National Institute on Aging (NIA)
National Advisory Council on Aging (NACA)
Review of the Division of Behavioral and Social Research (BSR)

2019 BSR Review Committee Report

Rev. December 16, 2019

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I. Executive Summary

The National Advisory Council on Aging (NACA) is tasked with periodically reviewing each of the four Extramural Divisions within the National Institute on Aging (NIA) to assess whether past performance and, more importantly, the future trajectory of research and training promoted and supported by the Division, are appropriate for the scientific advancement of the field in the coming decade. A key challenge is to evaluate the balance of research and training supported and identify areas that merit greater emphasis in the coming years. The review is meant to aid the Division in planning for the future through both self-evaluation and the expert advice of the Review Committee.

This cycle's Review Committee, co-chaired by Drs. Eileen Crimmins and Terrie Moffitt, consisted of 17 distinguished scientists (indicated on cover), selected for their broad expertise and scientific vision. Five of the Committee members were current NACA members during the review period and one is a former NACA member. One of the current Committee members served on the previous Behavioral and Social Research (BSR) review. Prior BSR reviews were completed in February 1998, May 2000, May 2004, November 2008, and February 2014. The future of BSR data resources was reviewed in 2016.

The 2019 Review had the following objectives:

- Assess the current state of the BSR-funded research portfolio and resulting scientific advances
- Provide comprehensive evaluation, constructive feedback, and specific recommendations to NIA on useful scientific directions for BSR focus going forward
- Evaluate ability of BSR to develop the research and training portfolio in recommended directions with current resources and mechanisms

A. The Current BSR Research Portfolio

The Committee members were overall astonished at the breadth and complexity of the BSR portfolio. The topics span the behavioral, psychological, economic, and social sciences, and increasingly incorporate approaches from biology, neuroscience, medicine, and organizational behavior to elucidate the mechanisms affecting health outcomes in the mid-life and older adult population. In addition, the levels of analysis include individuals, families, communities, countries, organizations, and programs and policies. BSR contributes to accomplishing all of the goals laid out in *Aging Well in the 21st Century: Strategic Directions for Research on Aging*. The complexity of the program poses challenges which reflect the complexity of the process of aging in real life settings. BSR also provides significant support for the development of data infrastructure and training for researchers across many fields, as well as strategic investments in emerging scholars and scientists new to aging, and international studies that capture differences in social environments and public policy and their effects on health and wellbeing at older ages.

BSR staff have done an excellent job synthesizing division activities and clarifying the content of the portfolio for the Committee. The overarching view of the Committee is that BSR has excelled in the past 5 years at developing its portfolio to incorporate recommendations from the last review, and to increase emphasis on Alzheimer's disease and Alzheimer's disease-related dementias (AD/ADRD) in its current portfolio. The science has moved markedly in recent years (see Section IV for examples of Advances). BSR staff have been nimble in using a variety of mechanisms to develop new research topics, new research infrastructure, and attracting new researchers in aging. This has included the development of Centers, Networks, training programs, and public-use data for the research community. The major advances and productivity of these mechanisms should be celebrated and continued. Recent years have also seen BSR increasingly work across divisions, across NIH, and with other government agencies. This too should be encouraged and continued.

B. Recommendations for Future Focus

Rather than evaluate the relative value of research in all the areas supported by BSR, the Committee's approach is to recommend increased focus on areas viewed as having scientific importance and potential in the coming years.

1. ***Improve understanding of health disparities in aging.*** The United States spends far more than other countries on health services but ranks 43rd in life expectancy, indicating that the United States now ranks well below countries once thought to be peers.[1] Life expectancy has been declining overall in the last few years with some subgroups having had little improvement in life expectancy for decades. Our poor rankings likely have little to do with a less well-developed understanding of the biology of disease in the United States. Rather, addressing social, structural, and behavioral causes of premature aging is an urgent priority for the country, and social and behavioral research has a central role to play. Long-standing differences between racial/ethnic groups, geographic regions, rural vs. urban residents, education levels, immigrant groups, language-use groups, sex, and gender exist in health. The shocking extent of growing SES and regional differences in mortality and life expectancy, as well as persistent racial inequalities, have been documented, and increasing understanding of the sources and approaches to ameliorating these needs to be a major research focus going forward. BSR should support the exploitation of all available data resources for studying mechanisms of disparities in the aging process and the slowdown in mortality improvement. These data include both nationally representative samples with disparity-group oversamples, cross-national comparative studies, and also smaller, more local samples that are targeted toward disparities questions. The supported research should move forward from merely documenting group differences to research that can shed light on mechanisms operating throughout the life course that can create and prevent

[1] Data reported from the CIA World Factbook available at https://www.cia.gov/library/publications/the-world-factbook/rankorder/2102rank.html; date of information est. 2017 and date of retrieval 11/08/2019.

health disparities and mechanism-based intervention research that aims to reduce these disparities and improve life expectancy. Research should also require inclusion of diverse populations in large enough size and appropriate geographic representation to ensure generalizability of the research. Committee members repeatedly emphasized the need for representation of diverse populations in adequate numbers for statistical power, to study within- and between-group variation, at multiple levels – biological, psychosocial, interpersonal, provider, population, system-wide – and across the life course. Mechanisms of explanation should include social, economic, psychological, behavioral and biological processes across the life span at the individual and interpersonal level, as well as provider-level behaviors that could lead to health-care disparities, and system-level policies that may contribute to health disparities. Support of intervention research that leverages better understanding of mechanisms to improve life expectancy, particularly among members of groups characterized by disparities in life expectancy, well-being, and cognitive function, should be a high priority.

2. ***Study influences of macro-social trends on aging*.** BSR should encourage research to examine the effects on aging of major social shifts including changing family lives of older adults, the rising number of older adults living alone, the rapidly changing nature of work and changing work lives of older adults, growing income inequality, trends in ageism and discrimination, immigration, climate change, and macro-social sources of the worsening mental and physical health and mortality that characterize adults now entering older ages. Cross-national comparisons may prove informative about the causes of macro-social trends.
3. ***Incorporate a range of approaches to understanding behavioral and social aging.*** Research supported by BSR has become truly multidisciplinary while maintaining its focus on the social determinants of health. BSR should continue to encourage research using a life-course approach to behavioral, psychological, economic, and social explanations for health outcomes. This research should also incorporate the geroscience agenda in evaluating the biological mechanisms that slow aging and prevent or delay the onset of disease, and affect physical, social, and cognitive functioning, and mortality. With many health disparities and chronic conditions emerging in midlife, attention to processes of aging during this life stage holds potential for identifying optimal time-points for interventions to reverse or redirect aging processes. It is also important to consider positive aspects of aging, including happiness and well-being, and how people become wiser, more compassionate, and better at regulating emotions with age. Such understanding of the determinants of health should be used to inform policy.
4. ***Enhance research on cognitive aging***. BSR should continue to support research on normal processes of cognitive aging as well as work in dementia and AD/ADRD. This work should be supported in diverse and representative populations. BSR should enhance and expand research on cognitive epidemiology, detection of cognitive and other psychological changes with aging, and where feasible, prevention of cognitive decline. Because cognitive

functioning at older ages is predicted by early life factors, BSR should support a life-course approach to research into cognitive function and AD/ADRD in order to clarify the time in the life course when intervention is most essential to maintaining cognitive functioning at older ages. BSR should support research to identify individual, social, contextual, structural, and organizational factors that can be modified to prevent ADRD and enhance healthy cognitive aging.

