# TABLE OF CONTENTS

Introduction ........................................................................................................................................................... 3
Welcoming Remarks ................................................................................................................................................ 4

SESSION 1: Personality and Healthy Aging ........................................................................................................ 5

Neuroticism, Conscientiousness, and Healthy Aging: Conceptualization, Measurement, and Intervention Efforts ........................................................................................................................................................... 6
Personality, Alzheimer’s Disease, and Other Major Health Outcomes ............................................................ 7
Behavior Change Interventions and Aging ....................................................................................................... 8
Personality and Healthy Aging Discussion ....................................................................................................... 9

SESSION 2: The NIH Stage Model of Behavioral Intervention Development .................................................. 10
What is the NIH Stage Model and Why Are We Using It? ............................................................................ 10
Application of the NIH Stage Model to the Development of a Coherent Program of Research: Mindfulness-based Interventions as an Example ................................................................................................................................................ 12
The NIH Stage Model of Behavioral Intervention Development Discussion ................................................. 13
Thinking about Stage V during Stage I ........................................................................................................... 14
Navigating through the Stages: Lessons learned from the P50 Psychotherapy Development Center + Applicability to Developing Interventions for Conscientiousness & Neuroticism ................................................................. 14
Day One Discussion ............................................................................................................................................ 16

SESSION 3: Targeted, Mechanism-Focused Stage I Behavioral Intervention Development ............................ 16
Modifying Personality Facets Using the Experimental Therapeutics Approach ............................................ 17
Cognitive and Brain Processes: How to Improve Interventions by Targeting These Mechanisms Directly .. 18
Developing Targeted Behavioral Interventions to Increase Distress Tolerance: Can Facets of Personality Be Modified? ........................................................................................................................................................... 19
Targeted, Mechanism-Focused Stage I Behavioral Intervention Development Discussion ........................... 20

SESSION 4: Revisiting the Stage Model with Technology ................................................................................ 21
Navigating the Stages: Using Technology to Help Understand Mechanisms and to Produce Scalable Behavioral Interventions ................................................................................................................................................ 21
Workshop Discussion ......................................................................................................................................... 22
Discussion Question I ..................................................................................................................................... 22
Discussion Question II .................................................................................................................................... 23

Works Cited ........................................................................................................................................................ 25
INTRODUCTION

The link between an individual’s personality traits and health outcomes later in life has been well-demonstrated in the literature. In fact, research has shown that personality traits measured in childhood predict health and mortality risk in midlife and old age, indicating the strength of the relationship (Kern et al., 2014). In a recent study of older adults, Baek and colleagues (2016) found that personality is linked with components of successful aging, such as cognition, volunteering, and activities of daily living among others. Two personality traits that have particular salience for a person’s health are conscientiousness and neuroticism.

The trait of conscientiousness is characterized by orderliness, industriousness, self-control, responsibility, punctuality, and other related facets. A meta-analysis conducted by Kern and Friedman in 2008 found that being more conscientious is associated with living longer. Additionally, higher levels are conscientiousness are associated with a host of other positive health outcomes, such as reduced stress and lower likelihood of Alzheimer’s disease, while low levels of conscientiousness are associated with riskier health behaviors and other negative health outcomes (Bogg & Roberts, 2013). On the other hand, individuals with high levels of neuroticism, defined as possessing more negative emotions and less emotional stability, are more likely to experience poor health. Studies have shown that higher neuroticism is associated with psychological distress, worse physical health, and poor mental health (Gale et al., 2013; Hengartner et al., 2016). Furthermore, having high levels of neuroticism has been linked with increased physiological stress reactivity, unstable social relationships, and unhealthy behaviors (Lahey, 2009).

The mechanisms and pathways to explain the association between personality and health are as yet undefined, but researchers have begun investigating potential mediators, such as stress exposure, health behaviors, and career success among others (Luchetti et al., 2014; Iacovino et al., 2015; Hampson et al., 2015; Kern et al., 2009). The National Institute on Aging (NIA) Division of Behavioral and Social Research (BSR) supports research to investigate these pathways and to uncover potential opportunities for intervention.

In 2009, BSR convened a teleconference and a series of short papers aimed at articulating an agenda for this field. These papers focused on issues related to conceptualizing and measuring conscientiousness, the malleability and reversibility of personality, pathways linking conscientiousness and health, and the role of genetics in personality. BSR continued this work with a workshop on Conscientiousness and Healthy Aging in 2011 that brought together researchers studying personality across the full life span to explore the developmental origins of conscientiousness, the role of conscientiousness in context, measuring conscientiousness,
intervention approaches, and integrating datasets. These discussions led to a special issue and paved the way for a deeper consideration of how these insights might inform the development of personality-informed interventions to promote healthy aging.

On June 9-10, 2016, BSR built on these previous efforts with a workshop entitled Modifying Facets of Personality to Promote Well-Being and Healthier Aging. This workshop had four main objectives:

1. To review the state of the science of personality characteristics as they relate to health and well-being, and the degree to which they have already been shown to be amenable to modification for individuals as they age.
2. To review existing behavioral interventions related to relevant facets of personality, their putative mechanism(s) of action, and their promise for utilization to modify personality facets to promote healthy aging.
3. To explore the development of targeted, personalized behavioral interventions to modify specific aspects of personality to promote well-being and healthier aging in individuals in mid-life, including the adaptation of relevant interventions in Stage I studies (see https://www.nia.nih.gov/research/dbsr/stage-model-behavioral-intervention-development).
4. To discuss how to integrate basic behavioral science questions with regard to mechanism of action of interventions into the intervention development process.

To tackle these objectives, the workshop was divided into four sessions, with a discussion following presentations in each session. The first day focused on the relationship between personality and healthy aging and on the NIH Stage Model as a framework for intervention development. The second day combined the topics from the first day with a discussion of developing targeted, mechanism-focused, personality-informed interventions in mid-life and the role of technology in doing so. This document presents a summary of each presentation and the emerging themes from the discussions.

