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Luis Miguel Gutiérrez Robledo *Editors*

Understanding the Context of Cognitive Aging

Mexico and the United States

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ISBN 978-3-030-70118-5 ISBN 978-3-030-70119-2 (eBook)
https://doi.org/10.1007/978-3-030-70119-2

This Springer imprint is published by the registered company Springer Nature Switzerland AG
The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

In memory of Dr. Steve P. Wallace
Colleagues, Friend, and CAA Advisory Group Member

Foreword

This is the fifth volume in the series on Aging in the Americas. A unique book—catalyzed by the 2019 INGER-ICAA Workshop held in Mexico City and organized jointly by Mexico's National Institute of Geriatrics (INGER) and the International Conference on Aging in the Americas (ICAA)—that builds upon the previous editions through a refreshing multidisciplinary bi-national perspective on Latino/a/x aging and longevity in the Americas. The United States is a rapidly aging country, and Mexico is following suit. This publication focuses specifically on the rapidly aging Mexican-origin population of the United States and Mexico. The research and ideas presented highlight concepts of diversity, social structure, and health inequality that are affecting the aging population in both countries, which are inextricably connected by history and geopolitical forces. The effects of discrimination, racism, and segregation are discussed, but so also are the resilient attributes that have enabled low income and marginalized elders of Mexican origin to survive and maintain a level of self-efficacy. The editors and authors bring together a body of work that instills dignity to the cause. They shed light on the serious gaps and provide solutions designed to address the burden of physical disease and mental disorders affecting the aging Mexican-origin population of the United States and the aging Mexican population. Not only are programs presented and discussed, but a special focus on policy and practice are introduced.

Indeed, this book by assembling a cadre of bi-national researchers educates and elevates the concepts, theory, and measurement of mental and cognitive health, the social determinants of mental and cognitive health, caregiving and long-term care services and supports including dementia care, and mental health policy and practice. In addition to seasoned researchers and authors such as Fernando Torres-Gil, Toni Antonucci, Jacqueline Angel, Silvia Mejía-Arango, and Isaac Acosta, this collection presents new research by emerging scholars, a wonderful section that introduces us to researchers and contributors of the future. Truly a compelling volume that will appeal to researchers, policy makers, and philanthropists focused on mental health, dementia, and long-term care issues. It will also interest social

scientists who teach courses in demography of aging, mental health, aging and the life course, race and ethnic relations, Latino/a/x sociology, and family sociology. This opus is an excellent addition to the series because it is thought provoking and in many respects a call to action.

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Chapter 1
Preface: Population Aging and the Evolution of Dementia Care

Jacqueline L. Angel, Luis Miguel Gutiérrez Robledo, and Mariana López Ortega

By 2025, at least one-fifth of the population of 15 countries in the Americas will be 60 or older (Pan American Health Organization, 2017). The populations of older adults in Mexico and older Latinos in the United States continue to grow dramatically (Central Intelligence Agency, 2015). Population aging is the most important, inevitable feature of the health and prosperity of both nations in the near future. In the short term, serious consequences exist for families, communities, and governmental agencies at all levels as they struggle to adapt to the needs of rapidly growing older populations while devoting adequate resources to foster economic development and full employment. The COVID-19 pandemic has shown the vulnerability of the older population and the role of the economic and social determinants of health in its outcomes (Bello-Chavolla et al., 2020).

Mexico is the world's 11th largest country in terms of population size and the largest in terms of Spanish-speakers (Central Intelligence Agency, 2015). A dramatic decline in global fertility and total mortality, an increase in public health interventions, as well as access to both health care and medical technology has led to substantial gains in life expectancy and a rapid demographic transition. The older population is expected to nearly triple from 6.3% of the total population in the year 2010 to almost 22.6% by 2050 (Central Intelligence Agency, 2015). In parallel, an epidemiological transition has brought about a change in disease patterns and causes of death where illness and mortality from infectious and communicable diseases shifted to a profile with high-prevalence chronic, non-communicable diseases. As in other low- and middle-income countries (LMICs), older adults in Mexico present a

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J. L. Angel et al. (eds.), *Understanding the Context of Cognitive Aging*,
https://doi.org/10.1007/978-3-030-70119-2_1

mixed epidemiological profile characterized by the coexistence of non-communicable diseases, communicable diseases, and malnutrition, along with various degrees of disability (Wong et al., 2015). However, this is taking place in a context of wide economic disparities, few public strategies for supporting an aging population, and continuing reliance on families for the care and economic security of older adults, and where responses to health and care for older adults are less than optimal (Gutiérrez-Robledo, Lopez-Ortega, & Arango-Lopera, 2012).

A direct impact of the factors previously described can be noted when looking at the burden of disease in Mexico. According to Parra-Rodríguez et al. (2019), the top three causes of burden of disease in Mexican older adults are diabetes mellitus, ischemic heart disease, and chronic kidney disease, which are also within the top causes of mortality in the country. The three illnesses have long, often subclinical courses, and the fact that their burden is so high may be indicating not only poor prevention and detection of disease but also inefficient chronic management and poor acute care (Parra-Rodríguez et al., 2019).

