization (e.g., keeping living and workspace organized), and Everyday Divided Attention (e.g., the ability to do two things at once). ECog scores range from 1 to 4. BHR uses a version adapted for online use,[9] with higher scores indicating a greater decline. The ECog is administered every 6 months in BHR. This analysis used baseline ECog scores. To identify participants with ECog scores falling into a range associated with possible MCI, we used cutoffs that were >1 standard deviation (SD) from the mean ECog scores of cognitively unimpaired participants in the Alzheimer's Disease Neuroimaging Initiative (ADNI) (Self-report ECog score mean = 1.34, SD = 0.31; Study partner-report ECog score mean = 1.17, SD = 0.26).[23] The cutoffs applied to define possible MCI were Self-report ECog score >1.65 or study partner report ECog score >1.43.[23]

2.2.5 | Additional subjective measures

The functional activities questionnaire (or FAQ) is a 10-item screening scale for evaluating instrumental activities of daily living (e.g., balancing a checkbook, writing checks, paying bills, and remembering appointments, family occasions, holidays, and medications) in research settings.[16,17] Items are rated on a six-point scale (1 = Normal, 2 = Never did, but could now do, 3 = Never did, would have difficulty now, 4 = Has difficulty, but does by self, 5 = Requires assistance, 6 = Dependent). The Cognitive Function Instrument (or CFI) is a 14-item scale that assesses recent changes (compared to 1 year ago) in cognition and activities of daily living.[18,19] Response options include Yes (1), Maybe (2), and No (3). The BHR Study Partner Portal uses online adapted versions of the FAQ and CFI reported by the study partner about the associated BHR participant. Baseline FAQ and CFI scores was used for this analysis.

2.3 | Feasibility metrics

2.3.1 | Enrollment metrics

Enrollment metrics included in this analysis are the number of BHR participants who (1) Completed the "My Study Partner" questionnaire; (2) Identified a potential study partner; and (3) Indicated that they did not have a potential study partner. For those who invited a potential study partner, we report whether the invitation status was accepted, pending, or declined. We also report whether the study partner is active, defined as having started any questionnaire in the study partner module.

2.3.2 | Task completion and retention metrics

Completion metrics included whether study partners completed all Study Partner Portal tasks at least once (yes, no) and whether study partners completed the core questionnaire at least once (yes, no). The core questionnaire is the first questionnaire that study partners are asked to complete, and asks about demographic information, mood, health, medications, memory, and self-report diagnoses of MCI and AD for the study partner and participant. Retention metrics included completion of the core questionnaire at least twice (yes, no) and completion of study partner rated ECog at least twice (yes, no).

2.4 | Usability metrics

2.4.1 | Feedback questionnaire

While logged into the Study Partner Portal, study partners can at any time provide optional feedback about their experience by clicking on a widget labeled "Feedback." The widget directs study partners to an online questionnaire that includes the following questions: (1) "*How easy was this site to use? From a 1–10 scale of not easy to very easy*"; (2) "*How clear were the instructions for the site? From a 1–10 scale of not clear to very clear*"; (3) "*How accurately did we predict the time necessary to answer the questionnaires and take the tests?*" (1 = It took a lot more time than expected – 5 = It took a lot less time than expected). The questionnaire also includes two questions with free-text response options (*"What, if anything, was frustrating?" and "How can we improve?"*). This analysis focused on the subset of study partners who provided this optional feedback, and used responses from the first time the questionnaire was completed (quantitative: $N = 2034$; qualitative: $N = 735$) the qualitative questions were analyzed using an open-coding approach and thematic analysis.[24] Blank responses were skipped.

2.4.2 | Statistical analysis

Descriptive information was tabulated for four samples: (1) all study partners, (2) all BHR participants with enrolled study partners, (3) study partners with an associated participant age 55 or older, and (4) BHR participants age 55 or older with enrolled study partners. Descriptive information was summarized using Ns and percentages for categorical variables (gender, race, ethnicity, subjective memory concern, family history of AD, BHR participant-reported MCI, AD) and means and SDs for continuous variables (age, education, study partner– and BHR participant–reported ECog scores, FAQ score, CFI score). In study partners with an associated BHR participant aged 55+, we estimated associations between study partner–reported ECog (outcome) and the following variables (predictors) using multivariable ordinary least-squares linear regression: participant-reported ECog; participant demographics (age, gender, education, race, and ethnicity); participant reported MCI, AD, and dementia; study partner demographics (age, gender, education, race, and ethnicity). Regression coefficients and 95% confidence intervals (CIs) are reported. In the same sample, multivariable binomial logistic regressions were fit to estimate associations between the study partner task completion and retention outcome metrics and demographic information. Each task completion and retention outcome metric was modeled separately. Predictors included either study partner– or BHR participant–reported demographic information (age, gender, education, race, and ethnicity). For all logistic regression models, odds ratios (ORs), 95% CIs, and *p*-values are reported. Analyses were done in SAS 9.4 (SAS Institute, Cary NC) and R.[25]