WELCOMING REMARKS

In their opening remarks, Drs. Lisa Onken, David Reiss, and Lisbeth Nielsen reviewed the history of NIA/BSR’s interests and investments in work aimed at understanding links between personality traits and age-related health outcomes, and its interest in exploring the potential of this work to inform the design of interventions to promote healthy aging. Dr. Onken highlighted the striking and well-documented associations between the personality traits of conscientiousness
and neuroticism and adult health. She noted that while personality traits are typically thought of as stable and unchangeable, some facets of personality traits, such as anxiety (a facet of neuroticism), have already been shown to be modifiable with existing interventions. Dr. Onken stated the goal of the meeting was to bring together researchers in the fields of personality research, aging, and intervention development to build on BSR’s previous work in this area as well as work done in the larger behavioral intervention development field, and guide BSR in determining if it is possible to develop and/or adapt personality-focused interventions to improve the trajectories and health of people in midlife.

Dr. Reiss highlighted the impressive evidence linking conscientiousness to health outcomes, such as protecting people from dementia and predicting longevity, even from an early age. He challenged the group to consider the following questions: can conscientiousness - or its subfacets - be directly targeted for interventions, is it malleable, and will changing it improve health? He stated that the National Institutes of Health (NIH) Stage Model is a useful conceptual framework for trying to answer those questions and that the public health significance of finding the answers could be huge.

Dr. Nielsen noted that efforts to modify personality may be met with resistance due to the misconception that personality is fixed and the confusion of personality with personal identity. That unease often stems from a misunderstanding of the goals of this work. She offered that, similar to how a major goal of cognitive interventions for aging individuals is to improve cognitive functions such as memory or reasoning, the present project is intended to focus on improving non-cognitive skills and capacities related to personality, such as self-regulation or socioemotional capacity, that if strengthened, may help people achieve better lives.

**SESSION 1: PERSONALITY AND HEALTHY AGING**

The workshop’s first session, entitled Personality and Healthy Aging, was designed to explore the links between personality and health outcomes. In this session, Dr. Brent Roberts presented his work on defining conscientiousness and neuroticism, how those traits are associated with health, and whether personality is malleable enough to be an intervention target. Dr. Antonio Terracciano discussed his research on the role of personality in influencing Alzheimer’s disease and other major health outcomes. Finally, Dr. Margie Lachman gave a talk on the importance of assessing individual differences, like personality, when designing behavior change interventions to promote healthy aging. Together, these talks provided a common foundation on which the
Neuroticism, Conscientiousness, and Healthy Aging: Conceptualization, Measurement, and Intervention Efforts

Brent Roberts, PhD, University of Illinois

The first talk, by Dr. Brent Roberts, focused on the traits of conscientiousness and neuroticism, their relationship to health, their changeability, and their potential as intervention targets. The associations between personality and mental and physical outcomes are high. For example, both neuroticism and conscientiousness predict major psychopathologic disorders. Additionally, conscientiousness has been linked to a variety of other outcomes, including educational attainment, health behaviors, and physical health.

The traits of conscientiousness and neuroticism can be broken down into subcomponents or facets. Facets of neuroticism include anxiety, adjustment, and even-temperedness (Drasgow F., 2012). Facets of conscientiousness include impulse control, responsibility/punctuality, orderliness, industriousness, conventionality, and virtue (Green et al., 2016; Jackson et al., 2010; Roberts et al., 2004). Ongoing research indicates that while self-control and conventionality were the most significant facets for predicting health behavior at the lower order level, the higher order trait of conscientiousness explained most of the associations, indicating that there is something shared by each facet creating those associations. Dr. Roberts posited that what is shared by these facets is an orientation toward the future, meaning that individuals will work hard to anticipate a reward later. However, research remains to be done to demonstrate if future orientation is actually the link among the facets of conscientiousness.

The importance of emotional stability (the opposite of neuroticism) and conscientiousness in predicting health indicates that it may be possible to enhance these traits to improve health. While personality is typically thought of as a poor intervention target because of its lack of changeability, Dr. Roberts pointed out that personality actually does change over the life course and in response to life experiences (Roberts et al., 2006; Luo et al., 2015). Furthermore, a new meta-analysis conducted by Dr. Roberts on the effect of clinical interventions on personality trait change revealed that people who see a therapist improve in emotional stability and, importantly, these improvements happen quickly and are sustaining over time. Dr. Roberts’s work on defining and potentially modifying aspects of personality indicates that there are opportunities in the field of personality research to improve health and wellbeing.
Dr. Antonio Terracciano gave a presentation on the relationship between personality and Alzheimer’s disease and other health outcomes. Alzheimer’s disease and dementia are known to produce changes in an individual’s personality and, in fact, personality change is one of the diagnostic criteria of dementia. Dr. Terracciano posed the question of whether the relationship works in the opposite direction, with personality influencing incidence of dementia. Results from The Baltimore Longitudinal Study of Aging indicate that personality is a risk factor for dementia. Individuals in the top quartile for neuroticism or in the bottom quartile of conscientiousness are at three-fold higher risk for dementia. A meta-analysis indicates that these findings are consistent across studies (Terracciano et al. 2014).

Research on the potential mechanisms to explain this association is mixed. Some individuals have evidence of Alzheimer’s disease pathology before developing dementia, so Dr. Terracciano tested the hypothesis that a person with greater emotional resilience and higher conscientiousness might be able to withstand more Alzheimer’s disease pathology. He found that within persons who have Alzheimer’s pathology, those with high conscientiousness are less likely to show clinical dementia than those with low conscientiousness (Terracciano et al., 2013). However, another study showed that persons with low conscientiousness have more brain tissue loss, meaning that personality could actually have an effect on brain pathology (Booth et al., 2014).

Finally, ongoing work by Dr. Terracciano tests the possibility that Alzheimer’s pathology could lead to a change in personality before onset of dementia, which in turn may explain the associations observed in prospective studies (reverse causality).