Similarly, longer lives in the Mexican-origin population come with major challenges in the United States. The exponential growth in the Latino population will have significant implications for the health and well-being of more than 16 million older Latinos—half of whom are of Mexican origin—by the middle of the century (U.S. Census Bureau, 2015). While Mexican-origin individuals enjoy the highest life expectancy compared to other ethnic groups, they suffer protracted periods of poor health and functional disability. The stark reality may be that morbidity may not be compressed, but rather potentially protracted. Gender and nativity magnify this health disadvantage. At age 65, foreign-born, Mexican-origin women in the United States have the longest life spans, but spend almost two-thirds of those added years with a disability (Angel, Angel, & Hill, 2015).

In addition to health vulnerability, many older Americans will have limited financial resources, which will lead to a growing number of Mexican-origin individuals and their families struggling with poverty and financial insecurity in later life (Angel, Prickett, & Angel, 2014). Researchers estimate Mexican-American assets to be only one-tenth that of non-Hispanic whites in the United States (Kochhar, 2014). Older Mexican Americans face an ever-increasing burden of disease, difficulties accessing health services, and the strain of an uncertain future for both themselves and the health care services available to them (González-González et al., 2011). The situation is especially problematic along areas of the U.S.-Mexico border region that has the largest and fastest growing number of Mexican Americans age 65 and older (Texas Demographic Center, 2018). In border states like Texas, where Latinos (Mexican Americans) disproportionately live, unmet need is especially high compared to individuals residing in the interior (Torres-Gil & Angel, 2019). Border *Colonias*, located five to 20 minutes outside major urban areas in the state, tend to be self-constructed permanent dwellings built 40 or more years ago when residents originally immigrated to the United States (Durst, 2015). Housing in *Colonias* bordering urban areas tend to be populated with mobile homes, and frequently, relatives build several structures on one lot (lot sharing). Older Texas residents are aging in place in these low-quality dwellings (non-functioning or no heating/cooling

systems, septic problems, and pest infestations), all of which disproportionately impact the mental and physical health of older residents (Ward, 2015).

These trends pose a series of objectively difficult decisions in the ways that developing nations like Mexico can address the problem of rapid aging along with neuropsychiatric and mental health issues. As scientists learn more about caring for an older population with serious cognitive impairment and related mental-health problems, lingering questions remain that demand research (Angel & Angel, 2018). Population aging in Mexico and the United States has implications for all aspects of social policy including health, mental disorders, dementia, and human security.

This book, the fifth volume in the series on *Aging in the Americas* (AIA)—which resulted from 21 invited lectures given during the third Bi-National Transdisciplinary Workshop titled "Framing Challenges of Ageing Cognitive and Mental Health Care in Mexican-origin Older Adults in Mexico and the U.S."—addresses these critical scientific and policy issues. Authors took a laser lens to investigate the complex social environment and cognitive and mental health of older Mexican-origin adults in two different national contexts. A key objective of the Workshop was to identify factors and processes that undermine attempts to sustain cognitive and mental health, and well-being among older individuals of Mexican origin who experience persistent economic inequality as the result of life-long exposure to structural disadvantage. Toward that end, implications of public policies, including national security, that help to achieve optimal care and support in later life for individuals with mental disorders and dementia were discussed and prioritized. This involved a Consensus Building session designed for constructive engagement and an actionable knowledge plan.

By way of background, the first conference, "Aging in the Americas: Critical Social Policy Issues," took place in 2001 and explored the consequences of changing population processes, including migration, on the economic dependency of Hispanic individuals. In 2005, the second conference on Aging in the Americas held on The University of Texas at Austin campus at the LBJ School of Public Affairs brought together scholars in the fields of Hispanic health, health care policy, and aging research. Their goal was to share and foster research that improves our national understanding of aging in the Americas and informs the development of science, policy, and aging services. Support for the meeting came from the Center for Population Health and Health Disparities (The University of Texas Medical Branch at Galveston), Janet F. Harte Lectureship in Population Issues (LBJ School of Public Affairs), Population Research Center (The University of Texas at Austin), Center on Population Health and Aging (The Pennsylvania State University), National Alliance for Hispanic Health, Foundation for Insurance Regulatory Studies in Texas, Bridging Disciplines Program (The University of Texas at Austin), AARP Global Aging Program, Mexican Center (Teresa Lozano Long Institute of Latin American Studies), Center for Health and Social Policy (The University of Texas at Austin), Latin American Initiative of the Office of the Executive Vice President and Provost (The University of Texas at Austin), as well as a travel grant for an invited speaker from the National Institute on Aging. Since 2009, a major grant from the National

Institute on Aging (R13-AG029767-01A3; PI: Jacqueline L. Angel) has funded the ICAA conferences series.

The Bridging ICAA conferences, an iteration of the Conference Series on Aging in the Americas (CAA), have taken place during the evaluation of the competing renewal application. Our first bridging conference, "Formal and informal systems of support in Mexico and the United States in the context of health and welfare reform," took place in Mexico City on September 17–18, 2015, where a group of scholars and experts discussed diverse topics related to the systems of support in place for older adults in Mexico and the United States. For this conference, we had the support of the Mexican National Science and Technology Council (CONACYT) and the U.S. Embassy in Mexico, in addition to invaluable resources from the National Institute of Geriatrics in Mexico.