5. ***Support research to improve care for persons with dementia and caregivers.*** One of the most important challenges in the coming decades will be to provide care to persons with dementia and support for their caregivers. BSR should continue its existing strong focus on research to design, finance, and deliver better care to persons with dementia and more support for their caregivers. Research that can be translated quickly into recommended approaches for a variety of community settings should be emphasized. More generally, financing of long-term care is a significant unfunded risk for many Americans. Research on service and payment strategies to provide appropriate and high quality long-term care for older Americans, including cross-national and cross-state comparisons, can shed light on how different support structures prevent poor outcomes.
6. ***Study aging earlier in the life course.*** BSR should encourage research that incorporates participants across a range of ages in order to clarify the mechanisms affecting the process of aging and to promote prevention. This can be accomplished through a strategic approach to identifying existing cohorts that began in early life and that contain prospective measurements that bring high value for the study of aging. Attention should be paid to the representativeness and the composition of the population in such studies. Investment in harmonization and adding aging-relevant measures to existing cohort studies of younger populations would be an efficient approach to better understanding the lifecycle process of aging.
7. ***Support research on behavior change in individuals and organizations.*** BSR makes major contributions to the study of behavior change in individuals and has been successful in this area with a well-developed portfolio. It is important that the portfolio increase focus on older adults. A complementary focus on behavior change in organizations that enhance wellbeing of older adults can enhance the strength of BSR's growing portfolio in organizational change by enhancing industrial/organizational research in areas relevant to aging. For example, Medicare payment changes or changes in drug pricing rules may affect both health care providers and aging individuals. Application of research advances in behavior change are central to the design of either individually- or organizationally-focused interventions to reduce premature aging and improve healthy life expectancy. It is important to support research that studies the changes in health care provider behavior overall and in response to changing incentives, policies and market forces.
8. ***Enhance research into technology and aging.*** New and newly applied technologies should benefit everyone, including older adults, and BSR is well-

placed to support research to ensure this. New applications of on-demand delivery and services have immediate relevance. Emerging technology in its myriad forms, including but not limited to artificial intelligence, robotics, bioengineering, internet communications, and self-driving vehicles, provides unprecedented opportunities to enhance the lives of older adults. Technology can also make possible new models of chronic disease management, more effective home-based care, and successful aging-in-place. New technologies are also affecting how research data are collected (e.g., increasing use of computers and smartphones). While these changes hold promise for increasing the amount and type of data collected, it is also necessary to study how use of these technologies affects participation by older adults in data collection. In particular, there may be differential accessibility by different "disadvantaged populations" and by those with cognitive or physical limitations; there may be privacy concerns unique to mode of data collection; there may be new sources of unreliability in self-administered computer or phone assessments; and comparability across modes of data collection is not fully established. BSR should support research to improve the accessibility of technology by older adults and reduce disparities in access to technologies by disadvantaged groups. However, technology also poses risks to older adults, for example, issues of privacy versus safety when technology is used for monitoring older adults. BSR should support research that improves understanding of how older adults interact with new technologies, including research on consumer protection to prevent older adults from becoming targets of fraud through technologies.

9. ***Emphasize multidisciplinary training including policy relevance.*** In addition to expected behavioral, psychological, economic, and social science capabilities, much cutting-edge research in behavioral and social sciences increasingly requires multidisciplinary knowledge (e.g., genetics, bioinformatics, physiology, neuroscience, technology). This recommendation was included in previous reviews of BSR, and was acted upon, but the need continues to grow. For instance, it is important to incorporate training that integrates health policy work that fosters understanding of how to work with stakeholders and collaborators. Supporting the most successful existing training programs and innovating new training supports to address diversity, provide appropriate financial and administrative supports, address strategic science and team-science models, and provide multidisciplinary training to researchers across career stages remains a high priority.
10. ***Reduce barriers to accessing data for research.*** BSR has invested in several long-running surveys of aging populations as a resource that allows investigators at all levels of experience to explore important research questions related to the determinants of aging processes. Making these survey data available to the research community remains a priority. A major advance of these surveys has been adding biology and genomics; the need to improve measurement in these areas continues. Another advance has been enabling linkage to routinely collected external data sources ranging from Medicare and Medicaid utilization

records to information about neighborhoods and local environments. These additions greatly enhance the scientific value of the survey data and should be supported in the future. In general, further availability of administrative data will provide an important source to address several of the areas of future research focus recommended here. Limitations of administrative data should also be studied. The Committee strongly supports BSR's continued efforts to work through the regulatory and privacy issues to establish secure data approaches through which administrative records and other protected data can be readily accessed for research.

II. The BSR 2019 Review Process

The 2019 BSR Review Committee received background material throughout the process to assist in its deliberations, including copies of the previous 2013 review report, memoranda prepared by BSR program staff on salient topics and in response to Committee queries, and summaries of key findings from meeting discussions prepared by Rose Li and Associates, Inc. (RLA). The Committee participated in two in-person meetings (May 20 and September 9, 2019), multiple phone calls during the months of July and August, and email correspondence to complete this report. A listing of the materials provided as supporting documentation for the Committee in advance of each meeting is provided in **Appendix I**. The co-chairs also met with all the NIA division directors on May 21.

The May 20 meeting featured presentations by BSR staff on funding trends, organizational structure, and current challenges, as well as cross-cutting themes such as BSR's role in supporting AD/ADRD research, basic behavioral and social research, interventions and translational research, training and career development, and centers and networks. BSR staff also prepared 15 brief (5-minute) presentations for the Committee's reactions on the following topics and later wrote short memos on them:

- Cognitive Aging
- Behavioral and Population Genetics
- Disability at Older Ages
- Social Networks
- Life-course Research
- Affective Science and Well-being
- Animal Models of Sociality
- Families and Interpersonal Relationships
- Family Demography
- Health and Place
- Insurance
- Work, Workplace, and Health
- Innovations in Measurement
- Cross-national Comparative Research

- Technology Applications

The Committee members' questions and feedback provided BSR staff with guidance for drafting the related short portfolio review memos and about updating the cross-cutting topics memos (Basic Behavioral and Social Research, Interventions and Translational Research, Training and Career Development, Centers and Networks, Disparities), as well as facilitation of emerging recommendations by the Committee.

In order to more deeply explore topic areas for which time constraints prevented further discussion at the May 20 meeting, the co-Chairs organized additional Committee member calls in late July and early August 2019 focused on five research areas. The selection of topics was not intended to indicate these are the only areas of importance for BSR's portfolio, but rather that these are areas that benefitted from further deliberation.

- Pathways and Prevention
- Cognitive Aging
- Modifying individual and organizational behaviors
- Population Aging
- Disparities

Committee members on each 1-hour call were asked to (1) consider BSR's past activity in the topic area; (2) identify the important future directions or questions in the topic area; and (3) assess what is needed for BSR to be well poised to address the identified future priorities and questions in this area. Each call was chaired by one of the Committee co-Chairs who emphasized the need to identify broad, high-level recommendations, and not be constrained in scope when defining priorities for the areas under discussion. Each Committee member was assigned to participate in two calls and invited to all of the calls. One or more BSR staff members joined each call to answer questions as necessary.

Background materials for the calls included the relevant cross-cutting memos prepared for the May 20 Committee meeting and selections of the Short Portfolio Reviews based on the May 20 presentations (**Appendix II**). All these materials proposed future directions representing important, burgeoning areas, or areas needing extra attention. BSR staff posed questions that were meant to guide (but not dictate) discussions.

The materials provided by BSR staff, the May 20th meeting discussion, the discussions on the calls, and the meetings of the co-Chairs with the heads of the other NIA divisions, served as the basis for organizing the recommendations contained in this document which were finalized by the full Committee at its September 9 in-person meeting. From this information, the Committee determined its recommendations (see Sections I. Executive Summary, and V. Committee Findings). The meeting on September 9 also included executive sessions with NIA leadership (Dr. Richard Hodes, Director and Dr. Marie Bernard, Deputy Director) that were closed to BSR staff as a way to encourage full and uninhibited deliberations about any potentially sensitive issues.

Committee members continued to provide input after the September meeting. All Committee members reviewed interim drafts of the Committee report and concurred with the final recommendations contained in this report.

III. BSR Descriptive Background

The initial vision for the NIA was to pursue "…a research program on aging designed to coordinate and promote research into the biological, medical, psychological, social, educational, and economic aspects of aging."[2] NIA has always had a relatively expansive view of what constitutes health, not just the absence of disease but the well-being of aging individuals and populations. BSR is one of the two original divisions of NIA at its inception, with the other combining what is today the divisions of neuroscience, biology, and geriatrics.

BSR supports research and training in the behavioral and social sciences on the processes of aging at individual and population levels. It focuses on how individuals change over the adult life course, on the interrelationships between older people, families, and other social institutions, and on the societal impact of the changing age composition of the population. Research supported by BSR is highly multidisciplinary. Much of it incorporates interactions among social, psychological, economic, physiological, neurobiological, genetic, medical, and environmental influences on health and well-being. BSR is distinguished by the breadth of science covered, reliance on multidisciplinary approaches, multiple levels of analysis (e.g., individual, organizational, interpersonal, family or household, neighborhood, geography), and for its international perspective. It is also highly involved in promoting the development of research resources for use by the entire research community as well as promoting multidisciplinary training to address current and future research foci, and developing a diverse workforce.

BSR operates under the direction of the Division Director, John Haaga (since May 2016; formerly Deputy Director beginning October 2004) and Deputy Director, Dana Plude (effective January 2017). BSR has two branches, with substantial interactions between them: The Individual Behavioral Processes (IBP) Branch is led by Lisbeth Nielsen (since April 2012), and the Population and Social Processes (PSP) Branch is led by John Phillips (since May 2018 and for 3 years in a prior term). IBP sections include behavior change and behavioral interventions, psychological development and integrative sciences, cognitive aging, behavioral genetics, and families and interpersonal processes. Within the PSP Branch, sections are devoted to demography of aging, economics of aging, epidemiology, and health and long-term care systems.