3 | RESULTS

3.1 | Feasibility

3.1.1 | Study partner enrollment

Of 92,626 participants enrolled in BHR, a total of 25,374 (27.4%) indicated that they did not have a potential study partner in the "My Study Partner" questionnaire (see Supplemental Material). A total of 18,802 (20.3%) indicated that they had a potential study partner, who was then sent an invitation to join BHR. A total of 10,644 study partners

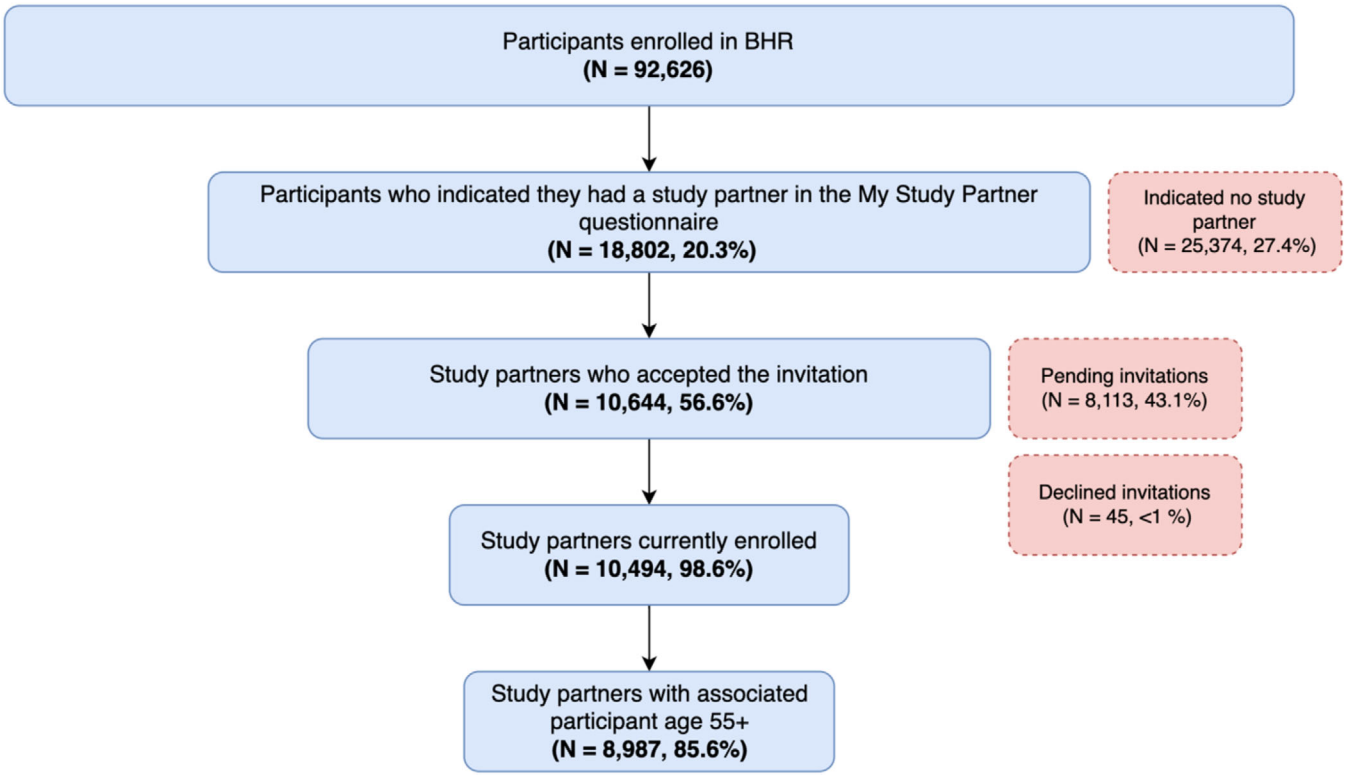

FIGURE 1 Study partner enrollment into the Brain Health Registry.

