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Age-Related Metric Invariance of the BIS/BAS

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AGE-RELATED METRIC INVARIANCE OF THE BIS/BAS

A Capstone Experience/Thesis Project
Presented in Partial Fulfillment of the Requirements for
the Degree Bachelor of Sciences with
Honors College Graduate Distinction at Western Kentucky University

By

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2019

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ABSTRACT

The goals of this study were to examine the suitability of Carver and White's (1994) BIS/BAS for use in adults of different ages, by examining the construct validity of the BIS/BAS, and testing for age-related invariance of the BIS/BAS. In addition, this study predicted that older adults would score higher on subscales of the BIS/BAS related to pursuit of immediate positivity, based on Carstensen's (2006) theory of Socioemotional Selectivity. This study recruited 314 adults under the age of 30, 320 adults of age between 30 and 60, and 341 adults over the age of 60. Participants completed Carver & White's (1994) BIS/BAS, along with measures Carver and White originally used as comparisons to the BIS/BAS: the EPQ-BV, PANAS, and MAS. The study supported the construct validity of the BIS/BAS subscales in each age group. The study also identified metric invariance of the BIS/BAS subscales with respect to the age. This metric invariance, along with construct validity, suggests that the BIS/BAS is suitable for use in adults of all ages, if scores are not compared between adults of different ages. Younger adults tended to score highest on nearly all measures in the study, which did not match our predictions.

Keywords: BIS/BAS, Invariance, Aging, Structural Equation Modeling, Personality

Dedicated to Clover Hornsby.

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INTRODUCTION

The Behavioral Inhibition System / Behavioral Activation System scales are a measure based on Gray's theory of personality (Carver & White, 1994), which has two orthogonally related factors: *impulsiveness* (or BAS in the BIS/BAS), indicating greater reward sensitivity, spontaneity, or sensitivity to positive stimuli, and *anxiety* (or BIS in the BIS/BAS) indicating greater punishment sensitivity, or sensitivity to negative stimuli (Gray, 1981). This measure is the focus of this thesis because few studies have been performed to understand how the aging process influences these two systems or to identify possible threats to validity that might emerge from the aging process. As will be discussed, advancing age is associated with changes in those domains that motivate humans to engage others or to invest cognitive resources into careful deliberation.

At the heart of the BIS/BAS scales are the measurement of one's responsiveness to reward and punishment. With age, emotionality becomes central to one's experience, including what might be perceived as a reward or punishment, especially in social settings. Gray's theory emerged as a modification of Eysenck's personality theory in order to better explain individual differences in conditioning performance as well as neurological differences in arousal (Gray, 1972). Eysenck's theory suggested that the Ascending Reticular Activation System (ARAS) was the neurological structure most important in the biological distinction between introverts and extraverts, as well as in the heightened conditioning sensitivity shown by introverts. Gray modified Eysenck's model based on a number of studies on the effects of sodium amobarbital on conditioning. Gray reports that in these studies, sodium amobarbital inhibited the effect of punishment in conditioning without altering the effect of rewards on conditioning (Gray, 1972). As

sodium amobarbital's behavioral effects resemble those of lesions to the septo-hippocampal area, which was found in other research studies to suppress the activity of the ARAS, Gray suggested that a negative feedback loop between the septo-hippocampal area and the ARAS was responsible for individual differences in introversion and extraversion. Gray associated the septo-hippocampal area with introversion and sensitivity to punishment in conditioning, with the ARAS being associated with extraversion and sensitivity to rewards in conditioning.

Gray later looked at the two components of this negative feedback loop for their individual effects on behavior (Gray, 1981), with the ARAS acting as a system for activating behavior and the septo-hippocampal area acting to restrain behavior. Gray claimed that the personality traits corresponding to these systems were impulsivity in the case of the ARAS and anxiety in the case of the cortex and septo-hippocampal system. These traits of impulsivity and anxiety were viewed by Gray as a rotation of Eysenck's traits of extraversion and neuroticism, with the purpose of better dividing differences in conditioning between individuals.