The Office of Research Resources (ORR) facilitates data infrastructure projects in the United States and around the world and is directed by Partha Bhattacharyya. BSR also has a program director for its small business activities, Dr. Plude. Until September 2019, BSR has had 10 staff members who serve as Program Officers for grants and Project Scientists for cooperative

[2] PL93-296, sec 464(a).

agreements. Three more have joined bringing the total staff who can serve as Program Officers to 13.

Since the last review in 2013-14, there has been a steady rise in the number of new and continuing awards managed by BSR staff, from 457 grants and cooperative agreement awards totaling approximately $182.1 million in FY2013 to 761 awards totaling approximately $407.4 million in FY2018.[3] The growth in numbers can be attributed to the growth in AD/ADRD-related grants. AD/ADRD has been readily integrated into existing BSR portfolios instead of creating separate AD/ADRD portfolios managed by program officers dedicated exclusively to dementia work. The integration of AD/ADRD-related work into existing portfolios has helped keep science coherent and has also brought new communities of researchers into dementia-related work supported by BSR.

Since around 2000, BSR awards have constituted roughly 20 percent of the NIA extramural research total. The number of new and renewal applications managed by BSR has grown more slowly than the number of awards. The number of general (not ADRD-focused) applications fell steadily between FY2013 and FY2017, and has increased slightly in FY2018 and FY2019, although not to FY2013 levels. BSR staff have been active in promoting a continued stream of high-quality applications, and encouraging career development, training, and fellowship grants, including diversity fellowship supplements, to ensure a future supply of capable and interested researchers.

By activity code, most BSR competing and continuing funding—approximately $213.3 million in FY2019—supports R01 and similar research grants. About $13.3 million funded P01 program projects and $63.6 million supported cooperative agreement awards. Institutional training grants (Ts), fellowships (Fs), and career development awards (Ks) received roughly $20.1 million in FY2019. The Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) grants managed by BSR received approximately $17.4 million in FY2019.

The three center programs managed by BSR—Centers on the Demography and Economics of Aging, Roybal Centers for Translational Research, and Resource Centers for Minority Aging Research— together received about $27.8 million in FY2019. A major development since the 2013 review is greater use of the R24 activity code to fund interdisciplinary networks that reach across institutions. Ten such research networks were active during FY2019.[4] The center

[3] Data reported in this section are best estimates from IMPAC II data (via QVR and iSearch) downloaded and analyzed on 11/07/2019 by BSR staff.

[4] Advancing Health Disparities Research in Aging: The Aging Research in Criminal Justice & Health Network, Advancing Psychosocial and Biobehavioral Stress Measurement to Understanding Aging, Infrastructure and Core Activities of the Social Science Genetic Association Consortium, Interdisciplinary Network on Rural Population Health and Aging, LINC-AD: Leveraging an Interdisciplinary Consortium to Improve Care and Outcomes for Persons Living with Alzheimer's and Dementia, Network on Life Course Health Dynamics and Disparities in 21st Century America, Network on Measurement of Biological Risk, Research Network for the Harmonized Cognitive Assessment Protocol, Research Network on Decision Neuroscience and Aging, Research Network on the Determinants of Life Course Capabilities and Outcomes.

programs and networks play an important role in fostering new research and career development for young scholars.

BSR is unusual among NIH units in its active use of the National Academies of Sciences, Engineering, and Medicine (NASEM) as a productive resource for scientific input. Historically, these panels and workshops have been used to refine emerging questions in areas of research which provide input to the BSR program. At present, BSR supports two multi-year NASEM panels working on major issues and planning to produce substantial written reports which outline needed future research (dealing with Midlife Mortality and Socioeconomic Disparities and Social and Behavioral Science Research on Alzheimer's Disease and Related Dementias).

IV. Scientific Advances

The committee that reviewed BSR for NACA in 2013 reported its "overwhelming impression…that BSR continues to be successful in moving science forward…in particular the integration of the biological, social, and behavioral sciences in ways that are innovative and illuminating for topics relevant for the NIA." In the last 6 years, BSR has continued supporting research and research training with these hallmarks of innovation and integration and the leaps appear even greater than in the previous 5 years. During the last few years, the larger NIA environment has changed substantially, with a tripling of appropriations, mainly but not entirely for new work on AD/ADRD. BSR has managed both to contribute needed breadth to the Alzheimer's work and to produce new basic and translational research on health and well-being of an aging population.

NIH has adopted for some purposes a new metric called the Relative Citation Ratio (RCR) for tracking productivity.[5] This measure has been criticized on several grounds, especially for publications outside the main biomedical journals; but it can be used to monitor broad trends across a large and changing portfolio. BSR grantees have been publishing work that consistently scores well above the NIH average in recent years—BSR grantee publications have had a mean RCR of 1.8 or higher each year; the average for all NIH-funded publications in a field each year (by design) is 1.0.

Publications by BSR grantees appear in all the top biomedical and general science journals, and all the major journals in the behavioral and social sciences. Following is a selection of some of these important contributions to the science of aging during the recent period. **This list is not meant to be exhaustive, nor are findings listed necessarily deemed more significant than findings not listed. The list here is intended to illustrate the range and quality of the research completed by BSR grantees.** The publications cited here are listed in **Appendix III**.

[5] Hutchins, B. I., Yuan, X., Anderson, J., M., & Santangelo, G. M (2016). Relative citation ratio (RCR): A new metric that uses citation rates to measure influence at the article level. *PLoS Biology*, 14(9): e1002541 https://doi.org/10.1371/journal.pbio.1002541

A. Disparities in Health at Older Ages

Those in the lower half of the socioeconomic distribution in the United States have worse mortality rates at older ages than those in the lower half of the Costa Rican socioeconomic distribution; despite a nearly five-fold difference in per capita incomes the average life expectancy at older ages is no greater for Americans than for Costa Ricans (Rosero-Bixby and Dow, 2016).

The association between income and life expectancy has increased overall, but there are large variations in this gradient even among metropolitan areas in the United States (Chetty et al., 2016).

At a county level, there is increasing geographic inequality in mortality rates for older adults over the period 1980-2014, but not for children and younger adults (Dwyer-Lindgren et al., 2017).

While the advantage of Hispanics over non-Hispanics in life expectancy has widened in the last decade, the age at onset of disability has not improved (Angel, Angel and Hill, 2015).

Midlife mortality rates have risen for white non-Hispanics, caused in large part by increases in deaths due to suicide, poisoning, and alcohol use. Death rates due to these causes have been rising for those with less education in all birth cohorts born after 1945 (Case and Deaton, 2015, 2017).

In international comparisons of mortality at older ages, the poor performance of the United States is largely explained by the earlier onset and greater severity of the obesity epidemic in this country (Preston, Vierboom and Stokes, 2018).

Medicare Advantage plans succeeded in reducing differences between black and white enrollees in the proportion receiving recommended screenings (testing of LDL cholesterol and glycated hemoglobin) in recent years, and Hispanic enrollees are now at an advantage relative to white non-Hispanics. But despite improvements for all groups, racial gaps remain in the successful *control* of cholesterol levels, glycated hemoglobin, and blood pressure. In the Western region, the racial gap has been eliminated while all groups improved, likely due to successful e-mail outreach by the dominant health system (Ayanian et al, 2014).

B. Early and Midlife Risk and Resilience Factors Affecting Late Life Health

Social isolation and loneliness are independent risk factors for all-cause mortality at older ages (Steptoe et al., 2013).

Social support in midlife provides a buffer against the effects of early childhood abuse on late life mortality risk (Chiang et al., 2018).

Higher levels of personal mastery in midlife buffer the effects of traumatic events throughout life on mortality risks (Elliott et al., 2018).

Eleven proposed biological mechanisms that have been shown to be related to lifespan are only weakly related to each other and to healthspan measures (Belsky et al., 2018).

Negative affective responses to daily stressors in midlife were associated with increased risk of chronic conditions and functional limitations 10 years later (Leger et al., 2018).

The association of older age with increased sense of well-being (especially evaluative well-being) found in high-income English-speaking countries is not universal – in the former Soviet and communist countries evaluative wellbeing is low for the elderly (Steptoe, Deaton and Stone, 2015).

Those at greatest genetic risk for obesity benefited most from additional years of education in terms of improvements in body size and lung function. This research took advantage of a natural experiment created by changes in mandatory schooling in England and Wales (Barcellos et al., 2018).

Sustained enjoyment of life as an adult is associated with lower risk of mortality (Zaninotto et al., 2016), as is optimism (Lee et al., 2019).