(56.6%) accepted the invitation, 45 (< 1%) declined, and 8113 (43.1%) invitations are pending, meaning the prospective study partner has not yet responded. A total of 10,494 study partners (98.6%) enrolled and signed an online consent. Of all enrolled study partners, 8987 (85.6%) have an associated BHR participant 55 years of age or older (Figure 1).

3.1.2 | Characteristics of BHR participants with study partners

Demographics of BHR participants with study partners are shown in Table 1. Compared to BHR participants ages 55+ who indicated that they did not have a potential study partner, participants with an enrolled study partner were significantly older (mean = 71.4, SD = 8.1 vs mean = 69.6, SD = 8.5 years of age) and had a higher educational attainment (mean = 16.6, SD = 2.3 vs mean = 15.6, SD = 2.5 years). Those with a study partner had a higher percentage of those identifying as White (n = 8361 [94.6%] vs n = 49,665 [81.3%]) and a lower percentage of those identifying as female (n = 5844 [66.1%] vs n = 45,684 [74.8%]). There were significantly higher percentages of participants with self-report MCI (n = 894 [10.1%] vs n = 2893 [4.7%]), AD (n = 245 [2.8%] vs n = 467 [0.7%]), and dementia (n = 274 [3.1%] vs n = 687 [1.1%]) in the group with a study partner versus the group without. For a more detailed comparison of these two groups, see Table S1.

3.1.3 | Characteristics of study partners

Study partners had an average age of 64.3 (SD = 14.25) and average educational attainment of 16.3 years (SD = 2.36). A total of 5174 (49.3%) identified as female, 9190 (87.6%) identified as White, and 437 (4.2%) reported Latino ethnicity. Study partners with an associated participant age 55+ were on average 67.1 years old (SD = 12.6) and had an average educational attainment of 16.3 years (SD = 2.37). A total of 4526 (50.4%) identified as female, 7950 (88.5%) identified as White, and 310 (3.4%) reported Latino ethnicity (see Table 2 for demographics of all ethnocultural groups).

3.1.4 | Task completion and retention

A total of 5370 (51.2%) study partners completed at least one longitudinal follow-up visit, and 4776 completed at least two instances of ECog. A total of 4741 study partners (52.8%) with participants age 55+ completed at least one longitudinal follow-up, and 4258 completed at least two ECog sessions (Figure 2). A total of study partners 6648 (74.0%) with participants age 55+ completed the entire study partner module at least once, and 7593 (72.4%) of all study partners completed the entire study partner module at least once. Fifty-three participants changed study partners over the course of their enrollment in BHR.

TABLE 1 Characteristics of all participants with study partners.

	N = 10,494 (all participants)	*N* = 8987 (participants age 55+)
Age, mean ± SD (*N*) (min–max)	66.9 ± 12.16 (*N* = 10,484) (22–90)	70.7 ± 7.97 (*N* = 8987) (55–90)
Education in years, mean ± SD (*N*) (min–max)	16.7 ± 2.26 (*N* = 10,483) (12–20)	16.7 ± 2.28 (*N* = 8985) (12–20)
Female, *n* (%)	7078 (67.4%)	5957 (66.3%)
Race, *n* (%)		
Black/African American	201 (1.9%)	162 (1.8%)
Asian	271 (2.6%)	190 (2.1%)
Native American	207 (2.0%)	164 (1.8%)
Pacific Islander	31 (0.3%)	21 (0.2%)
White	9832 (93.7%)	8507 (94.7%)
Other	253 (2.4%)	169 (1.9%)
More than on3 race	314 (3.0%)	233 (2.6%)
Latino ethnicity, *n* (%)	513 (4.9%)	350 (3.9%)
Subjective memory concern, *n* (%)	5311 (50.6%)	4690 (52.2%)
Self-report MCI, *n* (%)	806 (7.7%)	771 (8.6%)
Self-report AD, *n* (%)	214 (2.0%)	211 (2.3%)
Self-report dementia, *n* (%)	226 (2.2%)	221 (2.5%)
Family history of AD, *n* (%)	3888 (37.0%)	3523 (39.2%)

Abbreviations: AD, Alzheimer's disease; MCI, mild cognitive impairment; SD, standard deviation.

TABLE 2 Characteristics of study partners.