For the most recent meeting, held in Mexico City on September 30 and October 1, 2019, we would like to acknowledge the generous support of The University of Texas co-sponsoring institutions: Hogg Foundation for Mental Health, Texas Population Research Center (P2CHD042849), and Texas Aging and Longevity Support, as well as Texas AARP. In Mexico, our gratitude to Mexico City's Education, Science, Technology, and Innovation Secretary grant "Red Colaborativa de Investigación Traslacional para el Envejecimiento Saludable de la Ciudad de México, RECITES" (CM-SECTEI/041/2020) and the Mexican National Institute of Geriatrics (INGER) for funding and hosting the meeting. This volume has emerged from engagements with all of these organizations and addresses a broad range of aging and mental-health issues.

This edited collection also provides a bi-national perspective on informal and formal supports for the aging population in Mexico and U.S. Hispanics of Mexican origin. Despite the geographic proximity of the United States and Mexico, both nations differ greatly in the organization and financing of their health and welfare programs for older adults, including long-term care (Angel, Angel, López-Ortega, Gutiérrez Robledo, & Wallace, 2016). They also differ politically and organizationally in the responsiveness of governments at all levels to the needs of low-income and frail citizens. Of particular interest in this edited collection is the availability, use, and appropriateness of mental health and dementia care systems, and how they impact older adults' ability to age in place. While both countries are aging rapidly, Mexico faces more serious challenges in providing health and social support for older adults that arise from a less developed economy and a less developed old-age welfare state (Aguila, Diaz, Fu, Kapteyn, & Pierson, 2011). For Mexico, income support for older adults and medical care are universal rights, but limited fiscal resources and the needs of a large vulnerable population create inevitable competition for limited resources among the old and the young (Angel, Vega, & López-Ortega, 2017).

Although the United States has a more developed economy and well-developed Social Security and health care financing systems for older adults, older Mexican-origin individuals in the United States do not necessarily benefit fully from these programs. Longer life spans, smaller families, as well as changing gender roles and cultural norms, compound the institutional and financial problems in both countries.

On the other hand, rapidly increasing burden of specific age-related conditions, such as dementia, pose additional challenges to formal and informal care and support systems for both nation states.

The program of the 2019 Bridging ICAA conference focused on a constellation of topics encompassing mental health, cognitive aging, as well as neuropsychiatric disorders and dementia that have largely gone unaddressed. Invited speakers examined multiple aspects of the mental health of older Mexican-origin people and those with dementia, in particular. For example, depression is a "hidden public health problem" among Mexican-older adults in both countries and the issue is poorly understood. Although there exists a body of literature and research on older Hispanics and minority aging populations, most concentrate on the disadvantages, barriers and needs of older Latinos, especially of Mexican origin. This includes research over many years that examine the effects of discrimination, racism, and segregation, and the resulting needs for improving health, retirement security, social support, and caregiving. There has been some research on the mental health issues facing older Latinos in adjusting to migration and acculturation. Little work, however, has been done on the resilient attributes that have enabled low income and marginalized older people of Mexican origin to maintain a relatively strong level of self-efficacy. What is clear is that care for persons with dementia and related disorders is changing enormously. Deficiency of funding, limited research and statistical data, and inadequate geriatrics education make planning an appropriate care system for older adults a major difficulty.

As part of this conference, participants presented commissioned papers that address the following questions:

1. How do lifetime prevalence and risk factors for DSM-V psychiatric disorders differ between Mexican-origin older adults in Mexico and the United States?
2. How do Mexico and the United States compare in terms of their reliance on state-sponsored systems, the family, and local community in the mental and cognitive health care of older adults?
3. What sources of informal care are available in both countries? As both nations age, are traditional non-governmental organizations and faith-based organizations redefining their missions to include the provision of assistance to vulnerable older adults with mental disorders, cognitive impairment, and dementia?
4. What is the optimal mix of formal and informal care for older adults? Should governments formalize public/private partnerships for the community care of older adults with co-morbid mental disorders, cognitive impairment, and chronic physical conditions?
5. What are the best-practice models for community-based long-term care currently available for seriously cognitively-impaired individuals as they age?
6. How do specific national contexts and differences in economic, social, and political systems influence the possibilities in long-term care for older adults with serious cognitive impairments, including dementia and related disorders?

In addition to reviewing the aforementioned literature, speakers also discussed crucial areas of research that require immediate attention to serve the growing aging

population using a new methodology called Café-to-Go Conversations. This method allowed them to discuss priority issues for interdisciplinary aging and mental health-care research, and for actionable knowledge, and develop consensus on ways to improve support strategies for mental and cognitive health in both countries. Participants discussed three questions, then ranked the top three ideas for research, and ideas for dissemination and for immediate policy implementation. The process was democratic, interactive, and stimulated a great deal of informed and lively discussion. From these conversations, participants synthesized common threads and then a larger group ranked the items in a Qualtrics survey conducted in both English and Spanish. The last chapter in the volume presents a synthesis of the development of the Café-to-Go session and the most important findings. The ultimate objective of the Workshop involved identifying long-term care policies in place, in particular addressing mental health, dementia and related conditions, their scope, and what is necessary to achieve optimal care and support in later life.

Organization of the Volume

Section 1 begins with a summary by Kyriakos S. Markides and Mariana López-Ortega of chapters that examine key concepts, theory, and measurement of mental and cognitive health in the older Mexican-origin population in both Mexico and the United States. This section closes with a chapter by Ricardo (Rico) Ainslie, Director of the U.T. Austin Lozano Long Institute for Latin American Studies, Mexico Center, with a thought-provoking essay that summarizes his qualitative research as it relates to mental health, elaborating on the intersection of social structure, culture, and individual psychology.