Regardless of the mechanism, personality is an important risk factor for Alzheimer’s disease with associations to cognitive decline similar in magnitude to the associations of conditions like hypertension, diabetes, and obesity (Luchetti et al., 2016). Additionally, it is possible that personality contributes to Alzheimer’s risk through such conditions. For example, when looking at the relationship between personality and weight gain or physical activity, researchers found that low conscientiousness is associated with obesity and physical inactivity (e.g., Terracciano et al., 2009; Sutin et al., 2016). Impulsivity-related facets are particularly strong predictors of increased weight gain over the life course (Sutin et al., 2011). It also appears that the relationship is bidirectional, such that weight gain can lead to an increase in impulsivity, creating a vicious cycle (Sutin et al., 2013). The work presented by Dr. Terracciano demonstrates the importance of considering personality as a risk factor for Alzheimer’s disease and other health outcomes.
Dr. Margie Lachman began her talk on considerations for behavior change interventions with an overview of the role of individual differences in health behavior. When considering individual differences, such as personality traits, it is important to think not only about traits individually, but how they interact with each other as well. For example, people who are high in neuroticism, but also high in conscientiousness, have the lowest allostatic load, indicating that some degree of neuroticism may be necessary to engage in health promoting behaviors (N.A. Turiano et al., 2015).

Individual differences in personality related to health can also be seen in personal action constructs, which are a person’s attitudes, beliefs, expectancies, and self-regulatory mechanisms, like self-control and goal-setting. An important component of personal action constructs are control beliefs, or expectancies about how much influence an individual has over outcomes. Feeling more in control is associated with being happier and healthier later in life (Caplan & Schooler, 2003; Infurna, Gerstorf, & Zarit, 2011; Lachman & Andreoletti, 2006). Additionally, control beliefs are associated with conscientiousness, potentially with control beliefs serving as the mediator between conscientiousness and health (Mehta & Yan, 2015). However, control beliefs tend to decline with age, in contrast with conscientiousness and emotional stability, as individuals feel they have less control over their lives as they get older. Consideration of such individual differences when designing behavior change interventions is essential, particularly when conceptualizing control beliefs as a mechanism for behavior change.

Successful behavior change interventions are often multimodal, integrated into everyday life, preventive, remedial, compensatory, and often targeted at vulnerable high risk groups. Midlife is a pivotal period in the life course that is ripe for intervention. Midlife is a unique stage of life because it is the intersection of growth and decline in many domains, age-related changes are beginning to happen, people are thinking about aging, and people in their midlife often need to function at an optimal level while balancing the needs of both older and younger generations. Additionally, those with low socioeconomic status are a more vulnerable group, as health declines among people with low educational attainment are much steeper than those with higher education (Lachman & Agrigoroaei, 2010). This is important because people with low education and low control beliefs are at greater risk for mortality, but people with low education and high control have similar functional health to people with high education (Lachman & Weaver, 1998; Turiano et al., 2014). As a result, figuring out why some people with low education have high
control can provide an opportunity for intervention. Finally, Dr. Lachman noted that it is worth thinking about personalizing interventions in order to tailor them to individual differences. For example, different approaches may be more or less effective depending on level of socioeconomic status, or strategies for increasing the sense of control could be implemented prior to a behavior change intervention when targeting those with a low sense of control.

Personality and Healthy Aging Discussion

The discussion following the first three talks of the workshop centered on two main themes: the need for a common language when discussing personality and related constructs and next steps in the future of personality intervention research. One issue related to language raised by Dr. Carl Lejuez is how receptive people will be to personality interventions. People may not want to change their personality, if that is how an intervention is framed. Meeting participants agreed that what is really being altered is behavior, vulnerability, and risk factors, which people do want to change. Dr. Lachman noted that framing interventions as tailored to fit someone’s personality, rather than to change their personality, would likely be more acceptable in some cases.

A related language issue is that there are varying terms for similar constructs in different fields. Dr. Roberts suggested using more generic language to talk about resources and skills, rather than “emotional regulation” or “conscientiousness,” because interventions already exist to change these constructs, but they have not been linked to the field of personality research. Dr. Nielsen pointed out that clarity and precision of language could also be achieved through efforts to develop common measurement approaches or refined conceptual ontologies for these domains, such as self-regulation, something that is being pursued through a variety of NIA- and NIH-linked activities, including the NIH Science of Behavior Change Common Fund Program. Dr. Linehan reiterated that talking about facets of personality constructs as behavioral patterns could be constructive for intervention development. Dr. Roberts pointed out that the construct of conscientiousness is comprised of multiple facets, and thus can be parsed out for additional levels of analysis.

The discussion also focused on next steps in personality intervention research. The meeting attendees discussed the issue of recruiting and the difficulty of having participants without known disorders join a research study without knowing what outcome would be possible. Dr. Sona Dimidjian stated that the finding that low neuroticism is protective for early biological markers of Alzheimer’s disease might be compelling to participants. Dr. Kathleen Carroll raised that incorporating the physical activity piece could also draw participants. The possibility of
including caregivers for people with dementia was also discussed because collecting data on their thoughts of their own future could be an effective recruitment strategy.

Another possibility in the future of personality intervention research is leveraging existing datasets that include personality measures. Dr. Siegle pointed out that many studies include personality measures that have been analyzed as moderators for treatment effects, but not to see if these measures of personality show change. Dr. Dimidjian echoed this, stating that data on personality have not been published and are waiting to be used.