	N = 10,494 (all study partners)	*N* = 8987 (study partners of participants 55+)
Age, mean ± SD (*N*) (min–max)	64.3 ± 14.25 (*N* = 10,492) (18–90)	67.1 ± 12.51 (*N* = 8985) (19–90)
Education in years, mean ± SD (*N*) (min–max)	16.3 ± 2.36 (*N* = 10,110) (12–20)	16.3 ± 2.37 (*N* = 8648) (12–20)
Female, *n* (%)	5174 (49.3%)	4526 (50.4%)
Race, *n* (%)		
Black/African American	200 (1.9%)	155 (1.7%)
Asian	302 (2.9%)	219 (2.4%)
Native American	158 (1.5%)	124 (1.4%)
Pacific Islander	32 (0.3%)	25 (0.3%)
White	9190 (87.6%)	7950 (88.5%)
Other	271 (2.6%)	183 (2.0%)
More than one race	247 (2.4%)	183 (2.0%)
Latino ethnicity, *n* (%)	437 (4.2%)	310 (3.4%)
SP-report ECog score, M ± SD (*N*) (min–max))	1.35 ± 0.496 (1–4)	1.37 ± 0.507 (*N* = 7315) (1–4)
SP CFI score, mean ± SD (*N*) (min–max)	± 2.18 (*N* = 9747) (0–24)	1.46 ± 2.23 (*N* = 8364) (0–14)
SP FAQ score, mean ± SD (*N*) (min–max)	± 3.62 (*N* = 7472) (0–30)	1.24 ± 3.75 (*N* = 6526) (0–30)

Abbreviations: CFI, Cognitive Function Instrument; ECog, Everyday Cognition; FAQ, Functional Activities Questionnaire; SD, standard deviation; SP, study partner.

3.1.5 | Characteristics associated with task completion and retention

Higher study partner age (OR = 1.013, CI = 1.008–1.017), higher study partner educational attainment (OR = 1.115, CI = 1.090–1.140), study partner female gender (OR = 1.215, CI = 1.076–1.373), higher participant age (OR = 1.006, CI = 1.001–1.011), and participant African American/Black race (OR = 1.942, CI = 1.091 to 3.5) were significantly associated with a higher probability of study partner task completion. Study partner African American/Black race (OR = 0.386, CI = 0.234–0.636), study partner Asian race (OR = 0.614, CI = 0.440–0.857), study partner other race (OR = 0.507, CI = 0.360–0.714), and study partner multiple races (OR = 0.707, CI = 0.527–0.949) were significantly associated with a lower probability of study partner task completion.