In Section 2, Jacqueline L. Angel provides an overview of key issues in the behavioral and social sciences of mental health and dementia. Chapter contributors examine the several determinants of cognitive function, broadly construed, as it affects healthful aging in both countries. Section 3 opens with an overview of research by Sunshine Rote and Rogelio Sáenz on informal and formal care for older people with dementia and related disorders. Three contributors investigate facets of mental health care, caregiving, and community-based long-term care services and supports, including dementia care. In Section 4, the contributors offer new insights into solutions for mental health care problems in older populations in the Americas, and by example Mexico and the United States—led off by Flavia Andrade and followed by four analytic essays, one of which focuses on advancing a research agenda aimed at reducing Mexico's dementia burden.

In addition to invited speakers, ICAA seeks to provide opportunities to emerging scholars to pursue research that supports the mission of the CAA, which is a focus on dimensions of healthful aging for people of Hispanic/Latinx, Mexican, and Latin American descent. The overarching goal of the ICAA mentoring program is to provide the skills, knowledge, and experience to prepare emerging scholars to excel in their career paths toward behavioral and social research on aging Latino/

Hispanic. Supervised by an established investigator in the field, emerging scholars share their findings and research (which is not limited to the conference theme) at each iteration. To recognize these efforts, Section 5 includes a new part of the volume that highlights work completed by the INGER-ICAA Emerging Scholars as well as insights from the Decision Editor, Emma Aguila.

Population and Terminology

The authors of these chapters all deal with the Latino population of the United States which refers to those U.S. residents who trace their ancestry to Spanish-speaking nations. This group consists primarily of Mexican, Puerto Rican, and Cuban origin. Some authors may occasionally use the term Hispanic to refer to this population. Other authors employ the term Latinx to be more inclusive. Some authors focus on Mexicans in Mexico; those individuals are not Latino/Latina but are Mexican. We should point out that the volume does not follow any convention in terms of labeling the U.S. Hispanic-origin population.

Lastly, as Co-Chairs of the Workshop, we thank our Advisory Group, colleagues, and students for sharing so generously their expertise and time over the past year, and for many of them since the inception of the series. The Section Editors for this volume (Kyriakos S. Markides, Silvia Mejía-Arango, Sunshine Rote, Rogelio Sáenz, Flavia Andrade, and Emma Aguila) played an essential role in the assessment of the suitability and quality of the chapter, and therefore merit sincere appreciation. Special thanks to Stephanie Grasso, Editorial Assistant, Sofia G. Ayala, Copy Editor of the volume, Meghan Tantum, U.T. Austin Manager of Research Contract and Grant Services, and to Eveline Bakker, our Senior Editor at Springer Nature for their assistance with the project.

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Section 1
Concepts, Theory, and Measures of Mental and Cognitive Health

Mariana López Ortega and Kyriakos S. Markides

Population aging has been described as a human success story, reflecting the advancement of public health, medicine, and economic and social development, and the impact of these advances on the reduction in the risk of death. It has also been described as one of the four "mega-trends" that characterize the global population of today—population growth, population aging, urbanization and international migration (United Nations, 2020). On the other hand, population aging brings additional challenges such as an increasing number of older adults with chronic diseases and functional disability, including cognitive decline, dementia, and other mental health problems. These will likely increase the need for health care services.

In 2015, an estimated 46.8 million people worldwide were living with dementia. This number will almost double every 20 years, reaching 74.7 million in 2030 and 131.5 million in 2050. This is particularly relevant as demand for services will also increase, but it is unlikely that full coverage of dementia health care services will be available or affordable using the current specialist care model (Prince, Comas-Herrera, Knapp, Guerchet, & Karagiannidou, 2016).

While aging research has increased exponentially in the last decades, research on mental and cognitive health is still lacking. The 2018 World Alzheimer Report included a general revision of relevant research in related areas such as diagnosis, treatments, and risk reduction; and concluded that there is an urgent need for increased funding in neurodegenerative disorders like dementia, as it only represents

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a fraction of what is spent on other chronic non-communicable diseases such as cancer and diabetes (Patterson, 2018).

The volume *Understanding the Context of Cognitive Aging: Mexico and the United States* starts out setting the broad stage of mental and cognitive health of older adults in Mexico and older Hispanics or Latinos in the United States, with the objective of following the focus of our second Mexico-U.S. bridging Conference *Framing Challenges in Cognitive and Mental Health Care in Mexican origin Older Adults in Mexico and the U.S.*, which was jointly organized by the Mexican National Institute of Geriatrics (INGER) and the International Conference of Aging in the Americas (ICAA). The main objective of the meeting was to identify public policies and strategies that are in place to support aging mental health and care in both countries, their scope, and what is necessary to achieve optimal care and support in later life for these conditions. The meeting also addressed the different concepts, theories, and instruments of mental and cognitive health measurements as well as their social determinants.

This section of the volume includes four chapters and aims to provide readers with a conceptual foundation on the links between mental and physical health and quality of life of older adults, regarding the measurements of cognitive and mental health, as well as health needs and the use of mental health services.