SESSION 2: THE NIH STAGE MODEL OF BEHAVIORAL INTERVENTION DEVELOPMENT

The second session, The NIH Stage Model of Behavioral Intervention Development, included talks by Drs. Lisa Onken, Sona Dimidjian, Marsha Linehan, and Kathleen Carroll. Dr. Onken presented on the NIH Stage Model and its role in helping researchers maximize the potency and implementability of interventions. Dr. Dimidjian used the NIH Stage Model as a framework for reviewing literature related to mindfulness interventions and describing the state of research in that field. Dr. Linehan discussed the importance of conducting Stage I as often as is necessary—not only to boost treatment effects, but also to address fidelity and training issues prior to implementation and dissemination when developing an intervention, using Dialectical Behavior Therapy as a model. The session concluded with a talk by Dr. Carroll on her work using the NIH Stage Model to ensure that Cognitive Behavioral Therapy interventions developed at her research center worked well when administered by research therapists (in Stage II) and also when administered by therapists in the community (in Stages III and beyond). The goals of this session were to familiarize participants with the Stage Model, discuss how the Stage Model can be applied to developing interventions to modify facets of personality, begin evaluating the field of personality-informed intervention research, and think about next steps for future research.

What is the NIH Stage Model and Why Are We Using It?
Lisa Onken, PhD, National Institute on Aging

Dr. Lisa Onken provided an overview of the National Institutes of Health (NIH) Stage Model. The first iteration of the Stage Model, the National Institute on Drug Abuse (NIDA) Stage Model, contained three stages: creation/modification of the intervention, efficacy, and effectiveness, and attempted to parallel the medications development pipeline. The first stage, in
which interventions could be created or refined, allowed the field to conduct, develop, and pilot
test novel interventions. Although many efficacious interventions were developed, many
interventions that were shown to be efficacious did not turn out to be effective when
implemented in a real-world setting, and most were never implemented at all. One problem was
that many interventions were designed in a way that was not compatible with how service
delivery systems actually work. Interventions are often difficult to implement effectively because
they are complex, difficult to learn, and they require fidelity of administration to work. Another
factor limiting the behavioral intervention development process can be a lack of understanding of
how and why an intervention works, or the mechanisms of action. Understanding mechanisms of
action is essential because interventions can only be adapted for real world use and still retain
their potency if the critical components are intact.

The NIH Stage Model (Onken et al., 2014) updated the NIDA Stage Model to take these
considerations into account, with the guiding principle that intervention development is not
complete until the intervention reaches its maximum level of potency and is implementable with
a maximum number of people. In other words, efficacy is not enough. The updated model
includes six stages. Stage 0 is basic research, which can occur before Stage I, but can be
embedded in all stages by asking questions regarding mechanisms of action. Stage 0, like the
other stages, can be returned to at any time as appropriate and necessary. Stage I is when an
intervention is created, modified, adapted, and pilot tested. Stage I was updated to emphasize the
development of training and fidelity materials, as part of the intervention package. Stage II is
efficacy testing in a research setting, with research providers, while Stage III is efficacy testing
in a community setting, with community providers. Both Stages II and III aim to maximize
internal validity. Stage IV is less highly-controlled effectiveness testing, with a focus on
maximizing external validity. Finally, Stage V is implementation and dissemination research,
with implementing and disseminating a potent intervention as the ultimate goal.

The updated NIH Stage Model is nonprescriptive in that there is no one pathway for intervention
development. The model is iterative and multi-directional, with an emphasis on implementability
and potency as the ultimate goals. The model defines the activities that need to be considered to
maximize successful intervention development to achieve these goals. The model emphasizes the
need to understand mechanisms to bolster effect sizes, add validity to findings, augment research
efficiency, and increase innovation, among other benefits. As a result, the NIH Stage Model
attempts to both advance science while achieving the practical goal of creating powerful
behavioral interventions that can be used in the real world.
Application of the NIH Stage Model to the Development of a Coherent Program of Research: Mindfulness-based Interventions as an Example

*Sona Dimidjian, PhD, University of Colorado*

Dr. Sona Dimidjian presented her work on analyzing the field of mindfulness-based intervention research according to the NIH Stage Model as well as recommendations for developing interventions based on that work. The goals of this project were to ascertain if the field was developing interventions with the maximum potency for the most people and to provide a bird’s eye view of where there were gaps in the research. Dr. Dimidjian found that the majority of studies were in Stage I, there were a handful in Stage II, and very few in Stage III or beyond (Dimidjian & Segal, 2015). Mapping the evidence base in this manner made it apparent that while a number of new interventions were being developed, there were limited attempts to test their efficacy in research settings with rigorous controls, and few attempts to test community efficacy or effectiveness or focus on implementation and dissemination.

Dr. Dimidjian offered six recommendations to address this issue, starting with focusing on what can be changed and for whom. Keeping in mind specific targets and populations prevents researchers from making the mistake of trying to apply an intervention in an arbitrary manner. The second recommendation was to not conflate promise with efficacy, meaning that it is necessary to complete all Stage I work and then go beyond Stage I to test an intervention experimentally. The third recommendation was to uncover the mechanisms of action to find out the crucial components of an intervention. Fourth, researchers should consider skipping to, but not over, Stage III to test the efficacy of an intervention in a community setting (assuming all the necessary prerequisite Stage I work is completed). The fifth recommendation was that efficacy is necessary, but not sufficient for demonstrating effectiveness. Finally, researchers should be cognizant of the risk of over focusing on development without an eye to efficacy, effectiveness, implementation, and dissemination. Failure to address dissemination and implementation directly often can lead to an “implementation cliff” where effect sizes drop when an intervention is implemented in the real world or “implementation limbo” when settings seek to reduce the training or delivery intensity.

Dr. Dimidjian concluded her talk with a description of an intervention called Mindfulness Mood Balance (MMB). She gave an example of a study that integrates basic research, has clearly specified targets, a clearly specified population, and contains a standardized intervention (MMB). MMB is a web-based program aimed at reducing depression in those with a history of recurrent depression. Using a web-based program eliminates the need for training and ensures
that all necessary components are delivered. The initial development study (Dimidjian et al., 2014) showed a decrease in depressive symptoms, but was not a true efficacy test, so MMB will continue to be studied with a randomized trial. Dr. Dimidjian’s work in developing interventions with the Stage Model in mind and the recommendations from her review of mindfulness-based intervention literature provide good examples of how the Stage Model can be used as a framework when developing interventions to modify facets of personality to ensure that the interventions are effective in a real-world setting.