Carver and White (1994) later created the BIS/BAS scales to serve as a measure of impulsivity and anxiety as defined in Gray's theory. However, unlike Gray's theory, the BIS/BAS scales split the measurement of impulsiveness, or BAS, into 3 subscales: Drive, reflecting a tendency to pursue one's goals; Fun Seeking, reflecting a desire for novel rewards and a tendency to spontaneously approach rewarding stimuli; and Reward Responsiveness, reflecting positive responses to anticipated rewards. In contrast, anxiety remains a single factor, BIS. As the three BAS subscales are closely related to one

another, and Reward Responsiveness is also related to BIS, the BIS/BAS is usually considered to have four oblique factors (Carver & White, 1994), instead of Gray's theoretical two orthogonal factors.

The BIS/BAS Scale

Within the BIS/BAS, the BIS items ask the participant about feelings of anxiety for upcoming negative events (e.g., "I worry about making mistakes.") or negative feelings as the result of a past negative event (e.g. "I feel worried when I think I have done poorly at something."). Many of these items seem to specifically concern feelings of rejection or negative social judgments ("Criticism or scolding hurts me quite a bit."), or sensitivity to negative social contact. Overall, the BIS focuses on inevitable negative events, which are often at least partly social in nature, and how the participant will feel when they occur, or worry about them before they occur.

In contrast to the BIS, the BAS items generally ask the participant about how they feel when something good happens to them (Reward Responsiveness subscale, e.g. "It would excite me to win a contest."), determination to get things they want (Drive subscale, e.g. "I go out of my way to get the things I want"), or impulsivity and a desire for novel experiences (Fun seeking subscale, e.g. "I'm always willing to try something new if I think it will be fun."). In general, the BAS subscale has few items asking about future events, and implies that the test taker has an active role in which events are upcoming, unlike the BIS. The BAS also has no items with an explicit social component, unlike the BIS. This indicates that the BAS has more of a focus on positive events or

outcomes that the participant desires, and which the participant has an active, autonomous role in their occurrence.

Aging and Emotion-Related Motives in Relation to BIS/BAS

According to socioemotional selectivity theory, when time is perceived as limited, people focus less on negative things and are motivated less strongly to pursue long-term goals. Instead, they show a tendency to focus on their present psychological state, including seeking short-term goals and maximizing positive, emotionally meaningful experiences (Carstensen, 2006). As adults age, they tend to perceive time as being more limited, which mayFor instance, when individuals perceive an expansive future time, they are willing to invest more effort into new information and skills (Okun & Schultz, 2003). However, when future time is perceived as limited, individuals focus on maintaining existing relationships.

Additionally, future time perspective impacts how emotional stimuli are processed. People generally display an attentional bias toward negative emotional stimuli, likely due to perceptual enhancements conferred to emotional stimuli and an increased desire to protect one's self from possible threat (Rozin & Royzman, 2001). Older adults, though, display a preference for positive emotional information, directing attention toward positive faces and away from negative ones (Mather & Carstensen, 2003), remembering the positive aspects of choices more so than the negative ones (Mather, Shafir, & Johnson, 2000), remembering positive scenes more so than negative ones (Charles, Mather, & Carstensen, 2003), and expressing less confrontational or hostile

reactivity to negative emotional situations (Birditt, Fingerman, & Almeida, 2005; Charles & Carstensen, 2008)

The aforementioned shift in motivation and concomitant change in reactivity to, attention to, and memory for emotional stimulation may have implications for the Behavioral Activation and Behavioral Inhibition Systems for adults of different ages. One question that emerges from noted age differences in the experience of emotionality is whether scales like the BIS/BAS measure equivalent constructs given that the scales are intended to measure people's motivation and sensitivity to sources of positivity and negativity in one's environment. I might expect to see a decrease in BIS or anxiety as people age, or an increase in some or all of the BAS subscales, to coincide with the expectations of socioemotional selectivity theory.