In the first chapter, Arteaga Bracho and colleagues focus on the challenges of the assessment of cognitive domains in low literacy populations, and its estimation in a cohort born in 1945 or earlier in the city of Maracaibo, Venezuela. The study determines whether neuropsychological tests measure the same cognitive constructs across different educational levels in healthy adult Hispanics. Results indicate that memory, speed of processing, language, and visual-spatial abilities are latent factors identifiable from cognitive assessment in this population and emphasizes how future, cross-national studies will help to improve our understanding of dissimilar results regarding cognitive performance.

This chapter is followed by a study focusing on the role of discrimination in the use of mental health services by the Latino population in the United States by Padilla-Frausto and Wallace. Specifically, the study examines the effect of anti-Latino discrimination in the use of mental health-related services, and examines if the effects differed by age group, socioeconomic characteristics such as marital status, educational attainment and health insurance, as well as need for service. Interestingly, their results show that while Latinos may not meet criteria for a diagnosable disorder, they are indeed seeking help for mental health problems, suggesting that more preventive efforts are needed. In addition, they show how adequate services are needed not just for those with a clearly diagnosable disorder, but also for those dealing with major life stressors such as discrimination, where reducing stigma becomes a highly relevant factor.

The chapter by Sosa and colleagues presents an overall review of mental health in older adults, with an emphasis on the most frequent disorders in this population such as depression, anxiety, and dementia. In addition, the chapter introduces crucial links between mental and physical health, how these differ throughout the lifespan and the bidirectional relation of these links (i.e., from mental to physical and from physical

to mental health), and how in many cases they co-exist. Moreover, they importantly indicate that beyond these interactions, their impact on health-related quality of life is significant. In the last section of the chapter, public health challenges and the need for holistic care management strategies, including the implementation of evidence-based interventions are presented. The authors also note the need for person-centered care that uses community-based assessment of needs to best design and implement care plans, provide individualized monitoring and referrals as needed, and to support caregivers.

Finally, the chapter by Ainslie turns its attention to fundamental questions and challenges of high relevance for researchers interested in understanding the aging process. In addition, the chapter addresses how social context and cultural values operate in the context of Latino aging, a highly complex process affected by a variety of factors that are deeply embedded in, and influenced by, both biological and cultural variables. As way of discussing relevant methods in aging research, Ainslie explains how qualitative methods can be an important tool in helping us understand the differentiated degrees of these aging experiences and processes as well as the gaps that become apparent in conducting quantitative research.

In sum, the chapters in this section examine different aspects of the aging process, in particular, relevant mental health issues in older adults such as depression, anxiety and dementia, among others. In addition, the importance of social context and socioeconomic characteristics throughout the lifespan are explored as determinants in the aging process, including their impact on healthy aging. Access to health services and their adequacy, as well as the differentiated use of different services by vulnerable older adults in Mexico and among Latino older adults in the United States versus non-Hispanic Whites, is also discussed. In this sense, not only common determinants of use of services such as age, gender and socio-economic characteristics are examined, but also, less explored and equally relevant aspects such as discrimination.

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Chapter 2
Cognitive Domains in Low Literacy Populations: The Experience of the Maracaibo Aging Study

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Introduction

Although there is a growing interest in improving cognitive abilities in older adults, there has been considerable variation in how different cognitive domains have been conceptualized over time. Broadly, neuropsychology assumes that cognitive processes are fundamentally similar across humankind (Nell, 1999), and as such, the manner in which cognitive processes are assessed is similar across cultures (Rivera Mindt, Byrd, Saez, & Manly, 2010).

There is much cross-cultural evidence that the structure of intelligence is invariant across cultures but that assessment instruments may need smaller or larger adaptations to be applicable across cultural contexts (e.g., Berry et al., 2011). The extent to which adaptations maintain the original intention of the test, while increasing the ability of the test to accurately discriminate ability levels within the new cultural setting, remains controversial. Despite extensive discussion on the universality of cognitive constructs (Berry et al., 2011; Van de Vijver & Poortinga, 1997; Van de Vijver & Leung, 1997), there are very few studies that address the extent to which different tests or batteries of tests are able to measure the same cognitive constructs in a comparable manner across different economic, cultural, and linguistic groups (e.g., Helms-Lorenz et al., 2003). Hui and Triandis (1985) argue that a fundamental challenge in creating equivalence is that the instrument or test items should be similar or the same. In other words, each item on the test should have the same

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J. L. Angel et al. (eds.), *Understanding the Context of Cognitive Aging*,
https://doi.org/10.1007/978-3-030-70119-2_2

meaning across cultures. This limits not only cross-cultural comparability but also cross-cultural adaptability of tests because of cultural and linguistic differences.

Performance in tests of cognitive functioning commonly differs among populations, even after formal harmonization of tests (Parker & Philp, 2004; Pedraza & Mungas, 2008; Verhey et al., 2003). Several influential factors have been implicated, including socio-economic status (D'Angiulli, Lipina, & Olesinska, 2012; Dotson, Kitner-Triolo, Evans, & Zonderman, 2009), level and quality of education (Dotson et al., 2009; Manly, Byrd, Touradji, & Stern, 2004; Snitz et al., 2009), exposure to less than optimal testing conditions in terms of noise (Axelsson, Berglund, & Molero Suárez, 2010; Jukes & Grigorenko, 2010), and cultural differences (Ardila, 2005). For example, cognitively healthy older adults in developing countries tend to perform worse on memory, attention, and language tests than those in developed countries (Gupta et al., 2011; Moraes, Pinto Jr., Lopes, Litvoc, & Bottino, 2010). It is unclear whether such differences are entirely quantitative or partly qualitative, that is, whether the tests actually measure something other than the intended cognitive functioning (Early et al., 2013).