C. Normal Cognitive Aging and Pathways to Cognitive Impairment and Dementia

In recent decades, the prevalence of dementia has declined overall among older Americans (Langa et al., 2017). The expected number of years of life remaining at age 65 lived without cognitive impairment or dementia has increased, especially for those with higher levels of education (Crimmins et al., 2018).

The “compression of cognitive morbidity” at older ages is most strongly associated with the increased educational attainment of successive birth cohorts reaching old age (Leggett et al., 2019). The higher prevalence of dementia among rural Americans appears to be explained by lower levels of education (Weden et al., 2018).

Self-reported physical activity in midlife was associated with less cognitive decline and incident dementia at older ages (Palta et al., 2019), while self-reported diet quality in midlife was not significantly associated with late-life cognitive outcomes (Akbaraly et al., 2019).

Note that an NIA-commissioned review by AHRQ and the NASEM of the evidence on prevention of cognitive impairment and dementia called the evidence for physical activity and cognitive training was “encouraging but not conclusive” (Downey et al., eds., 2017). Research goes on; BSR is currently managing 32 trials of “non-pharmacological interventions” to evaluate the feasibility and efficacy of preventing cognitive decline and dementia.

D. Dementia Care and Caregiver Support

Family caregivers experience particularly difficult strains as persons with dementia near the end of life (Vick et al., 2019).

Caregiving networks for older adults with dementia are larger than those for disabled elderly without dementia and include more "generalists" sharing tasks; future training programs for dementia care may need to take account of task-sharing and change over time in caregiving networks (Spillman et al., 2019).

Despite guidelines discouraging use of mechanical ventilation and intensive care for patients with advanced dementia, and despite evidence that their use does not increase survival time, their use has doubled for nursing home residents admitted to hospitals in recent decades (Teno et al., 2016).

A video decision support tool for advance care planning used in nursing homes for residents with advanced dementia improved alignment between care decisions and goals of care, and increased the number of do-not-hospitalize and no-feeding-tube instructions for those preferring comfort care, though it did not affect all types of advance care directives (Mitchell et al., 2018).

E. Interventions to Improve Health and Functioning

Expansion of Medicaid coverage to near-poor adults produced a mixed set of results, with fewer depressive symptoms reported, fewer financial problems reported, and more preventive services used, but no fewer emergency room visits or improved health after two years. The research used a lottery-based waiting list design (Baicker et al., 2013, Taubman et al. 2014).

A home-visit intervention that elicited personal goals, identified risks in the home, and provided home improvements for low-income Baltimore residents, reduced disability for those in the treatment group by 30 percent relative to a comparison group – though both groups improved notably (Szanton et al., 2019).

Low-cost, noncoercive behavioral interventions ("nudges") directed at primary care physicians reduced inappropriate antibiotic prescriptions by 11 percentage points in a randomized controlled trial (RCT) in two metro areas, reducing the rate by half (Meeker et al., 2016). A series of interventions to increase physical activity showed an increase of meeting step goals of about 50 percent using loss-framed financial incentives (Patel et al., 2016).

A community cohort intervention for low-income older people at high risk of disability did not lead to differences between treatment and attentional control groups in loneliness or interest in life (Johnson et al., 2018).

V. Committee Findings

The overarching view of the Committee is that BSR has done a remarkable job in the past 5 years managing the breadth and complexity of science under its purview, including incorporating increased emphasis on AD/ADRD, working collaboratively across divisions, NIH Institutes, and government agencies, and demonstrating agility in the use of a variety of mechanisms to develop new research topics, new research infrastructure, and new researchers in aging. The Committee identified a number of topic areas (discussed below) meriting emphasis going forward because of their scientific importance and potential for productive research in the coming years.

Prior to listing these topics, we comment on two areas for focus that apply to all the research areas that follow.

Diversity and Disparities. Across the study topics, Committee members repeatedly emphasized the need for representation of diverse populations in adequate numbers for statistical power, to study within- and between-group variation, at multiple levels – biological, psychosocial, interpersonal, provider, population, system-wide – and across the life course. There is increasing complexity in understanding the mechanisms underlying disparities. Some disparities emerge from factors beginning in early life, and result from intergenerational transmission of disadvantage. In addition, recent trends in geographical differences in mortality and other health outcomes increase the need to examine geographic diversity in designing data collection systems. Differences in provider behavior, and differential access to quality of care are important inputs into understanding geographic differences as well as offering a potential focus for intervention.

Larger numbers are particularly needed to fill the diversity gap in types of research that historically have had difficulty providing reliable findings about disadvantaged groups, such as genetics research, biomarker research, and intervention research. Pervasive problems include lack of trust and lack of equitable community partnerships, discrimination, language incompatibility, and other obstacles to participating in research that are encountered by diverse or disadvantaged populations. As an example, lack of researcher knowledge about cultural differences in dementia care and recruitment strategies for different communities are contributors to caregiver research that over-represents the white and well-educated. There is a real need to develop and test scalable interventions that can help improve life expectancy, health and well-being among Americans, particularly those who are doing relatively poorly. Disparities are also seen in technology developers, technology access, technology uptake, and in the results of how new technologies are applied to the population.

Scientific Rigor. The Committee also underscored the need for scientific rigor among BSR-funded researchers, particularly in the areas of cognition, mechanisms of aging, disparities, and individual and organizational behavior change. This rigor includes addressing issues of study design, sample construction, measurement reliability, reproducibility, replication, and causal inference. BSR should continue to foster research innovations in recruitment, measurement,

study design, and analysis, tied to formal evaluation of rigor, reliability, and validity of such innovations. This includes approaches for evidence triangulation that make use of the complementary strengths of alternative data sources. BSR should also continue its support for networks and conferences like those of the Open Science Initiative and the Berkeley Initiative on Transparency in the Social Sciences.

A. Health Disparities

One of the most shocking trends in health in America has been the lack of improvement in life expectancy in recent years; another is the growing socioeconomic and geographic inequality. Parts of the country and some subgroups of the population have had very little health improvement for decades. At the same time, long-term disparities in life expectancy between African Americans and the rest of the population, though still marked, have been reduced. BSR is well-placed to continue to support research to understand health disparities and research to ameliorate the impact on aging of disadvantaged position in society. A successful BSR portfolio should reflect the social determinants of health, to improve care of older adults, and inform policy. Exploration of select causes of disparities should include stigma, bias, discrimination, racism, and inequity. It should include both individual-level factors and structural factors which vary across geographic areas and relate to health care availability and delivery.

For a number of BSR studies, studying aging diversity requires having representative samples for analysis. In recent years it has become harder to recruit and retain study samples. It is imperative for maintaining the value of population samples that representative samples with high participation rates be maintained. It is important to prioritize funding to improve the diversity of participants in funded clinical research, in order to ensure the generalizability of the findings and to engage all communities in aging and BSR research. The NIH is mandated by the U.S. Congress under the NIH Revitalization Act of 1993, Public Law 103-43, Section 492B(2)(f), to report on the inclusion of women and minorities in all NIH-funded clinical research studies. There is a critical need to revamp the NIH-mandated Inclusion Enrollment Form to reflect more meaningfully the data about real time cumulative enrollment in clinical studies, and to embed accountability for recruitment of diverse participants into regular grant monitoring.

BSR should continue its inclusive approach to the definition of disparities, including groups with lower education, differently-abled individuals, rural non-metropolitan residence, low income, or technology-displaced workers. Alternatively, BSR may include groups sorted by sex and gender, racial/ethnic and cultural affiliation, language use, immigrant status, or generation. Unhealthy aging is often more prevalent in these groups, yet, historically many studies of health and aging have generated findings that are most relevant for educated, English-speaking, US-born, urban, and majority racial/ethnic groups.

BSR should support the exploitation of all available data resources for studying disparities, including population based studies using census and other administrative records, nationally representative samples with disparity-group oversamples, cross-national studies, and also smaller, more local samples that are targeted toward disparities questions. The supported

research should move forward from merely documenting group differences to research that is adequately powered to, and designed to, shed light on mechanisms creating and preventing health disparities. Because disparities may arise from conditions early in life, it is essential to study early- and late-life social forces to support designing approaches to prevention.

BSR should encourage work on sex and gender differences in the aging process, and intersection of these differences with other social determinants of health. These differences, aside from descriptive differences in morbidity and mortality, have not been a strong focus of mechanistic research in recent years.