Prior research in how older adult's responses on the BIS/BAS may differ from younger adults has been conducted by Windsor, Pearson, and Buttersworth (2012), who studied the BIS/BAS in a large scale mixed design study, featuring three age groups sampled three times over a 8-year period to take the BIS/BAS. Windsor et al. (2012) found that younger adults showed higher scores on the BAS subscales of the BIS/BAS than older adults did, and found that the age groups showed little difference on the BIS. They also found that, in all of the age groups, BAS decreased over the 8-year period, while BIS showed little change. This finding is particularly interesting given the predictions posited by socioemotional selectivity theory that advancing age is linked to greater motivation to pursue positive outcomes. In addition, Windsor et al. (2012) tested to see whether the BIS/BAS showed invariance both over time and within the age groups.

Testing for invariance using structural equation modelling is a method for confirming that a measure works similarly in different samples. This testing can also determine what level of similarity is present between the different samples.

Three commonly studied levels of factor invariance are configural, weak, and strong invariance (Timmons, 2010). Configural factor invariance means that a model of traits will fit well for all groups, but not such that the scale scores will necessarily be comparable at all. In other words, the same items in a questionnaire capture the same latent constructs across groups, but not necessarily to the same degree of importance across groups. Weak Invariance, also known as metric invariance, means that a trait has a comparable scale unit in all groups, but not necessarily comparable trait scores. In other words, items that measure a trait do so to the same degree across latent constructs for all groups, but not holding the average levels of the traits equivalent across groups. Strong Invariance, also known as scalar invariance means that a trait score is also directly comparable in different groups, in addition to the trait having comparable scale units and the same model in all groups. Finally, strict invariance means that the error variance is equal in all groups, in addition to every property that a strongly invariant model has.

Windsor et al. (2012) found that both across age groups and over time, the BAS subscales of the BIS/BAS showed weak invariance, while weak invariance of the BIS could only be observed after allowing certain items of the BIS to correlate with one another independently of the construct. They found that strong invariance of either the BIS or BAS subscales was only observed after they eliminated certain items from testing for strong invariance. However, the Windsor et al. (2012) study showed some room for

improvement. Windsor et al. did not attempt to observe how the BIS/BAS's relationships to other, related measures, might change over time. Furthermore, Windsor et al. did not administer the Fun-seeking subscale of the BIS/BAS to all of their samples, limiting the conclusions they could draw based on it.

Another study of the age-related invariance of the BIS/BAS, Pagliaccio et al. (2015), which in addition to including adult age groups also included adolescents and children, found that, while the standard four-factor model from Carver and White (1994) showed relatively poor fit in many age groups, it did not show even configural age-related invariance. However, they found that if a revised version of the BIS/BAS model is used which eliminates the Fun Seeking subscale and four items which tended to perform badly, that a weak invariance model of the BIS/BAS was found to fit their data well. They also noted that strong or strict invariance models of the BIS/BAS demonstrated acceptable fit, but the strong invariance model fit significantly worse than the weak invariance model.

Pagliaccio et al. (2015) also investigated trends in scores on the BIS/BAS subscales by their participant's age, and reported that Drive and Reward responsiveness were predicted to be highest in younger adults, suggesting growth through childhood and adolescence and decline after young adulthood. They suggested that BIS followed a more complex trend over an individual's life, with an initial rapid increase in childhood and adolescence, followed by a slight decline from young to middle adulthood, with some increase after middle adulthood. However, as Pagliaccio et al. (2015) used a cross-sectional design, this may be a result of cohort effects.

Another study used structural equation modelling to understand invariance with the BIS/BAS and focused on invariance by racial group. Demianczyk, Jenkins, Henson, and Conner (2015) found that, for all racial groups, it was necessary to make a series of modifications to the standard model in order to produce good fit. They reported that the BIS/BAS subscales were not unidimensional, but that the observed multidimensionality differed by racial group. Demianczyk et al.'s (2015) final model retains the fun subscale, but removes at least one item from all of Carver and White's subscales to achieve unidimensional subscales.