The NIH Stage Model of Behavioral Intervention Development

Discussion

One of the central topics of discussion following Drs. Onken and Dimidjian’s presentations was the need for collaboration among intervention developers and experts in dissemination and implementation. Dr. Siegle pointed out that often researchers are trained in Stage I (creating interventions) and may integrate Stage 0 (basic research) but they are not trained in Stage V (dissemination and implementation). Dr. Dimidjian concurred, stating that this can lead to a myopic focus, and that designing a maximally potent and implementable intervention requires collaboration. Dr. Terracciano said that there should be pressure in the field of interventions to collaborate and try implementing interventions that have already been tested. There was general support among the workshop participants for this concept and some of the participants suggested creating specific funding opportunity announcements (FOAs) as a strategy for encouraging collaboration.

A second theme that emerged from the discussion was the utility of involving service delivery systems in the development stage of an intervention. Dr. Dimidjian noted that one of the important findings from her work on reviewing mindfulness interventions was the need to integrate areas of expertise at every stage. Doing so allows for conversations about barriers in primary care settings, what care recipients are and are not willing to do, and other important considerations. Dr. Linehan expanded on this idea, adding that talking to institutions to determine which aspects of the intervention they are willing to use and if they will make the modifications to their schedules that a treatment might require is essential for dissemination. Dr. Nielsen commented that these strategies could be applicable to institutions with which midlife and older adults engage, such as insurance companies, community organizations, and workplaces, offering potential intervention contexts for aging research.
Thinking about Stage V during Stage I  
*Marsha Linehan, PhD, University of Washington*

Dr. Marsha Linehan oriented her talk around the development and dissemination of Dialectical Behavior Therapy (DBT), which she created as a treatment for high risk for suicide, difficult to treat individuals, most of whom have borderline personality disorder. Dr. Linehan’s presentation highlighted the importance of continually returning to Stage I to refine an intervention in order to ensure that it is maximally efficacious. For example, Dr. Linehan completed multiple Stage I iterations to determine and hone the constructs that should be included in DBT. These studies elucidated that using dialectics to balance teaching both change skills and acceptance/mindfulness skills was the most favorable strategy for both therapists and their clients.

Dr. Linehan then focused her efforts on understanding barriers to implementation and dissemination. Dr. Linehan discovered that it was difficult to ensure fidelity of treatment without oversight from others trained in DBT. To that end, she defined DBT as a team treatment focused on support and attention to fidelity of all therapists.

Dr. Linehan’s next step was to run Stage II studies to evaluate efficacy. These studies found that DBT was efficacious in reducing number of suicide attempts as well as improving outcomes for a host of disorders, including substance dependence, depression, and eating disorders among others (Harned et al., 2008; Linehan et al., 2006; Linehan et al., 2002; Linehan et al., 1999). However, even with promising findings, Dr. Linehan knew that more development work was needed and returned to Stage I to try to understand the mechanisms underlying DBT’s efficacy. By studying the mechanisms, Dr. Linehan hoped to be able to understand the key constructs and principles of DBT, meaning that DBT could be modified where necessary, but still retain the essential components that made it efficacious. Dr. Linehan’s work in developing DBT demonstrates that paying attention to implementation, or Stage V, during Stage I and continuing to return to Stage I to refine the treatment as more information is gained is essential for more efficacious and implementable interventions.

Navigating through the Stages: Lessons learned from the P50 Psychotherapy Development Center + Applicability to Developing Interventions for Conscientiousness & Neuroticism  
*Kathleen Carroll, PhD, Yale University*
Dr. Kathleen Carroll’s presentation provided an overview of the Yale University Psychotherapy Development Center (PDC)’s work to develop an intervention using the NIH Stage Model and some more recent efforts that focus on translation and implementation. The PDC evaluated Cognitive Behavioral Therapy (CBT) in each one of Stages I (intervention development), II (efficacy testing in a research setting), and III (efficacy testing in a community setting) before encountering issues with dissemination and implementation. These challenges included complexity of the intervention, time needed for training, limited clinician time, lack of fidelity and more. One study of clinicians in treatment as usual (TAU) arms of clinical trials of empiric therapies found that the most consistent activity by clinicians was not linked to any specified treatment method. Instead, it was conversation (unrelated to the treatment) with their patients (Santa Ana et al., 2008). In this study, interventions that the clinicians previously indicated they used often in treatment were generally not included in these sessions, indicating that the type of therapy found to be efficacious in the research setting was not being provided in a community setting.

To overcome the fidelity of delivery issue, and to propel the translation from a research setting to a community setting, Dr. Carroll and her colleagues returned to Stage I and modified CBT into a computer facilitated form of CBT, called CBT4CBT. The core principle behind CBT4CBT was to build each module in such a way that the skills being taught are representative of the underlying constructs from CBT. This allows for the delivery of a potent dose of CBT, durability of effects through repeated skills practice, and modeling skills through demonstrations in realistic situations. Three clinical trials have demonstrated the efficacy and durability of effects of CBT4CBT, and plans for the future are to uncover potential mechanisms and test the efficacy and effectiveness of CBT4CBT in more populations (Carroll et al., 2008; Carroll et al., 2009; Carroll et al., 2014; Kiluk, Nich, Babuscio, & Carroll, 2010).