There is a need to acknowledge the challenges inherent in disparities research, and support research on approaches to enrolling and retaining samples of participants who represent disadvantaged groups, as well as approaches to engaging systems that serve disadvantaged groups but may be under-prepared to take part as collaborative partners. For instance, there are serious problems obtaining (and retaining) diverse participants for clinical trials and empirical studies of AD/ADRD patients and caregivers. There are also issues arising from the sources of care available to minority group members in some geographic areas. Rural or poor hospitals and other providers serve a disproportionate share of minority and rural patients; these facilities often have insufficient experience to serve as a site for conducting rigorous, protocol driven research.

An important priority is to support mechanism-based intervention research that is designed to reduce disparities. Such research will need to pay particular attention to the representativeness of the groups involved to clearly incorporate the targeted disparities. A “virtuous cycle” should create the expectation that this research be used as a way to further refine our understanding of the underlying mechanisms.

B. Population Aging

BSR should support research that examines the effects on aging of now-occurring major social shifts. Such shifts include the changing composition of families and changing quality of family life for older adults, the rising number of older adults living alone, the rapidly changing nature of work and changing work lives of older adults, growing inequality in income and wealth, trends in ageism and discrimination, climate change, and macro-social sources of the worsening mental and physical health and mortality characterizing groups now entering older adulthood.

BSR is widely recognized for its data-infrastructure investments in longitudinal cohort studies in the United States and internationally. These studies have been the source for descriptions of trends in health and mortality, insights into the mechanisms promoting and retarding the process of aging, and research into the causes and consequences of population aging. BSR should continue to support panel studies of population aging in the United States and abroad with representative samples and high rates of participation. This research has helped us to understand reasons for disparities in health in the US population; we must transcend this to develop and test scalable interventions that help us improve life expectancy and well-being among Americans, particularly those who are doing relatively poorly.

BSR should continue its very successful focus on integrating social, behavioral (including psychological, gait, sensory, functional), economic, and biological data, including genetic and genomic data, and additional indicators of cellular and molecular mechanisms of aging into these studies. BSR needs to continue to monitor that its population studies have sufficient power to study disadvantaged groups.

Some of the important health disparities to emerge in recent years reinforce the need to link macro and administrative data with micro data in order to understand the mechanisms affecting population health. Large national samples may prove inadequate to capture adverse aging experiences in some sub-populations which may require special study. Developing a methodology to move back and forth between data that has limited depth but great coverage and micro-data that has more detail is an essential skill that needs to be developed and exploited.

BSR should continue to support population studies and protect BSR's investments in them, by prioritizing research to develop new, more effective, technologies for recruiting participants to ensure samples are population-representative, data collection, and data-linkage to administrative data registers.

BSR should continue investment in its remarkably successful set of centers and networks focused on population aging issues.

One of the continuing trends in population studies is the difficulty of maintaining high sample response rates which are essential for representative data. Response rates include initial recruitment of participants into a research sample, but also retention of participants long-term over successive waves of a longitudinal study. New focus needs to be placed on encouraging participation so that participation rates return to higher levels. This may mean reconsidering techniques and rewards for participation; reconsidering the burden of response; and reconsidering the return of data to participants. Research on trial solutions to address falling response rates is warranted.

C. Mechanisms of Aging

BSR research has made significant strides in determining mechanisms of aging in recent years. Incorporation of biological measurement in large data sets, including genetic and epigenetic information has helped to clarify the roles of social, economic, behavioral, and biological factors in the aging process. BSR should continue to support the development of data that enable more mechanisms to be examined.

BSR should also continue to encourage research using a life-course approach to behavioral, psychological, economic, and social explanations for health outcomes. This research should incorporate the geroscience agenda in evaluating mechanisms at all of these levels of analysis for slowing aging and delaying the onset of disease, declines in physical and cognitive functioning, and mortality. Prevention and intervention require understanding the independent effects of all mechanisms affecting the aging process.

Aging is a lifelong process, providing opportunities for prevention in advance of late-life disease onset, and for improving individuals' preparedness for post-retirement life. BSR is well-placed to promote increased emphasis on prevention through a continued emphasis on a life course approach to the pathways to healthy aging and disease prevention, particularly in disparities populations that are bearing a heavier burden of adverse health with aging. As risks to healthy aging are increasingly identified at earlier ages, BSR should support research to identify the benefits and risks of early detection (e.g., false positive screens) and identify best practices for informing research participants of risk and returns of other research results (e.g., blood pressure, cognitive test scores, MRI, actigraphy).

BSR should encourage inclusive research that incorporates participants across a range of ages in order to clarify the mechanisms affecting the process of aging. This can be accomplished through a strategic approach to identifying existing cohorts that have been observed beginning in early life and contain prospective measurements that bring high value for the study of aging. Investment in harmonizing and enhancing these cohorts' measurement of aging-relevant indicators would be an efficient approach to better understanding the lifecycle process of aging. Prospective basic studies beginning in early life can identify opportunities for prevention, and through applied intervention studies be designed to mitigate or reverse risks by midlife. Both men and women should be included; disadvantaged groups should be represented in life-course research, and studies of emerging disparities encouraged.

BSR should encourage joint work with the Division of Aging Biology (DAB) and NIA's other divisions in order to support animal-model life-course research that takes advantage of shorter animal lifespans but addresses hypotheses derived from the human lifespan and human social context. Increased collaboration with other divisions is also important in ensuring that sex differences are adequately included in NIA research in order to address some of the lack of understanding about the mechanisms related to sex differences.

Mechanisms of aging can be further teased out with more attention to samples of siblings and twins. BSR should consider enriching population data resources with additional samples of siblings and twins.

Training and capacity building are needed in this area. Incorporating the geroscience agenda as well as new measurement approaches to diagnosis of AD requires skills in new fields. Use of large -omics data is increasingly a part of this approach and requires new bioinformatics skills as well as analytic approaches. Training that emphasizes quantitative skills in longitudinal data analysis should continue. Training should give trainees skills across multiple disciplines, skills in causal inference, and translation of findings from basic life-course research to behavior-modifying intervention research. Training is also needed to generate a pipeline of researchers with diverse backgrounds and skills to design longitudinal studies, collect data, otherwise generate and sustain life-course data resources for the future, and optimize use of extant data resources.

D. Cognitive Aging and AD/ADRD-related Research

Research in the area of cognition was not a focus of the 2013-14 review, though the study of normal cognitive aging has long been a cornerstone of the BSR portfolio. BSR has also long integrated important approaches from affective, social and decision neuroscience and other areas of psychological science into its portfolio on cognitive aging. This integration of normal cognition and emotional, motor, social, language, and other behavioral changes (e.g., self-awareness) is important to retain as research suggests that these aspects of AD/ADRD may account for the greatest challenges and burdens for caregivers.

The growth in projects on AD/ADRD was not foreseen at the time of the last review. Nevertheless, BSR was well-situated to undertake growth in AD/ADRD. In order to address AD health disparities, BSR should ensure that disadvantaged populations are well represented in research on cognitive aging and AD/ADRD, as well as research on dementia care and caregiving, in numbers sufficient to study sources of variation within groups over time and across the life course.

BSR has made significant investments in collecting large data sets with longitudinal cognitive testing for both the United States and for other countries. It has supported extensive harmonization of data both across countries and within the United States, and it has supported training activities. BSR has also managed the expansion of Center programs to include centers focusing on research on cognitive decline and dementia. This infrastructure has been one reason BSR was able to effectively increase its portfolio on AD/ADRD by integrating much of this work into existing portfolios, including the cognitive aging portfolio, but also portfolios in population sciences, psychological development, and behavior change. At this point BSR plays a central role in supporting research that addresses the aims of the National Plan to Address Alzheimer's disease and Alzheimer's related dementias.

BSR should continue to support research on normal processes of cognitive aging and age-related psychological change as well as AD related work among diverse populations. BSR has a long history of supporting work in normal cognitive aging, and most older adults have normal cognition. Integration of work on normal cognitive aging with research on AD/ADRD will inform both areas, as long as the design of these samples includes sufficient representation from subgroups who are at higher risk for cognitive decline and AD/ADRD. BSR should enhance and expand research on cognitive epidemiology, detection of cognitive changes through new approaches, and prevention of cognitive decline. In this BSR should support a life-course approach to research into cognitive function and AD/ADRD in order to clarify when in the life course interventions could be attempted and what mechanisms are most essential to maintaining cognitive functioning at older ages. Research should identify which individual, social, structural, and organizational factors can be modified to prevent AD/ADRD and enhance healthy cognitive aging.

A range of behavioral, psychological, sensory, physical, and social changes are symptoms of cognitive decline that emerge early in AD and these are the changes that have very high importance for patients and families. BSR should continue to encourage research that links

behavioral, psychological, and social change with additional approaches to early detection of AD/ADRD such as scans and blood tests in its supported research and its large population data infrastructure development. BSR should also encourage research that integrates cognitive with non-cognitive motivational and emotional aspects of both normal and abnormal age-related changes in psychological and brain function, as well as with other aspects of mental health. This can be supported by integration of research on cognitive aging with approaches from affective, social and decision neuroscience and other areas of psychological science.