Current Study

The current study was designed to further examine whether the BIS/BAS measures similar constructs in different adult age groups, including what mean score differences it may show in different age groups, whether the BIS/BAS relates differently to other measures in different age groups, and which types of invariance with respect to age it may show between age groups. I expected that older adults will on average show higher scores on the BAS Fun-Seeking and Reward Responsiveness subscales than younger adults, based on the predictions of socioemotional selectivity theory that older adults, who are more likely to perceive time as limited, would be more strongly motivated to maintain a pleasant emotional state and attend to pleasurable stimuli. However, I expected to see that older adults have lower scores on the BIS and BAS Drive subscales than younger adults, in accordance with the socioemotional selectivity theory (Carstensen, 1995), where older adults are expected to show less motivation toward goals that only show long-term reward as well as a tendency to avoid stimuli associated with a

negative emotional state. I expect to see weak invariance by age group, as I expect there to be mean differences between the groups, but prior research has suggested that the BIS/BAS shows at least partial weak invariance (Windsor et al., 2012).

METHOD

Participant Samples

Three samples of participants of different ages were recruited to examine cross-sectional age differences in responses to the BIS/BAS, including whether the measure is metrically invariant across age groups using a confirmatory factor analysis. The first sample, a sample of 320 college students consisting primarily of younger adults over the age of 18, was recruited via Study Board, an online system for psychology student research participation, from a university in the Southeastern United States. Six students in this sample were over the age of 30, but the remaining $n = 314$ students (143 males, 171 females) ranged in age from 18 to 29 years ($M = 19.2$ years, $SD = 1.5$ years). The second sample consisted of 315 middle-aged adults between the ages of 30 and 58 recruited from Amazon Mechanical Turk (MTurk). Five of the six adult students over the age of 30 from the first sample were added to this one to create a sample (143 males, 171 females) of $n = 320$ middle-aged adults ($M = 45.1$ years, $SD = 6.2$ years). The third sample consisted of 340 adults over the age of 60, also recruited from MTurk. One of the six adult students from the first sample was over the age of 60 and was added to this sample, creating a sample of $n = 341$ older adults (150 males, 191 females) aged 60 to 81 years ($M = 65.3$ years, $SD = 4.3$ years). Tables 1 and 2 provide more information on the racial backgrounds and age distribution of the samples.

Table 1

Percentage of Racial Backgrounds by Age Group

Age Group	American Indian or Alaska Native	Asian	Black or African American	Caucasian	More than one race	Other
Young Adult	1.9%	0.6%	7.6%	85.4%	3.8%	0.6%
Middle-Aged Adult	0.3%	3.8%	4.7%	89.1%	1.6%	0.6%
Older Adult	0.0%	0.6%	5.3%	92.1%	1.5%	0.6%

Table 2

Age Distribution by Age Group

Age Group	Mean	SD	Min	Q ₁	Q ₂	Q ₃	Max	N
Young Adult	19.2	1.5	18	18	19	20	29	314
Middle-Aged Adult	45.1	6.1	30	39	45.5	50	58	320
Older Adult	65.3	4.3	60	62	64	68	80	341

All participants provided informed consent before participating (WKU IRB# 17-265); college students were awarded course credit for participating, and individuals participating through MTurk were compensated with \$1.45 upon completion of the survey and the HIT being returned on MTurk. For the college student sample, study availability was sometimes restricted based on participant gender, to ensure relatively equal numbers of male and female participants. During participant recruitment on MTurk, study availability was restricted based on the possible participant's age and location (United States of America) using filter tools. The middle-aged adult sample was recruited using filters for (a) 35-45 years of age and (b) 45-55 years of age. The older adult sample was recruited using a filter for 55 years of age or older. Additional screening items were included in the online survey software to further hone the age range of the samples to meet the requirements for each age group: young 18-30 years, middle-aged 30-60 years, and older age 60 years and over, and to ensure that the male and female participants would have equal representation. The sample recruited via Study Board might be considered a convenience sample, as it is unclear if younger adults who were not registered at a university would provide the same pattern of responses across the measures used. Samples recruited via MTurk have the potential to be more representative of the population of the United States, as anyone with access to a computer could take part even if not enrolled in a college psychology course. However, self-selection to participate is still a concern for generalizing our findings.