Dr. Carroll concluded her talk by describing ways to engage individuals in treatment. For example, there is the potential for modularizing interventions in order to provide personalized treatment, based on the recipient’s strengths and weaknesses. She also described how contingency management, or providing rewards, was successful in retaining patients in treatment in a proof of concept study that served as the basis for an ongoing clinical trial. This trial will examine the effects of contingency management combined with cognitive control training before receiving CBT4CBT, using neuroimaging to examine neural mechanisms in addition to self-report measures. Dr. Carroll’s work with the PDC and developing CBT4CBT demonstrates that not only is designing engaging treatments important, but paying attention to fidelity issues and mechanisms early on is also essential for developing an efficacious and effective intervention.
DAY ONE DISCUSSION

Key themes emerging from the first day included understanding the importance of skills training and homework in interventions and how continuous measurement can be leveraged to flexibly adapt interventions to an individual’s needs. Dr. Linehan and Dr. Carroll both found that practicing skills predicts outcomes. Dr. Carroll added that completing CBT4CBT homework was a strong predictor of treatment success, which could be a marker of conscientiousness. In fact, there is evidence that studying and doing homework leads to changes in conscientiousness. The meeting participants wondered if it is the content of the skill or the act of practicing the skill that leads to the outcome, which Dr. Roberts suggested could be studied in the future.

Dr. Lisa Marsch remarked on the opportunities technology provides for assessing how people’s personalities and outcomes change over time and how interventions could be flexibly adapted to accommodate those changes. Technological innovations allow for continuous measurement and sporadic access to different tools as people’s needs change. Dr. Siegle added that physiological profiles can also be extracted from data being measured through tools such as Fitbits, instead of only asking self-report questions. Dr. Roberts said there is an ongoing continuous assessment project that looks at state changes in personality, but that it is the first study he knows of using continuous assessment of personality traits. Computerizing interventions to better understand constructs, understanding how skills training leads to better outcomes, and flexibly adapting interventions in response to continuous measurement all represent avenues for potential future research.

SESSION 3: TARGETED, MECHANISM-FOCUSED STAGE I BEHAVIORAL INTERVENTION DEVELOPMENT

This session, Targeted, Mechanism-Focused Stage I Behavioral Intervention Development, included talks by Drs. Arielle Baskin-Sommers, Greg Siegle, and Carl Lejuez. Dr. Baskin-Sommers relayed the importance of designing interventions that are targeted on the underlying etiology of problematic behaviors in order to ensure the intervention is appropriate and efficacious, using externalizing and psychopathic individuals in prisons as an exemplar. Dr. Siegle’s presentation focused on individual differences in brain processes and how interventions can directly target those mechanisms to improve outcomes. Finally, Dr. Lejuez discussed interventions to modify three personality characteristics: distress tolerance, impulsivity, and risk taking. The aims of this session were to demonstrate how facets of various personality traits are
already being modified in clinical settings and underscore the value in developing interventions that target individual differences and mechanisms.

Modifying Personality Facets Using the Experimental Therapeutics Approach

Arielle Baskin-Sommers, PhD, Yale University

In the first talk of the second day, Dr. Arielle Baskin-Sommers presented her work on developing targeted interventions for two different antisocial subtypes: externalizing traits and psychopathy. Individuals with externalizing traits are impulsive, antisocial, deficient in executive functioning, emotionally reactive, low on conscientiousness, and high on neuroticism. Individuals with psychopathic traits are callous, unemotional, impulsive, antisocial, emotionally unreactive, and have abnormal attention control. Psychopathic individuals are emotionally cold and have problematic attention to context whereas externalizing individuals are emotionally reactive and have problematic affective cognitive control. These types of individuals account for the highest costs of treatment in prisons, yet the efficacy of treatment with these individuals is disappointing.

Dr. Baskin-Sommers developed targeted computerized treatments for each type of individual (attention to context training for psychopathic individuals and affective cognitive control training for externalizing individuals). These trainings were based on the principles of cognitive remediation, which trains individuals in particular cognitive skills. In a clinical trial that took place in a prison, half of each type of individual was randomized to the treatment appropriate for their disorder and the other half to the training appropriate for the other disorder. All participants completed tasks that measured attention, emotion, working memory, cognitive control, and distress tolerance before and after receiving the training.

Psychopathic individuals who received the appropriate training (attention to context; ATC) showed an improvement on the trained and non-trained tasks compared to psychopathic individuals who received the affective cognitive control (ACC) training (Baskin-Sommers, Curtin, & Newman, 2015). Externalizing individuals showed improvement on the trained tasks after receiving ACC, but only mild improvement on the non-trained tasks, however, much of this effect was driven by the fact that externalizing individuals who received ATC became much worse. The latter effect could indicate the dangers in providing people with an inappropriate cognitive training that does not take underlying etiology into account. Conduct reports were also examined to see if training effects extended to the real world. Psychopathic individuals who
received ATC had fewer and less severe conduct reports after training compared to prior to training. Externalizing individuals who received ACC had less severe conduct reports. Dr. Baskin-Sommers concluded her presentation with a discussion on the importance of understanding the etiology of behaviors and translating that into targeted treatments.

Cognitive and Brain Processes: How to Improve Interventions by Targeting These Mechanisms Directly

*Greg Siegle, PhD, University of Pittsburgh*

Dr. Greg Siegle described his work on elucidating the neural profiles associated with different affective styles and how to target interventions to address those neural mechanisms directly. To illustrate, three different neural profiles were identified in a cohort of mid-life depressed individuals including reactivity that could yield high negative affect, blunted negative and positive affect, and anhedonia (low positive affect). Research has demonstrated that high negative affect co-occurs with low self-control in the elderly, blunted affect is present in aging, and anhedonia increases with aging (Esposito et al., 2014; Esposito, Rochat, Juillerat Van der Linden, & Van der Linden, 2012; Lemke, Brecht, Koester, Kraus, & Reichmann, 2005; Turner, Capuano, Wilson, & Barnes, 2015). This suggests that midlife is a critical intervention point.

Dr. Siegle described the neural mechanisms involved in processing emotion. For example, in people who display sustained reactions to emotional information (e.g., rumination), brain areas associated with emotional reactivity, such as the amygdala, are more reactive. Regions that regulate emotion, such as the dorso-lateral prefrontal cortex (DLPFC), are less reactive, yielding a high-level reactivity with a lower level of control (Siegle, Thompson, Carter, Steinhauer, & Thase, 2007).