BSR should also support development of novel cognitive measurement technologies to accelerate discoveries about changes in normal cognitive function, mild cognitive impairment, and AD/ADRD. Some of these technologies may provide both unobtrusive and efficient measurement of cognitive ability and other functional or psychological changes. Measurement of cognitive function is an important area of focus particularly measurement that clarifies the importance of cross-sectional differences in cognitive ability, rates of change in cognitive ability, and rates of dementia.

BSR should continue its investments in theoretically-motivated uni- and multi-modal interventions to target behavioral and social processes, as well as their combination, to prevent, delay or remediate age-related cognitive decline and dementia, with special emphasis of development of relevant interventions for disparities populations. Research that elucidates and intervenes upon the causal pathways that account for links between education, socioeconomic position, race/ethnicity, immigration status, personality, health behaviors, social engagement, complex work, and other social and behavioral factors can lay the groundwork for a robust AD prevention agenda.

Outside of the cognitive aging portfolio, BSR also invests heavily in AD/ADRD research on care and services. One of the most important challenges in the coming decades will be to provide care to persons with dementia and support for their caregivers, especially in disparities populations. BSR should continue its existing strong focus on research to design, finance, and deliver better care and supports to persons with dementia and their caregivers. BSR should also support research to examine the benefits and risks to patients and families of early detection of cognitive decline and AD/ADRD and identify best practices. BSR should support implementation to scale, testing the value of embedding such interventions within functioning health care systems to translate care interventions from the domain of researcher-implemented to health care system implemented.

Training and capacity building are needed in this area to fill the skills gap needed to meet the aims of the national AD/ADRD plan, encouraging national goals for improved knowledge and skills, from pre-doc level to senior scientists transitioning to AD/ADRD research.

E. Modifying Individual Behaviors

A large proportion of the burden of disease is attributable to behavioral and social causes, which makes modifying individual behavior a high priority. Modifying individual behaviors associated with positive and negative health outcomes in later life can result in improvement in

health without additional scientific advances in understanding health. Understanding how to encourage changes in individual behavior is a science in and of itself. Individuals are embedded in family, community, and care-provider network contexts that can help or hinder behavior change. BSR has made impressive contributions to the study of behavior change in individuals. BSR should continue investment in the remarkably successful centers and networks that support research on behavior change. However, understanding individual behavior often requires understanding the impact of policies and market forces on behavior and more emphasis should be put on integrating these factors into studies of individual behavior change. In the area of AD/ADRD, BSR should continue to support research into mechanisms of behavior change identified as encouraging reduction in these conditions (e.g. cognitive training, blood pressure management, physical activity) and in need of further research (e.g., depression treatment, dietary interventions, sleep quality, education, stress reduction, interpersonal support, occupational and social engagement). There could be more focus on behavior-change interventions focused on older adults and behavioral issues specific to them (e.g. post-retirement activity, social isolation, mobility).

BSR should continue to support foundational research to develop effective methods of recruiting diverse, representative trial participants and to develop reliable and valid measures of outcomes and mechanisms of change. In order to enhance a focus on prevention in the behavior-change field, it may be useful to involve younger participants in basic research and clinical trials. Because incentives and approaches to behavior change may be viewed differently by age groups or cultural groups, research that clarifies how different individuals and groups respond to incentives or intervention models is imperative. These approaches are more likely to succeed when undertaken in collaboration with diverse communities.

Moving forward, BSR should increase its efforts to ensure that all behavior-change studies are adequately powered to test for subgroup differences and inclusive of diverse populations to ensure internal and external validity. In order to increase the potential for implementation and successful dissemination, BSR should encourage effectiveness analyses as part of the initial development of behavior-change trials. BSR should support research within the NIH (six) Stage Model, with a focus on careful testing of mechanism-driven interventions in small-scale pilots before consideration is given to funding larger-scale interventions. Larger trials (such as Stage IV pragmatic trials to test interventions in the community) may also benefit from incorporating a focus on mediators (mechanisms), and moderators to help identify how the intervention works and for whom, helping to identify heterogeneous subgroup effects. In addition, NIA should support careful consideration of the settings in which interventions are tested, with an eye towards leveraging capabilities of organizations with access to populations, a communications infrastructure for reaching them, and the potential for scaled implementation.

F. Organizational Change

BSR has made major contributions to the science of behavior change in individuals and has been highly successful in this area with a well-developed portfolio. A complementary focus on behavior change in organizations that influence the quality of life of older adults can enhance the strength of BSR's growing portfolio in organizational change. This work should include

better understanding of organizations providing multiple types of care and support to older adults and it should include evaluating the impact of policies or market forces on both organizational and individual change. For example, how do Medicare payment changes or Medicaid expansion affect provider behavior and individual behavior? Or how might changes in drug pricing rules affect both health care providers and aging individuals?

In order to understand how to modify organizational behavior change to improve outcomes of older adults and how policy and market changes might modify organizational behavior, BSR should support research on the effects of modifying behaviors at all levels of organizations, from the behaviors of health-care providers, to businesses and organizations who affect the lives of middle-aged and older adults, to broader policy making. Payment models and insurance structures can provide strong financial incentives to change behavior for firms, providers, and individuals, and other non-financial strategies to influence behavior can also be hugely impactful in increasing the efficiency of organizations in improving health. Environments in which people live and work have a major impact on health behavior and health outcomes and better understanding that elucidates that and figures out how to create synergy would be important. Some of this research could make use of naturally occurring experiments in organizational change.

The workplace is an important source of exposure to social, physical, and economic stress. BSR should encourage research that focuses on the workplace, as an organizational setting likely to experience marked change over the coming years, and a setting that provides most adults with potential behavior-change initiatives, including those focused on midlife prevention. This research should include research into effective (re-)training for older adult workers, to meet the needs of an aging workforce that is encountering rapid change in the structure of jobs and skill needs. Interventions aimed at organizational change and workplace redesign and labor policies may reduce employee risks and improve health outcomes. Some evidence suggests this may be especially true for middle aged and older workers and those in more disadvantaged situations.

One in five prime-aged Americans, aged 25-54, and one in three Americans aged 55 to 64 are not participating in the labor force, so that working longer is not a likely outcome for large segments of the population. A life course perspective would help us better understand the relationship between health and employment and may suggest which experiences are important in working longer and achieving a healthy old age. RCTs, evaluation of natural experiments, and analysis of observational longitudinal data should all be considered.

Another aspect is understanding more about health care providers and systems that have to change to accommodate the needs of increasingly older populations. New forms of interventions can make a useful link between organizational theory and implementation science. In light of NIA's investment in embedded pragmatic trials, BSR is positioned to learn about organizational change.

Work on organizational behavior should encourage effectiveness analyses as part of the initial development of organizational behavior-change trials, to increase potential for implementation and successful dissemination.

G. Technology and Aging

BSR has made inroads in technology related research but could do more to inject the energy of the technology world into its portfolios. Novel approaches are needed to attract behavioral and social researchers to the emerging field of technology and aging, and to support development of specialized skill, training, and capacity building. Technology has untapped potential for prevention research, for improving the efficiency of management of chronic disease, and for research modifying individual and organizational behaviors to improve aging outcomes which should be encouraged by BSR. Technology integration in behavioral and social aging research was a topic raised repeatedly during Committee discussions. Technology is a complex, wide-ranging, and swiftly moving area that poses challenges for researchers as well as research administrators. Yet, new technology should benefit everyone, including older adults, and BSR is well-placed to support research to ensure this.

Technology in its myriad forms, including artificial intelligence, robotics, bioengineering, internet communications, self-driving vehicles, virtual reality, and more, provides unprecedented opportunities to enhance the lives of older adults, but technology also poses some risks to older adults, especially with diverse linguistic and cognitive backgrounds. For example, issues of privacy arise when technologies are used to monitor older adults. In order to improve the well-being of older adults, BSR should support research to improve the accessibility and usability of technology by older adults with diverse linguistic, educational, and cultural backgrounds, and research that improves understanding of how older adults interact with new technologies, incorporating sensory, cognitive, motivational, physical, and emotional factors. Research that focuses on the shift in care towards home and that creates new possibilities for more efficiently managing chronic diseases using remote sensors and monitoring devices should be explored. The use of technology holds promise for ensuring the fidelity and scalability of interventions to support healthy aging in diverse populations.