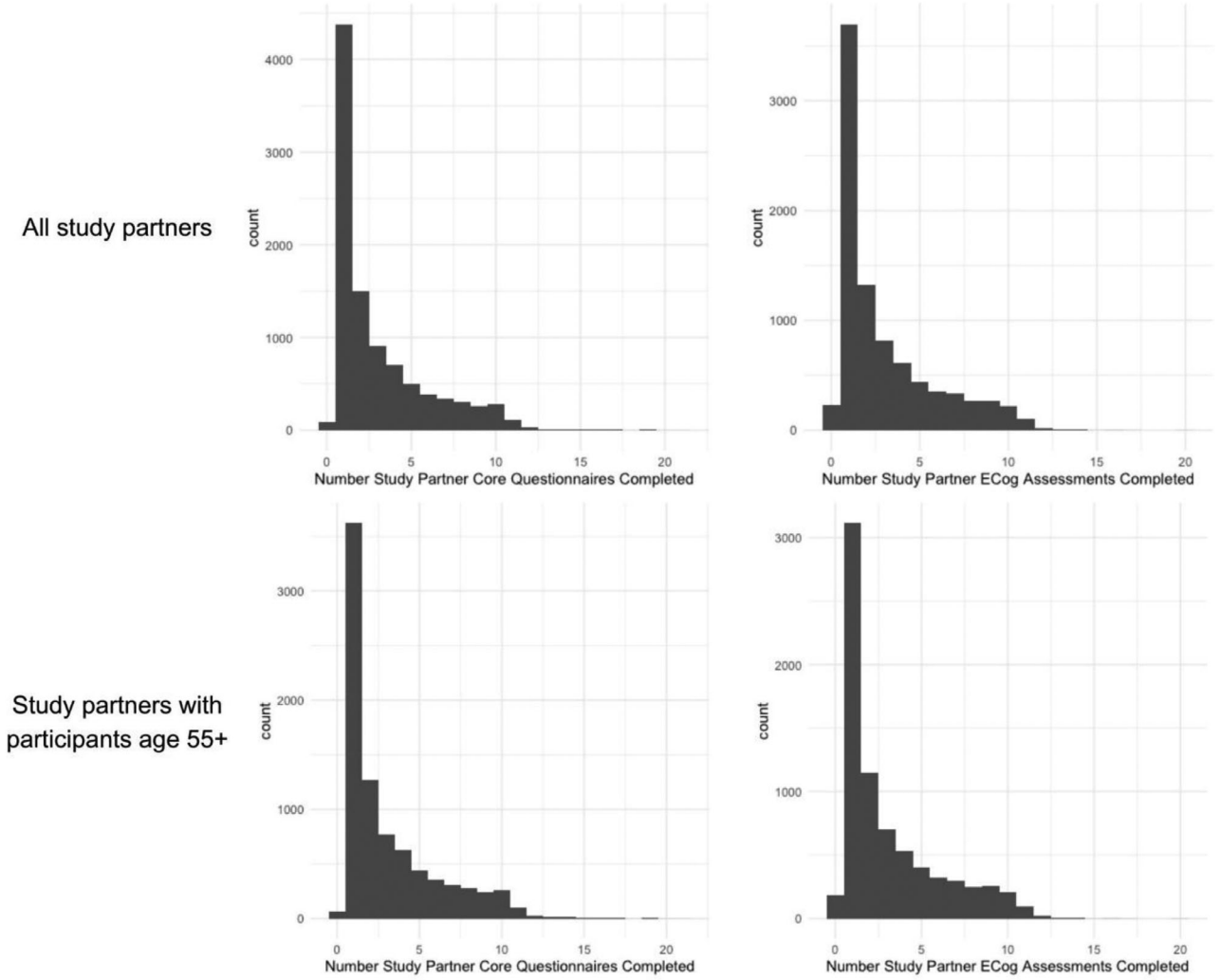

FIGURE 2 Top row: Study partner core questionnaire and Everyday Cognition assessments completed by all study partners. Bottom row: Core questionnaire and Everyday Cognition assessments completed by study partners with participants age 55+.

Higher study partner age (OR = 1.010, CI = 1.005–1.014), higher study partner educational attainment (OR = 1.075, CI = 1.053–1.099), study partner female gender (OR = 1.187, CI = 1.056–1.334), and higher participant educational attainment (OR = 1.027, CI = 1.005, –1.050), were significantly associated with a higher probability of completion of at least two study partner ECog sessions. Participant other race (OR = 0.610, CI = 0.374–0.995) and participant Latino ethnicity (OR = 0.734, CI = 0.557–0.968) were associated with a lower probability of completion of at least two study partner ECog sessions.

3.2 | Study partner– and self–report subjective cognitive and functional decline

3.2.1 | ECog scores

For study partners with participants age 55+, the mean study partner–report ECog score was 1.37 (SD = 0.507) and mean self-report ECog score was 1.47 (SD = 0.47). Using the established cut points, we found that of 7315 participants age 55+ with available study partner–report ECog scores, 2038 (27.9%) were possibly impaired. A total of 2095 (24.2%) of 8652 participants with available self-report ECog scores were possibly impaired. For ECog results in the entire study partner cohort, see Supplemental Results.

3.2.2 | Relationship between self- and study partner–report ECog

Study partner– and self-report ECog scores were correlated for the entire study partner cohort (r = 0.47, $p < 0.001$) and for the age 55+ cohort (r = 0.46, $p < 0.001$) (Figure 3).

3.2.3 | Dyad characteristics associated with ECog scores

In study partners with associated participants age 55+, higher (worse) study partner ECog score was associated with a lower