The Maracaibo Aging Study (MAS) provided an opportunity to examine potential variability in the structure of cognitive functioning tests among groups of subjects residing in a developing country, and to explore whether neuropsychological tests measure the same cognitive constructs across different educational levels in

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healthy adult Hispanics. The MAS is a longitudinal project that has been following age-related conditions in an elderly (≥55 years) population in Venezuela (Maestre et al., 2002). The baseline study, in 1998–2000, assessed 2454 participants using the core battery designed for Hispanics and other ethnic groups residing in New York City (Stern et al., 1992). The MAS tests were administered by psychologists, whose training was overseen by the neuropsychology team from Columbia University, and testing conditions replicated those in the New York City study as much as possible.

Before results of cognitive-functioning tests are compared among different populations, it is important to determine what exactly the variables are measuring, and how the variables relate to one another. The goals of the present study were threefold: (1) to determine the cognitive constructs measured by the core battery of neuropsychological variables in groups of cognitively healthy participants in the MAS; (2) to evaluate the validity of the emergent model; and, (3) to examine whether the cognitive constructs remained invariant across the groups of educational attainment, using structural equation modeling (SEM). We addressed the first and second goals by adopting the strategy of Siedlecki et al. (2010), consisting of exploratory factor analysis (EFA) and confirmatory factor analysis (CFA). The present study is the first to examine the factor structure of neuropsychological variables in healthy adult Hispanics residing in a developing country.

Methods

Participant Selection

Subjects for this analysis were participants of the MAS. All subjects were residents of Santa Lucia County in Maracaibo City, born in 1945 or earlier. Detailed survey methods and characteristics of the population were previously described elsewhere (Maestre et al., 2002). Briefly, a door-to-door registry was built, and all subjects 55 years and older were invited to participate. Sixty-five percent of qualifying subjects (2453 of 3765) agreed to participate. All subjects gave informed consent prior to inclusion. The research protocol was approved by the Institutional Review Board of the Cardiovascular Institute, University of Zulia in Maracaibo.

Baseline data were collected during 1998–2000. The protocols closely followed those used in the northern Manhattan community of Washington Heights Inwood, where approximately one third of the subjects were Hispanics (Stern et al., 1992). All participants underwent medical history review, medical and neurological examinations, and a standardized neuropsychological evaluation. Physician-rated measures of daily functioning included the Blessed Dementia Rating Scale (Blessed, Tomlinson, & Roth, 1968) and the Schwab and England Activities of Daily Living Scale (Schwab & England, 1969), which were completed by the subject, an informant, or both, and the Neuropsychiatric Inventory (Cummings et al., 1994). In addition, a social worker visited each participant and obtained information about changes in cognition, mood, and personality from a proxy, using an adapted version of the Dementia Questionnaire (Kawas, Segal, Stewart, Corrada, & Thal, 1994), as

Table 2.1 Demographic characteristics of participants across different levels of education

Demographic Variable	Low Level ($n = 362$) *M (SD):* Range	Average ($n = 442$) *M (SD):* Range	High Level ($n = 525$) *M (SD):* Range	All ($n = 1329$) *M (SD):* Range
Age in years	67.88 (7.45): 55–89	64.98 (7.33): 55–92	62.44 (6.43): 55–86	64.77 (7.36): 55–92
Years of education	2.51 (1.45): 0–4	5.86 (.35): 5–6	10.91 (3.35): 7–26	6.94 (4.12): 0–26
Percentage females	71.5	63.3	55.8	62.6

well as information about living conditions and daily functioning. All subjects underwent blood testing that included hematology, clinical chemistry, and plasma homocysteine, folate, and vitamin B12 levels, as well as cardiovascular, nutritional, and anthropometric assessments. All information for each participant was discussed at a clinical diagnostic conference of the health professionals that evaluated the participant. A diagnosis of dementia was made based on the DSM-IV criteria (American Psychiatric Association, 1994). A participant was classified as cognitively healthy if their Clinical Dementia Rating (CDR) (Morris, 1993) was zero.

To be included in the current analyses, subjects needed to be free of dementia (CDR = 0) and free of history of stroke, depression, brain tumor, epilepsy, Parkinson's disease, Korsakoff's syndrome, Huntington's disease, schizophrenia, bipolar disorder, and mental retardation. None of the included subjects were taking anticonvulsant, antidepressive, or antipsychotic medication. A total of 1329 subjects without significant medical history were classified as cognitively healthy, older adults (Table 2.1). All spoke Spanish as their first language and completed all 17 of the neuropsychological tests that were administered.