However, there are individual differences in depressed people. People with blunted negative and positive affect may have low reactivity in regions that react to emotion such as the amygdala, and people whose mood tends to fall, even during positive affect, have sustained reactivity in regions that regulate emotion, such as the DLPFC and ventromedial prefrontal area, in response to positive information. Dr. Siegle posited that different interventions might be more effective for each of these groups. Psychotherapy and cognitive therapy work for people with high amygdala reactivity (DeRubeis, Siegle, & Hollon, 2008). Dr. Siegle described two manipulations that could eventually lead to interventions for people with blunted affect. First, individuals who attended a haunted house, where people had a safe place to explore negative affect, described mood improvement and their neural reactivity changed following the experience. Second, an ongoing intervention trial in his lab is using mild electrical stimulation to produce an itchy sensation on the skin, which teaches people to attend to low levels of emotional information.
Developing Targeted Behavioral Interventions to Increase Distress Tolerance: Can Facets of Personality Be Modified?

Carl Lejuez, PhD, University of Kansas

Dr. Carl Lejuez constructed his presentation to focus on the modification of three key personality variables: distress tolerance, impulsivity, and risk taking. Distress tolerance is associated with clinical outcomes such that people who are able to tolerate distressing tasks for longer are more likely to stay in substance use treatment after 30 days. Dr. Lejuez and colleagues conducted a randomized control trial to determine if an intervention called Skills for Improving Distress Intolerance (SIDI) would increase the amount of time participants spend on distressing tasks, which could serve as a proxy for doing better in substance use treatment. Participants who completed SIDI showed increased performance on the distress tolerance tasks compared to participants in treatment as usual or supportive counseling conditions (Bornovalova, Gratz, Daughters, Hunt, & Lejuez, 2012). Distress tolerance is now being studied in a full-scale trial to examine distress intolerance as a mediator for clinical outcomes related to substance use.

Dr. Lejuez also discussed his ongoing work to reduce drinking on college campuses by targeting impulsivity. It is often difficult to obtain student participation in interventions aimed at problem-drinking, so the stated focus of the intervention, which is built on mindfulness techniques, is impulsivity. Preliminary data show that students were willing to sign up and that scores on both impulsivity and alcohol use measures were reduced. Dr. Lejuez is also currently implementing a study to test whether an active executive function training will decrease delay discounting.

Finally, Dr. Lejuez described a balloon popping task he developed to examine a person’s propensity to take risks (Lejuez et al., 2002). In the task, participants are asked to inflate a balloon that will eventually pop, but they have the option to collect money before it pops. Research showed that providing people with the amount of money they would gain if the balloon did not pop increased risk whereas showing people how much money they would lose if the balloon popped decreased risk, although the effect was not long lasting. Another study showed that when high sensation seekers were given a subliminal prime that risk is bad, they were more
likely to take risks, indicating that telling people what not to do can backfire. Dr. Lejuez drew parallels to presentations earlier in the day, stating that tasks such as these can be created and modified in the same way treatments are, depending on what specific process the investigator wants to measure.

Targeted, Mechanism-Focused Stage I Behavioral Intervention Development Discussion

Discussion following the presentations by Dr. Baskin-Sommers, Dr. Siegle, and Dr. Lejuez revisited the topics of terminology differences and continuous measurement, but also covered ideas for different measurement modalities. Dr. Nielsen raised the point that there is a disconnect between behavioral tasks and self-report measures that are intended to measure similar constructs, which Dr. Lejuez attributed to the fact that the tasks might be tapping something different than the self-report measures. With respect to the skills or processes different interventions try to promote, Dr. Linehan noted that creating pro and con lists is an essential skill in Dialectical Behavior Therapy, and wondered how that fit in as a personality characteristic. Other meeting participants thought that this skill might be related to overlapping constructs of future orientation, conscientiousness, and self-control.

Dr. Roberts added that, in order to really understand these constructs and predict long-term outcomes, deep phenotyping through continuous assessment needs to occur. An example would be to repeatedly measure affective reactivity to a stimulus, from which personality traits and phenotypes could be extracted and reassembled. Dr. Marsch agreed that there is a richness of data in sleep, activity, and contextual information, all of which can be measured continuously. Dr. Lejuez also stated that continuous measurement would also be valuable for assessing what is happening around the person as they complete a task or an assessment, and the group echoed the importance of context and environment.

Dr. Dimidjian pointed out that continuous measurement can be done with different modalities and asked about the possibility of coding audio tapes for personality characteristics. Dr. Roberts said that personality can be extracted from tapes, as well as from what someone writes or what they post on Facebook, indicating that there are non-traditional methods of measurement available to assess personality. Dr. Siegle also thought that passively acquired measures, such as voice, video, social media, and accelerometer data, might offer a better picture of people’s lives. Dr. Marsch wrapped up the discussion by illustrating the feasibility of such measures, as most
people do have some form of mobile device and the rates are growing exponentially across the world.

**SESSION 4: REVISITING THE STAGE MODEL WITH TECHNOLOGY**

The final session of the workshop, Revisiting the Stage Model with Technology, focused on how technological innovations can be used to facilitate moving an intervention through the stages. Dr. Lisa Marsch described the benefits of using technology in intervention development and her experiences in incorporating technology into interventions. This session was designed to explore the utility of technology for maximizing the potency and implementability of interventions and to identify ways in which technology can be used in future on the development of personality-informed interventions.