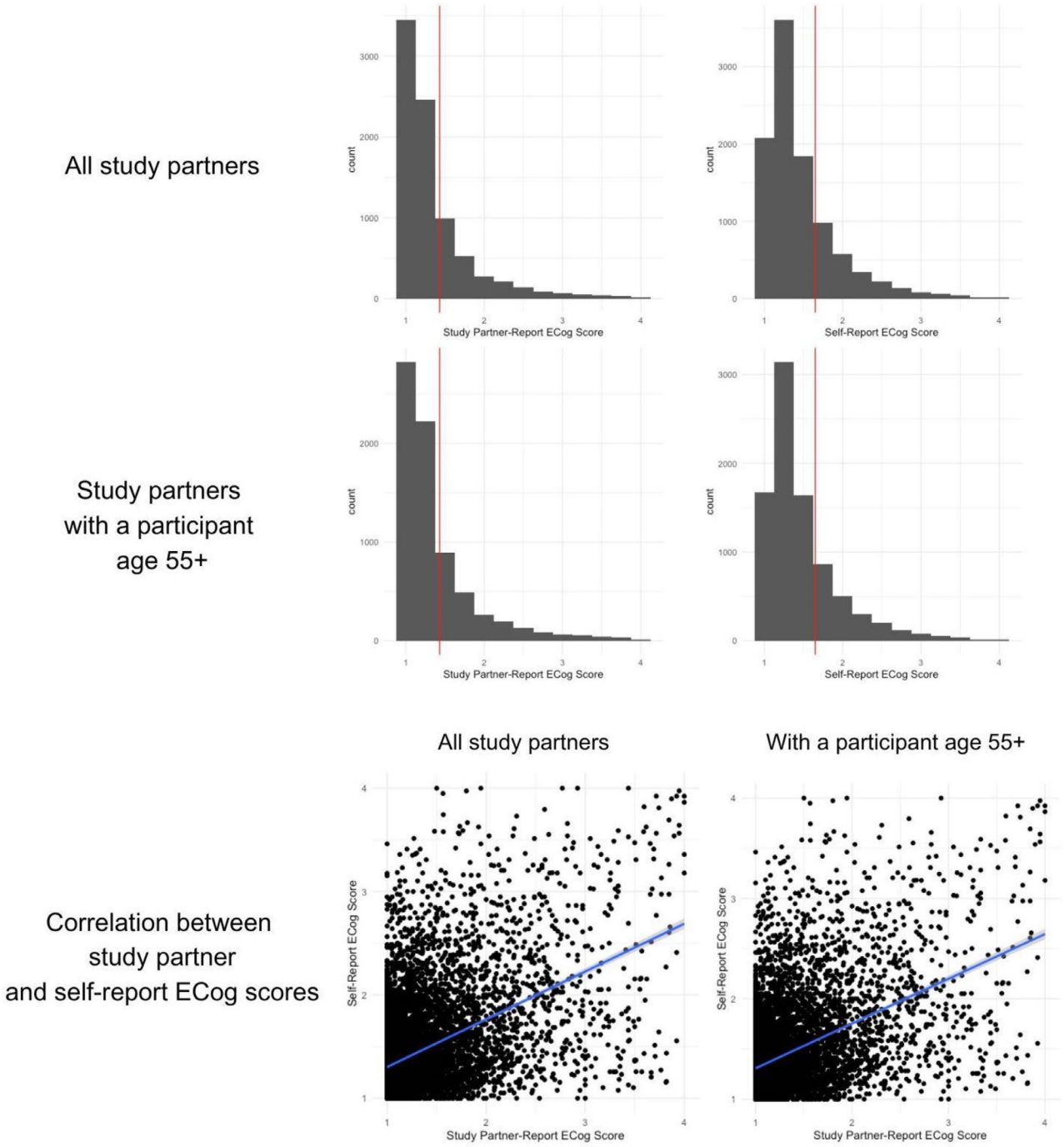

FIGURE 3 "Possibly impaired" cut points are represented by red vertical lines (1.43 for study partner–report scores and 1.65 for self-report scores). Top row: Self- and study partner–report ECog scores for all study partners and all associated participants. Middle row: Self- and study partner–report ECog scores all study partners with participants age 55+ and associated participants age 55+. Bottom row: Scatterplot of study partner– and self-report ECog scores in all participants and study partners versus participants 55+ and associated study partners.

study partner age in years, Native American study partner race, and study partner identification with multiple races. Higher study partner ECog score was associated with advanced participant age in years, lower participant educational attainment, male participant gender, and participant Native American race (Table 3).

3.3 | Usability of the BHR study partner portal

3.3.1 | Quantitative feedback

Study partners who answered the optional feedback questions about their experience ($N = 2034$; See Table S2) rated the portal as very easy

TABLE 3 Estimated regression coefficients and 95% confidence intervals from linear regression models fit to study partner ECog score.