Technology in many ways also drives the process of how research can be done and what can be done, and who can participate in research. Technology makers have limited insight into linguistic, cultural, and educational differences that lead to disparities in technology access, technology uptake, and application of technologies to the science of aging. BSR should consider the support of platforms that bring together innovation in technology and behavior change interventions to create scale economies for researchers. BSR should also support research to develop tools that researchers in the aging field can benefit from including the artificial intelligence (AI) and machine learning (ML) revolutions. This revolution is generating enormous amounts of data and applications; researchers in aging should be supported to use these resources effectively.

The well-being of older adults is being threatened by abusive internet, mail, and telephone fraud. BSR should support integrative research on age-related changes in decision-making and on the theme of consumer-protection where older adults are the targeted victims. This includes protection against misleading information on the internet touting unsubstantiated preventions or cures for AD/ADRD and other conditions. Consumer-protection is likely to find solutions in technology.

H. Training

The Committee recognizes the importance of training scientists to become the leaders in future BSR-supported research. Unlike past generations, today's researchers need more skills in a broader array of fields (e.g., bioinformatics, genetics, epigenetics, neuroscience, inflammatory mechanisms, immunology, physiology, AD/ADRD, statistics, technology, and clinical research design). In some areas of psychology and behavioral science, allied training in neuroscience, physiology, immunology, and endocrinology is increasingly common. However, there is typically little contact between behavioral science and population science, and little training in the use of large datasets for tackling questions that have typically been studied in convenience samples. At the doctoral level, there is not enough significant multidisciplinary training. This means that postdoctoral training has become much more important in providing training in current multidisciplinary research topics. However, postdoctoral training is, in general, less systematic and routinized than predoctoral training. Much of the cutting-edge research in BSR requires multidisciplinary knowledge which requires new methods and mechanisms of training. BSR has contributed to national-level modular training with support of programs in genetics, cognitive analysis, and summer institutes. New approaches, more topics, and new formats should be investigated.

Needs differ among the multidisciplinary researchers potentially supported by BSR. Training that emphasizes quantitative skills in longitudinal data analysis should continue. Training should give trainees skills across multiple disciplines, causal inference, and translation of findings from basic life-course research to behavior-modifying intervention research. Training is also needed to generate a pipeline of researchers with diverse backgrounds and skills to design longitudinal studies, collect data, and otherwise generate and sustain life-course data resources for the future.

The approach to supporting predoctoral training may also need to be reevaluated, as the cost/benefit of training programs for universities has changed. It is essential to continue to develop this pipeline, but the mechanisms need reevaluation. In particular, funding levels need to be re-evaluated to cover the full costs of predoctoral training (e.g., fees and tuition) and support provided for critical administrative staffing.

The BSR-funded Resource Centers for Minority Aging Research (RCMAR) as well as the use of diversity supplements have offered opportunities for promoting diversity in the workforce among BSR grantees. However, BSR grantees and the reviewers of BSR applications still lack diversity. New approaches are needed to encourage greater population representativeness among these groups, and to promote diversity across the workforce. BSR should seize this time of accelerated funding to train the next generation of researchers, focusing on diversity of trainees by gender, race/ethnicity, socio-economic status, and scientific discipline. BSR should build support team programs to proactively invite and guide young investigators, especially from underrepresented populations, into leadership positions.

I. Data Resources

BSR undertook a comprehensive review of data infrastructure needs in 2015-2016.[6] The Committee's deliberations reinforced the recommendations in this earlier report and did not contradict any of the recommendations. The Committee particularly reinforced the need for BSR infrastructure to continue to evolve and develop in line with scientific focus and technical capability, aiming for efficiency, cost-savings, and "democratization" of widespread access to data resources for researchers working in aging. This is true for work in the AD area as well as other health-related outcomes.

There are potential efficiencies in creating shared data resources across governmental agencies. The current approach to having each investigative team try to assemble these datasets on their own is inefficient, costly, and may deter research teams from undertaking this effort. Skills and experience gained in data linkage, the development of algorithms and synthetic data resources by one group of investigators with NIA grant resources should be shared with others. This resource sharing would be greatly facilitated if BSR supports access to secure, accessible, and well-documented data for a wider array of investigators and projects to enable research.

BSR should continue to prioritize data linkages between national surveys and administrative data such as Medicare/Medicaid data, payer data bases, and the National Death Index (NDI). Centers for Medicare and Medicaid (CMS) and NDI data linkages have great potential for research to improve population health. But the processes for data linkage and requirements imposed on analysts have been a deterrent to effective use. The reduced access to NDI information has been a serious impediment to some kinds of work as has been the onerousness process of establishing Data Use Agreements (DUAs) for use of Medicare data. Use of the Medicare data for research has been limited because of financial as well as security issues. BSR should develop and implement new models for gaining access to these and other data sets of importance to the user community as soon as possible. NIA should continue to work with CMS and NCHS, in collaboration with other NIH institutes and HHS agencies, to ensure broad and timely access to data while maintaining safeguards for confidentiality.

While linking of individuals to additional administrative records is recommended, the Committee recognized that data linkages do not fully meet the need to capture lifespan circumstances for an older population, suggesting cohorts and administrative data are complementary and add value to each other.

The Committee underscored the expectation that the data sharing policies developed by NIA and BSR should be enforced and that BSR should consider exploring opportunities for greater efficiencies in data sharing and to find ways to increase the democratization of data access.

[6] The *2016 BSR Data Infrastructure Review Final Report* (rev. 11/29/2016) was shared with the current Committee members, available at: https://www.nia.nih.gov/research/dbsr/2016-data-infrastructure-review-report

Several new issues vis a vis data were raised by this Committee. Some of these had to do with understanding diversity and disparities in health. Samples need to be appropriately sized to allow analysis within as well as between groups. Sample size is particularly a concern for research addressing the intersectionality of subgroup characteristics; while not all data resources can support all planned studies, BSR should work to ensure that the portfolio does include data resources for studies of intersectionality.

While BSR work has for many years emphasized the high value of representative samples, the value of this approach should be demonstrated with comparisons between findings from population-representative samples and volunteer samples such as the UK Biobank and All of Us. The approaches to big data developed by social media giants also may offer tools to BSR researchers.

J. BSR's Collaborations

BSR maintains an impressive number of connections to research initiatives in other NIH Institutes and Centers (ICs), NIA Divisions, and other government agencies. The scientific climate has increasingly brought about opportunities for collaboration across Divisions and BSR has taken advantage of this opportunity and should be encouraged to increase cooperation in the future as the science warrants. Given that many of the topics are cross-cutting across the Divisions, there are many opportunities for BSR to influence the work in other divisions and agencies, and vice versa. BSR has had a particularly productive partnership with the Social Security Administration (SSA) that should continue to be supported. BSR contributions to wider NIH efforts are also notable, especially but not limited to Common Fund programs such as Science of Behavior Change. NIA should continue to devote resources strategically to such efforts, and to build bridges to important initiatives (e.g. All of Us) where behavioral and social research have something important to contribute. BSR is encouraged to continue strategic and systematic collaborations across Divisions, as well as with outside partners, as appropriate. This includes other NIH ICs and Federal agencies.

The use of NASEM by BSR to provide expertise from the research community has been particularly productive. This has been useful in directing research to national issues of increasing health disparities, to clarifying valuable future focus in the sociology, economics and demography of aging, and in multiple areas related to AD including defining risk, elucidating causal pathways, and developing research on caregiving.

Some members of the Committee felt that BSR might evaluate potential for interaction with industry, other members advised this be considered as an experiment to fully explore pros and cons. There are significant shared interests between industry, the government, and academia in developing and testing ways to prevent premature aging and increase wellbeing among middle-aged Americans. Industry perspectives could help inform the research agenda by broadening the perspective on the types of research that are applicable to improving the health of the US population. Partnerships with commercial entities might provide a source of new funding to leverage shared interests in training or in research. Concepts could be developed that target shared interests, access to otherwise unavailable data, and opportunities to test interventions

in settings with access to large populations, a communications infrastructure for reaching them, and where they could potentially be scaled. In addition, for some kinds of research, it could be useful to encourage stakeholder/community involvement early in research planning to increase policymaker buy-in to research findings. BSR should horizon-scan for such potential opportunities, while remaining alert to its role as a funder of independent, impartial, and objective science

K. Staffing

BSR is commended for its ability to remain nimble in absorbing new areas of science despite constraints on hiring and growing demands (e.g., monitoring clinical trials, data sharing). BSR staff have managed to handle the increased scope of their work in recent years, but growing size and complexity of portfolios, the increased prominence of interdisciplinary research, and the increased emphasis on interventions will require a continued emphasis on recruiting, training, and retaining staff with the appropriate skills. The workload has grown since 2013 but the number of full-time staff has not kept pace. In 2013, BSR had eight professional staff members who served as Program Officers for 457 grants and cooperative agreements; in FY2018, BSR had ten Program Officers to manage 699 awards. Three new professional staff members started work in August and September 2019. New staff responsibilities in recent years have included dealing with a new apparatus of committees and advisory groups for the National Plan to Address Alzheimer's Disease, issuing new funding opportunity announcements (FOAs), tracking progress toward AD/ADRD research implementation milestones, planning and participating in AD/ADRD Summits, and contributing to annual Alzheimer's Disease Bypass Budgets. A major challenge for BSR leaders in the next few years will be meeting the demands of the AD/ADRD complex, and of a growing portfolio, while still giving staff members time to stay on top of professional developments, reach out to new audiences, and develop new program initiatives. New NIH requirements about clinical trial oversight such as the requirement for data safety monitoring boards for even small pilots have dramatically increased the workload for BSR staff; consideration should be given to new metrics beyond number of projects or dollars under management for NIH staff to incorporate recognition of the workload of NIA staff in managing Center grants, particularly those that incorporate multiple pilot studies.