Neuropsychological Evaluation

All subjects were given a battery of 17 tests designed to assess a broad range of cognitive functioning, including memory, language, visual-spatial ability, and reasoning (Table 2.2). The 17 tests were a subset of the full diagnostic battery developed by Stern et al. (1992). They included the *Selective Reminding Test* (SRT) (Buschke & Fuld, 1974), the modified 15-item *Boston Naming Test* (Goodglass & Kaplan, 1983), the *Letter Fluency* test and the *Category Fluency* test, the *Benton Visual Retention Test* (BVRT) (Benton, 1955), the *Rosen Drawing Test (*Rosen, 1981*)*, the *Similarities test* (Wechsler, 1981), the *Identities and Oddities test* (Mattis, 1976), and the *Repetition* task (Goodglass & Kaplan, 1983), which are described in detail by Siedlecki, Honig, and Stern (2008). The present study also included the *Cancellation Test,* in which subjects were presented with one sheet of paper with target stimuli at the top of the page. In the shape portion of the test, the paper was filled with different shapes, and subjects were instructed to find and cross out the target stimulus as quickly as possible. *Shape Time* refers to the time to complete the

Table 2.2 Mean test scores (± SD) and ranges on the neuropsychological tests within levels of education

Variables	Low *M (SD):* Range	Average *M (SD):* Range	High *M (SD):* Range	*F*
Total recall	35.00 (8.65): 9–58	38.47 (7.99): 17–67	41.80 (8.56): 14–69	70.68***
Delayed recall	4.97 (2.07): 0–12	5.28 (2.01): 0–11	6.09 (2.16): 0–12	35.38***
Delayed recognition	10.50 (1.66): 2–12	10.83 (1.52): 2–12	11.23 (1.23): 4–12	27.59***
Benton recognition	5.26 (2.13): 0–10	6.50 (2.05): 0–10	7.51 (1.83): 1–10	137.67***
Similarities raw score	5.66 (4.16): 0–21	8.36 (4.94): 0–25	13.15 (5.84): 0–27	245.16***
Identities/oddities total	13.34 (1.79): 6–16	13.28 (1.79): 4–16	13.81 (1.94): 6–16	11.57***
Naming total	13.68 (1.54): 0–15	14.08 (1.12): 8–15	14.40 (1.19): 0–16	33.82***
Letter fluency mean	19.07 (8.74): 2–48	24.10 (9.05): 3–60	32.17 (10.45): 0–68	213.89***
Category fluency mean	11.07 (2.89): 5–21	11.94 (3.15): 4–22	14.21 (3.53): 6–27	114.29***
Repetition	7.40 (.98): 1–8	7.51 (.80): 3–8	7.70 (.68): 0–8	15.67***
Comprehension	4.34 (1.29): 0–6	4.54 (1.28): 0–6	5.08 (1.04): 2–6	46.32***
Rosen	2.69 (1.03): 0–5	3.22 (.90): 1–5	3.68 (.83): 1–5	127.34***
Shape time	100.27 (30.70): 20–240	89.78 (27.81): 10–253	81.74 (31.00): 15–240	41.23***
Shape omits	7.40 (4.50): 0–20	5.81 (3.97): 0–19	5.03 (3.74): 0–20	37.32***
TMX time	112.08 (26.90): 44–246	102.43 (27.41): 10–240	89.81 (26.98): 18–240	74.87***
TMX omits	5.40 (4.29): 0–19	3.25 (3.47): 0–19	1.96 (2.79): 0–16	104.65***
Benton matching	7.32 (2.18): 1–10	8.29 (1.71): 1–10	9.05 (1.24): 0–10	112.43***

*** $p < .001$

task, and *Shape Omits* refers to the number of target stimuli that the subject failed to cross out. In the letter version of the test, the paper was filled with letters, and the subject was instructed to cross out the target letter triad (TMX) as quickly as possible. *TMX Time* refers to the time required to complete the task, and *TMX Omits* are the number of target letters omitted. In all four of these tasks, greater numbers indicated poorer performance (slower speed to complete and more omission errors).

Analyses

An ANOVA was performed to compare age, and a chi-square analysis was used to compare the proportion of women across education groups. The overall

neuropsychological test performance across groups was compared using ANOVAs; post-hoc Tukey tests were conducted to determine which comparisons were significant. Kruskal Wallis Test was used to determine if there was a difference in distributions between three education groups.

EFA was performed with the 17 test scores as variables to identify the underlying factor structure. Following the approach used by Siedlecki et al. (2008), a model was constructed in which each variable was loaded onto the factor on which it had the highest loading. The model fit was tested using confirmatory factor analysis (using the AMOS 5 program; Arbuckle, 2003). This empirical model was compared to the following three theory-based models: a one-factor model in which all 17 variables were loaded onto the same factor, a four-factor model based on a similar dataset of healthy elders in New York City (Siedlecki et al., 2010), and a proposed four-factor model based on experience with the MAS population.

The one-factor model was based on the hypothesis that one general factor underlies cognitive function (Gustafsson, 1984; Thurstone, 1938). The four-factor model generated for healthy elders in New York City comprised Processing Speed, Memory, Language, and Fluid Ability (gF) as described in Siedlecki et al. (2008). Our proposed four-factor model included a Visual-Spatial factor composed of the BVRT Recognition variable, the Rosen and BVRT Matching tasks, and the TMX Omits and Shape Omits variables; a Language factor, which included the Similarities and Identities/Oddities subtests, Letter Fluency, Comprehension, and Category Fluency variables; a Speed factor composed of the Shape Time and TMX Time variables; and a Memory factor composed of the SRT Total Recall, SRT Delayed Recall, and SRT Delayed Recognition. The four factors correspond to the latent abilities thought to be measured by the tests. For all models, fit was evaluated using chi-square (X^2), Bentler's Comparative Fit Index (CFI), the Relative/Normed Chi-Square (X^2/df; (Bollen, 1989), and the Root Mean Square Error of Approximation (RMSEA, as recommended by Kline, 2011). A good fit to the data is indicated by CFI values close to 1.0 and RMSEA values <0.06 (Kline 2011).