Study partner characteristic	Study partner–report ECog score β (95% confidence interval)	Participant characteristic	Study partner-report ECog Score β (95% confidence interval)
Age in years	−0.003 (−0.004, −0.002)*	Age in years	0.013 (0.011, 0.015)*
Years of education	−0.005 (−0.010, 0.001)	Years of education	−0.016 (−0.022, −0.011)*
Gender		Gender	
Male	1.0 (reference)	Male	1.0 (reference)
Female	−0.011 (−0.043, 0.021)	Female	−0.093 (−0.125, −0.061)*
Race		Race	
African American/Black	0.106 (−0.045, 0.256)	African American/Black	−0.062 (−0.216, 0.092)
Asian	−0.037 (−0.133, 0.058)	Asian	0.006 (−0.098, 0.109)
Native American	0.278 (0.043, 0.513)*	Native American	0.317 (0.074, 0.560)*
Pacific Islander	−0.30 (−0.367, 0.306)	Pacific Islander	−0.240 (−0.666, 0.187)
White	1.0 (reference)	White	1.0 (reference)
Multiple	0.130 (0.037, 0.222)*	Multiple	0.051 (−0.032, 0.134)
Other	−0.015 (−0.136, 0.107)	Other	0.053 (−0.088, 0.193)
Ethnicity		Ethnicity	
Latino	0.016 (−0.068, 0.100)	Latino	−0.028 (−0.107, 0.051)
Not Latino	1.0 (reference)	Not Latino	1.0 (reference)

Note: * = $p < 0.05$.

to use (mean = 9.2, SD = 1.4) and the site instructions as very clear (mean = 9.2, SD = 1.3). Over half of the respondents (54.9%) indicated that it took them more time than expected to complete the tasks.

3.3.2 | Qualitative feedback

A total of 735 study partners answered one or both qualitative feedback questions. Answers fell into three overarching themes: task completion issues, content issues, and feedback that was not actionable (answers unrelated to questions, or study partners indicating that they had no feedback). For the task completion issue theme, technical issues and accessibility issues were identified as sub-themes. For the content issue, difficulties and design change requests were identified as sub-themes. See Table S3 for overarching themes, sub-themes, and a detailed description of each sub-theme.

4 | DISCUSSION

The main findings of this study are (1) Collection of remote, unsupervised, digital, online longitudinal subjective cognitive/functional data from a large cohort of dyads (participant– study partner pairs) is feasible. Dyads had high task completion and retention rates. However, characteristics associated with study partner enrollment, engagement, and retention levels highlighted important selection biases, including those for older and more highly educated dyads. (2) Greater subjective cognitive/functional decline (higher ECog scores) are associated with advanced dyad age, lower participant education, participant male gender, and dyad Native American ethnocultural identity; (3) Approximately 25% of older adult participants in our cohort demonstrated evidence for possible cognitive impairment, based on ECog scores; (4) The BHR Study Partner Portal has good usability, as demonstrated by positive study partner feedback about their experience.

In terms of feasibility, we found that 74% of study partners with participants age 55+ completed all study questionnaires. Furthermore, in terms of longitudinal retention, we found that just over 50% of study partners completed at least one longitudinal follow-up visit. In comparison, in a recent analysis of the entire BHR participant cohort,[13] we found that only 45% of participants completed at least two core questionnaires. This suggests that enrolled study partners have a high level of engagement, compared to BHR participants. This may be because initial enrollment in the Study Partner Portal is a sign of a high level of engagement, causing a selection bias for highly engaged participants. In addition, the entire study partner module is substantially shorter than the BHR participant module (30 min vs >1 h). In terms of usability, we found that, on average, study partners who answered optional questions about their study partner experience rated the BHR Study Partner Portal site as very easy to use and rated the site instructions as very clear. It is important to note that these feasibility and usability measures are limited by a biased sample that is disproportionately well educated and White.

Although we have previously analyzed engagement and retention of BHR participants, this is the first study to report these metrics specific to enrolled study partners. We identified study partner and participant demographic characteristics associated with higher levels of engagement and retention. In terms of engagement, study partner older age, female gender, and higher educational attainment, and

participant Black/African American ethnocultural identity were all associated with a greater probability of completing tasks. In terms of retention, higher study partner and participant educational attainment and study partner female gender were associated with a higher probability of longitudinal retention. Participant Other race and participant Latino ethnicity were associated with a lower probability of longitudinal retention. This is consistent with previous findings that many studies fail to adequately engage and retain non-White individuals, those with lower educational attainment, and male participants.[26,27] These findings also are consistent with a previous analysis of the BHR cohort,[28] which found that non-White race, Latino ethnicity, and lower educational attainment were associated with decreased task completion.