BSR is about to experience a leadership change with the retirement of Dr. Haaga at the end of 2019. It is always unsettling when someone with a long and distinguished tenure in a leadership capacity (BSR Deputy Director since 2004, Acting Director since April 2015, and Director since May 2016) departs, but such transitions can create opportunities for growth. There is a stable corps of program officers who can be relied upon to advance BSR areas of science and support the next director when appointed.

VI. Conclusion

The overarching view of the Committee is that BSR has excelled in the past 5 years at developing its portfolio to incorporate recommendations from the last review, to incorporate increased emphasis on AD/ADRD in its current portfolio, and to generally move science

forward. BSR staff have been nimble in using a variety of mechanisms to develop new research topics, new research infrastructure, and new researchers in aging. This has included the development of Centers, Networks, training programs, and public use data for use by the research community. The major advances and productivity of these mechanisms should be celebrated and continued. The Committee reinforced recommendations to continue to develop data for diverse populations across the life course, to continue to integrate genomic and biological data into population level data sets, and to support analyses of the very valuable cross-national data sets supported in part by BSR.

The Committee outlined several areas where it was felt future emphasis should be placed either because of emerging issues in the health of the American population or because of opportunities in the scientific landscape. Most importantly, the poor overall health in America and the growing disparities in some parts of the population and country require increased attention. The Committee feels it is time to not only document disparities, but also to suggest approaches to intervention and prevention. Such suggestions will require more attention to the multiple mechanisms affecting health and the life cycle experiences of the aging population. Intervention and prevention will require understanding of individual, contextual, social, structural, and organizational behavior as well as potential integration of developing technological opportunities.

Dr. Haaga has ably led the Division since April 2015, after serving as its Deputy Director since October 2004. He continued the path begun under the previous director of adopting life course perspectives and interdisciplinary approaches, creating data resources and facilitating linkages to administrative data, funding analyses of precursors to clinical manifestations, leading hopefully to new approaches to prevention and remediation, and promoting research on causal mechanisms underlying health disparities. Dr. Haaga has overseen the AD/ADRD funding boon in a scientifically coherent way, and promoted a continued stream of high-quality research applications while maintaining BSR's commitment to career development and training. He has been resolute in focusing on central questions in the social and behavioral sciences of aging and tireless in advocating on behalf of the essential contributions that behavioral and social scientists can make. The Committee thanks Dr. Haaga for his excellent service in positioning BSR so well for future success. We hope this report provides the next BSR Director with helpful guidance on promising future directions, and confidence that BSR is on a solid foundation.

Appendix I: Background Documents Provided to Committee

All materials provided to Committee members were posted on a password-protected Web site so that reviewers could access them at their leisure.

1) May 20, 2019 meeting agenda and participant list
2) BSR Overview 2013-2019 (rev. 05/17/2019)
3) Schedule for 2019 NACA Review of BSR (rev. 05/17/2019)
4) 2013 NACA Review of BSR, Final Report (rev. 02/26/2014)
5) 2016 BSR Data Infrastructure Review Final Report (rev. 11/29/2016)
6) 2016 NIA Strategic Directions Document
7) List of BSR Funding Opportunity Announcements (FOAs), 2013-2019
8) Active BSR Projects (Rev. 04/25/2019)
9) List of BSR-Organized Meetings FY2014-2020 (rev. 04/28/2019)
10) Cross-cutting Theme Memos:
    a. Alzheimer's Disease and Related Dementias (rev. 05/06/2019)
    b. Basic Behavioral and Social Research (rev. 05/09/2019)
    c. BSR Center and Network Initiatives (rev. 05/10/2019)
    d. Health Disparities Portfolio Analysis Report (rev. 05/07/2019)
    e. Interventions (rev. 05/10/2019)
    f. Research Training and Career Development (rev. 05/10/2019)
    g. BSR Disparities Research (rev. 07/25/2019)
11) How BSR Sets and Implements Priorities (rev. 7/31/2019)
12) 16 Portfolio Review Memos (see Appendix II)
13) Workshops and Other Reports (see Appendix II)
14) September 9, 2019 meeting agenda and participant list
15) Draft Committee Report (Rev. 9/5/19; Updated 11/12/19, 12/5/19)

Appendix II. Background Materials Related to Topics

BSR Staff-provided Background Material	Topic				
	Modifying Behaviors	Disparities	Pathways & Prevention	Cognitive Aging	Population Aging
Cross-Cutting Theme Memos					
BSR Disparities Research	X	X			
BSR Intervention Research, 2013-2019	X				
Alzheimer's Disease and Related Dementias	X		X	X	
Portfolio Review Memos					
Affective Science: Non-Cognitive Portfolio in Psychology and Behavioral Science	X	X	X	X	
Behavioral and Social Animal Models of Aging		X	X		
Cognitive Aging	X	X	X	X	
Disability		X			X
Families, Interpersonal Relationships, and Social Connectedness	X	X	X		
Family Demography		X			X
Genetics	X		X	X	X
Health and Place		X			X
Innovations in Measurement				X	X
Insurance	X		X		
Life Course Research		X	X		
Social Networks					X
Technology for Older Adults	X				
Work, Workplace, and Health	X	X	X	X	
Science of Behavior Change Common Fund Program	X		X		
Nielsen, et al. (2017) The NIH Science of Behavior Change Program: Transforming the science through a focus on mechanisms of change, *Behaviour Research and Therapy*	X		X		

BSR Staff-provided Background Material	Topic				
	Modifying Behaviors	**Disparities**	**Pathways & Prevention**	**Cognitive Aging**	**Population Aging**
Workshop and Other Reports					
Selected BSR Workshops and Meetings FY2014-2020: Modifying Individual and Organizational Behaviors	X				
BSR Health Disparities Portfolio Analysis: 2007-2018		X			
Health Disparities Across the Life Cycle (2016), NASEM CPOP		X			
Socioeconomic Status and Increasing Midlife Mortality Planning Meeting (2017), NASEM CPOP		X			
Selected BSR Workshops and Meetings FY2014-2020: Disparities		X			
Understanding Pathways to Successful Aging: Behavioral and Social Factors Related to Alzheimer's Disease (2017), NASEM BBCSS			X		
Understanding Pathways to Successful Aging: How Social and Behavioral Factors Affect Health at Older Ages: Workshop in Brief (2015), NASEM BBCSS			X		
NIA Expert Meeting on Pathways and Mechanisms Linking Behavioral and Social Factors to Health (2014), NAS BBCSS			X		
Selected BSR Workshops and Meetings FY 2014-2020: Pathways and Prevention			X		
Preventing Cognitive Decline and Dementia: A Way Forward (2017)				X	
Selected BSR Workshops and Meetings FY2014-2020: Cognitive Aging				X	
New Directions in Sociology of Aging (2013), NASEM CPOP					X
Future of the Study of the Demography of Aging: A Planning Meeting (2015), NASEM CPOP					X
Future Directions for the Demography of Aging: Proceedings of a Workshop (2013), NASEM CPOP					X

BSR Staff-provided Background Material	Topic				
	Modifying Behaviors	**Disparities**	**Pathways & Prevention**	**Cognitive Aging**	**Population Aging**
Selected BSR Workshops and Meetings FY2014-2020: Population Aging					X
Other					
List of relevant Funding Opportunity Announcements (FOAs)	X	X	X	X	X

NOTES:
BBCSS = Board on Behavioral, Cognitive, and Sensory Sciences
CPOP = Committee on Population
NASEM = National Academies of Sciences, Engineering, and Medicine

Appendix III: References

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