Following the analytical procedures of Siedlecki et al. (2008), the best-fitting model was used in subsequent analyses that examined invariance across participants distributed in three groups of years of education (low: 0–4; average: 5–6; and high 7–26 years). The fit of different invariance models to the data was compared using $\Delta X^2/\Delta df$. According to Byrne (2001), a model is invariant across groups when its factor loadings, variances, and covariances are equivalent across groups. Following Byrne (2001), these steps were taken to ascertain invariance across levels of education:

1. The fit of the baseline model was assessed within each group.
2. The groups were tested simultaneously (i.e., low vs. average; low vs. high; and average vs. high), with all parameters free to vary. The chi-square value for this first procedure served as the baseline measure for succeeding steps.
3. The groups were tested simultaneously, with all parameters fixed as equal across groups; the change in chi-square value between the baseline measure and this second simultaneous test was taken. A significant change in chi-square indicated

that one or more of the parameters were not invariant across groups. Accordingly, several simultaneous tests were conducted to determine which parameters were not invariant across groups: invariant factor loadings were identified first, followed by invariant construct variances, and then by invariant covariances (although correlations are reported for ease of interpretation).

Results

Demographic Characteristics

Mean age of the total population sample was 64.77 years, but was different across the three education groups, $F(2, 1326) = 64.38$, $p < .001$. Post-hoc Tukey comparisons revealed that individuals categorized into the low education group were older than those in the average ($p < .001$) and high education groups ($p < .001$); those categorized into the average education group were significantly older than those in the high level of education group ($p < .001$). The range of years of education for the total sample was broad (0 to 26 years), with a mean of 6.94 years. Group differences in gender were significant, χ^2 (2) = 22.82, $p < .001$; the percentage of females was highest in the group with low level of education (71.5% vs. 63.3% vs. 55.8% of females, for low, medium, and high level of education, respectively).

Cognitive Performance

Since years of education have been shown to be associated with scores in neuropsychological tests across different populations (Farias, Mungas, Hinton, & Haan, 2011; Proust-Lima et al., 2008), we sought to examine performance on a battery of neuropsychological tests across education groups in the current sample. Individuals with the lowest level of education had worse performance than individuals with average and high education levels in Total Recall, Delayed and BVRT Recognition, Similarities, Naming total, Letter and Category Fluency, Comprehension, Rosen, Benton Matching, Shape Time and Omits, and TMX Time and Omits (Table 2; post-hoc Tukey $p < .005$ for all group comparisons). Interestingly, individuals categorized into the average level of education group had higher scores in the recall, recognition, naming, fluency, and matching tests but lower scores in the time and omissions measures than individuals who were in the highest level of education group (all at $p < .001$ except for Comprehension at $p < .05$).

Exploratory and Confirmatory Factor Analysis

To investigate whether the scores derived from the neuropsychological examination are intrinsically associated among each other as groups that measure distinct cognitive domains, we used a previously characterized strategy by Siedlecki et al. (2010). Briefly, we only used neuropsychological scores from cognitively healthy subjects with no missing data ($N = 1329$) to be loaded in EFA. Principal Axis Factoring was used to extract the factors and a Promax oblique rotation was used to rotate the extracted factors. Three tests with communalities <0.20 were omitted from the analysis (Identities/Oddities, Repetition, and the Boston Naming Test) because low communality could indicate that a variable is not related to the other variables, that an additional factor should be explored, or that reliability is low (Costello & Osborne, 2005).

Three factors were retained based on a break in scree plots and eigenvalues >1. Together, the three factors explained 57.19% of variance. The solution (Table 2.3) was in part consistent with research on neuropsychological variables. The factors speed (Shape and TMX Time) and memory (three SRT variables) were consistent with the EFA-derived four-factor model by Siedlecki et al. (2010). Interestingly, most of the variables that composed the other two factors (visuo-spatial and language)—including the BVRT Recognition and Matching variables, Letter Fluency, the WAIS-R subtest of Similarities, Comprehension, and the Rosen variable—were grouped in a single factor. These results suggest that 17 different scores derived from the core neuropsychological battery measure three different cognitive constructs in a population of healthy Hispanic elders living in Latin America.

Table 2.3 Pattern matrix from the EFA

Test	gF	Memory	Speed
BVRT recognition	***.73***	−.06	.01
Similarities raw	***.58***	.16	.04
Letter fluency	***.56***	.17	.08
Comprehension	***.45***	.08	−.01
Rosen test	***.55***	−.10	.18
BVRT matching	***.64***	−.05	.06
TMX omits	***−.77***	.06	.16
Shape omits	***−.64***	.06	.16
Category fluency	***.43***	.22	.15
SRT total recall	.00	***.84***	.00
SRT delayed recall	−.12	***.91***	−.06
SRT delayed recognition	.11	***.42***	.03
Shape time	.02	.04	***−.80***
TMX time	.10	−.00	***−.86***