The BHR Study Partner Portal is the largest study to our knowledge to include longitudinal measures of subjective cognitive and functional decline, with 56,839 instances of self-report ECog, 22,554 instances of study partner-report ECog, $n = 8480$ unique study partners providing ECog data, and $n = 4776$ study partners with longitudinal ECog data. We found that ≈25% of older adult participants have ECog scores indicating the possibility of cognitive impairment within the MCI range.[23] Collection of dyadic subjective decline data in the Study Partner Portal represents a scalable, efficient strategy for screening older adults for cognitive impairment relevant to AD, especially in light of past work demonstrating a strong relationship between BHR study partner–report ECog scores and clinically confirmed MCI diagnosis.[14] One of the main ways that BHR facilitates AD and related research is through referral of BHR participants to other studies, with more than 25,997 BHR participants enrolled in 30 different studies.[13] Dyadic BHR data can be used in the future to identify participants to be referred to studies seeking older adults with MCI, including observational studies and treatment trials.

This large longitudinal data set, combined with demographic data, also provides a unique opportunity to identify dyad characteristics associated with subjective decline scores. We found that higher (worse) study partner ECog scores were associated with advanced participant age, lower participant educational attainment, male participant gender, study partner identification with multiple race categories, and study partner and participant Native American race. This finding contributes to a growing literature characterizing subjective decline in diverse populations.[29–32] It suggests that dyad demographics can influence study partner reports of subjective cognitive decline and should be accounted for in future studies. An important next step is to look at the relationship between subjective and objective cognitive measures, and the contributions of demographics to this relationship. Others have found that this relationship is weaker in older adults from minoritized ethnocultural communities.[29] Another next step is to investigate the role of dyad relationship (i.e., spouse versus other type of study partner) in engagement and completion rates. Other research has demonstrated that spousal study partners are more willing to participate and have lower dropout rates compared to non-spousal study partners.[7,33]

Limitations of our study include selection biases at multiple study stages, including BHR enrollment, study partner enrollment, and study partner longitudinal retention. At each stage, we demonstrate a failure to adequately include and engage dyads from underrepresented ethnocultural groups and those with low education levels. There are numerous, complex factors contributing to the lack of inclusion of these groups in research, including failure of researchers to gain trust in these communities due to a legacy of unethical treatment, higher rates of comorbidities among these groups, failure of investigators to share information about studies with these groups, time burden of participation, issues with study design, and structural factors.[34,35] Frameworks such as community-engaged research have shown promise for increasing inclusion and engagement of minoritized communities, such as Black and Latino individuals, in ADRD research.[35–37] Several initiatives are now underway in BHR to improve participation of minoritized groups.

Furthermore, as with other online research studies, BHR, including the Study Partner Portal, has selection biases for those with adequate technology and internet access and literacy to complete online tasks remotely and unsupervised. These selection biases limit the generalizability of our results. Although the digital divide is narrowing for underrepresented populations, it still persists.[38,39] We have begun multiple new initiatives aimed at including and engaging diverse dyads, which is a crucial next step in realizing the potential impact of this approach. An additional, more general limitation of relying on study partner data in AD research is that many older adults, especially those from underrepresented populations, do not have someone who is able to serve as their study partner.[40] This limitation has the potential to further exacerbate the selection biases we described.

In conclusion, the BHR Study Partner Portal is a novel, scalable approach to the collection of dyadic, subjective cognitive and functional data. This approach has many potential high impact applications in the clinical neuroscience, cognitive aging, and ADRD fields. The data collected can be used to characterize longitudinal subjective decline in a large cohort of adults who have extensive cognitive, health, and lifestyle data through their BHR participation. The entire de-identified dataset can be shared with other investigators, who can test their own hypotheses related to dyadic subjective measures. Enrolled study partners and their associated participants can be referred to other studies, facilitating recruitment and screening in many clinical research studies. The Study Partner Portal online infrastructure can be adapted for use in many different studies and settings, so that other investigators can collect and analyze dyadic data.

AUTHOR CONTRIBUTIONS

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CONFLICT OF INTEREST STATEMENT

Anna Aaronson, Chengshi Jin, Jessica Bride, Josephine Decker, Aaron DeNicola, Catherine Conti, Rachana Tank, Monica R. Camacho, Derek Flenniken, Juliet Fockler, Diana Truran, Aaron Ulbricht, and Maria C. Carrillo report no potential conflict of interest. Author disclosures are available in the Supporting Information.

CONSENT STATEMENT

All participants and study partners in the Brain Health Registry provided informed consent by signing an electronic consent form.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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