**Navigating the Stages: Using Technology to Help Understand Mechanisms and to Produce Scalable Behavioral Interventions**

*Lisa Marsch, PhD, Dartmouth University*

Dr. Lisa Marsch focused her talk on the promise of technology for modifying behavior, results from randomized control trials using technology, and how technology relates to the fundamental principles of behavior change. Advances in technology offer new opportunities to assess and modify health outcomes with a variety of tools: web/mobile technologies that are easily accessible to many people, mobile and wearable sensing to infer details about health, the ability to look at population trends through social media, and using data analytics for mining data and predictive modeling of outcomes. Additionally, technology-based interventions can be widely disseminated, delivered with fidelity, personalized, and engaging to participants. Not only are technological strategies for modifying behavior change promising, but they are becoming more feasible as access to smartphones and the Internet grows across the world, even in underserved populations.

To illustrate these points, Dr. Marsch provided examples how technology has been used in interventions. She presented results from a randomized control trial that replaced 80% of addiction treatment with mobile technology and found that it was as effective as clinician-delivered treatment. In other studies of addiction, replacing half of the treatment with mobile technology led to increased drug abstinence compared to the standard of care, and adding a
mobile intervention as an adjunct to standard treatment increased treatment retention as well as abstinence. Dr. Marsch reported that these effects have been seen in other types of health behavior, including smoking cessation, depression, and medication adherence, among others.

While evidence shows technology-based interventions can modify behavior, adhering to fundamental principles of behavior change increases their effectiveness. For example, mobile interventions that target mechanisms, such as coping, social support, and self-efficacy, allow for a better understanding of when and how interventions are effective. Additionally, technology offers the ability to create interventions that are flexibly adaptive in response to changes in people and that can be delivered unobtrusively as people move through their daily lives. Dr. Marsch concluded her presentation by highlighting opportunities for the future in technology-based interventions, such as continuous assessment, care integration across multiple health concerns, and personalized medicine.

WORKSHOP DISCUSSION

The final discussion session was organized around two main questions.

1. How ready is the field to develop targeted interventions to modify facets of personality in mid-life to promote healthy aging?
2. What are the next steps? What types of research are most needed, and what can NIA do to support this research?

Discussion Question I

*How ready is the field to develop targeted interventions to modify facets of personality in mid-life to promote healthy aging?*

There was consensus among the workshop participants that the field is well-poised to develop interventions to modify facets of personality in order to promote healthy aging and is currently at Stage I – generation and refinement. Thus, the conversation focused on targeting, specifically developing predictive models to identify individuals most at risk and retaining individuals in technology-based interventions. Dr. Dimidjian asked if models could be built to predict which interventions would work for different people, using already existing data. The group discussed the potential of using available data from previous studies that included personality variables, and cited evidence that personality disorders, if not traits, are predictive of treatment success. Dr. Marsch agreed that this is a worthwhile avenue for research, but cautioned against building
predictive models too soon without rich enough data. If there are too many false positives, people will no longer trust the models. Dr. Lachman reminded the group of additional individual difference variables related to risk and outcomes besides the Big Five personality traits, and emphasized that it will be important that researchers do not have tunnel vision, only focusing on conscientiousness and neuroticism.

Another topic of discussion was how to best keep people engaged in technology-based treatments, as there is a risk for drop-out. Dr. Marsch emphasized the utility of targeting by developing tools that are relevant to the user and that will adapt to his or her changing needs. Dr. Linehan pointed out the importance of making technology interventions desirable and exciting, particularly for older adults, who may be likely to want to see a therapist. Dr. Siegle suggested that a potential method for making interventions compelling to people is to involve the gaming industry. Additionally, people are more likely to spend time on sites or smartphone apps that are relevant and that hit on their concerns, which underscores the importance of targeting. This discussion revealed that researchers designing or adapting interventions for personality research need to target the people most in need and that these interventions need to be relevant and compelling to the recipients in order to keep them engaged.

Discussion Question II
What are the next steps? What types of research are most needed, and what can NIA do to support this research?

Meeting attendees cohered around three overarching themes for next steps in personality intervention research. The first is better define personality constructs; the second is to foster collaborations of researchers who are experts in each of the stages to promote efficacious and effective interventions that are ultimately implemented; and the third is to use technology to overcome barriers related to study design. Dr. Reiss commented on how several of the presenters were able to better understand constructs after modularizing them for computerized interventions, which might be a useful exercise to better understand both conscientiousness as a trait and its lower order facets. Dr. Carroll stated that understanding constructs is essential for delivering interventions that match a person’s needs, as different treatments are appropriate for different individuals. Dr. Onken supported these ideas and said that interventions that have already been developed with a demonstrated effect on conscientiousness and neuroticism can be adapted for midlife and studied to understand mechanisms of change.
An additional avenue to pursue for future research is collaboration. The meeting attendees agreed that NIA could play a role in developing collaborations by requiring them as part of funding opportunity announcements. Two types of collaborations rose to the surface of the discussion as worthy pursuits. First and foremost, the meeting participants discussed providing a framework for creating teams of investigators that combine expertise in basic research (Stage 0), early-stage intervention development (Stages I) as well as efficacy (Stages II and III), effectiveness (Stage IV) and implementation and dissemination (Stage V), so researchers are better able to consider the full range of research necessary to maximize successful intervention development. Secondly, it was suggested that investigators should have a plan in place to make their data available in the future, so others can conduct analyses that might inform future behavioral intervention development research. These strategies could help to promote better and more efficient and ultimately successful research.

The discussion turned to the utility of technology in future research studies. Dr. Siegle noted that it is often difficult to have enough power to truly evaluate the efficacy of interventions in treatment-matching studies, for example, studies where a group of individuals who receive treatment targeted for their specific problem or deficit (matched individuals) are compared with individuals from the same sample who are treated with an intervention not specifically targeted to their specific problem or deficit (mismatched individuals). Dr. Dimidjian offered that using automated methods of recruiting and assessment may help trials to become more efficient and cost effective. Technology also helps overcome design barriers by ensuring fidelity through computerized interventions, which make it easier to test efficacy and effectiveness. Utilizing the strategies for future research suggested by the workshop participants could help advance the field of interventions to modify facets of personality to promote healthy aging.