Measures

Participants completed four measures at their own pace. The primary focus of the study was the participants' responses to the BIS/BAS scale (Carver & White, 1994) and to investigate the degree of response invariance observed across age groups. In addition, I included two other measures featured in Carver and White's paper that developed the BIS/BAS scale as well as one additional scale to assess the convergent and discriminant validity of the BIS/BAS across the three participant samples. These measures were the Positive and Negative Affect Schedule (PANAS; Watson, Clark, & Tellegen, 1988) and the shortened form of the Manifest Anxiety Scale (MAS; Bendig, 1956), both included in Carver and White (1994). The final scale was the Eysenck Personality Questionnaire Brief Version (EPQ-BV; Sato, 2005). The EPQ-BV is not the version of the Eysenck Personality Questionnaire used by Carver and White to measure Extraversion in the Eysenck model, but was chosen to also allow comparison of the neuroticism subscale with the BIS/BAS, and was expected to correlate greater than $r = .90$ (Sato, 2005) with other versions of the EPQ. Again, these measures were selected because they (or similar measures) displayed especially strong relationships to the sub-factors of the BIS/BAS scale and were relatively brief and thus easy to administer online with less concern for participant fatigue. All of the measures used in the study are described below.

Behavioral Inhibition System/Behavioral Activation System (BIS/BAS) Scale.

This 24-item scale measures individual sensitivity to punishment and to reward (Carver & White, 1994). Specifically, seven items are BIS items which capture one's sensitivity to punishment and avoidance of negative outcomes through inhibition of behavior, and

13 items are BAS items which capture one's sensitivity to reward and tendencies to seek positive outcomes through activation of behaviors. Two of the BIS items are reverse scored. The 13 BAS items are further divided into three sub-scales: Drive (BAS-Drive, 4 items), or being motivated towards whatever goals one may have; Fun Seeking (BAS-Fun, 4 items), or trying to experience new, exciting sensations; and Reward Responsiveness (BAS-Reward, 5 items), or being motivated to do things for the rewards one expects from performing them. The remaining 4 items are filler items and are not part of any sub-scale. All of the items are mixed in their position in the survey, not separated by sub-scale. For each item, participants rate the degree to which a statement accurately describes them, by using a scale ranging from 1 (very false for me) to 4 (very true for me). All of these scales demonstrated reasonable internal consistencies (measured via Cronbach's alpha) in all samples, especially in the older and middle-aged adult samples, with all alphas being greater than 0.65, which is comparable to Carver & White's paper. The alphas for the BIS/BAS subscales are shown in Table 3. Participant scores on the BIS subscale range from 7 to 28, where higher scores reflect a greater tendency to inhibit behavior. Participant scores on the BAS-Drive subscale range from 4 to 16, with higher scores reflecting a greater tendency toward goal-motivated behavior. Participant scores on the BAS-Fun Seeking subscale range from 4 to 16 with higher scores reflecting a greater tendency to perform behaviors that one expects to be fun. Participant scores on the BAS-Reward range from theoretically range from 5 to 20, with higher scores reflecting a tendency to behavior motivated by the prospect of external rewards.

Table 3

Cronbach's Alpha for BIS/BAS Scales

Subscale	Items	Cronbach's alpha		
		Younger Adults	Middle-Aged Adults	Older Adults
BIS	7	.790	.881	.858
BAS Drive	4	.676	.853	.815
BAS Fun	4	.682	.818	.752
BAS Reward	5	.684	.816	.734

Eysenck Personality Questionnaire Brief Version (EPQ-BV). The EPQ-BV is a 24-item measure of extraversion and neuroticism (Sato, 2005). It is divided into two sets of 12 items. The first 12-item set measures extraversion, or a tendency to seek arousing, usually sociable experiences. The second 12-item set measures neuroticism, or a tendency for emotional instability and experiencing anxiety. For each item, participants answer a question about themselves using a 1-5 scale, where 1="not at all" and 5="extremely". All odd numbered items are part of the extraversion subscale, and all even numbered items are part of the neuroticism subscale rather than the items being blocked by personality sub-scale. Two of the items in the extraversion subscale are reverse-scored. Participant scores on this measure range from 12 to 60 for each personality dimension, where higher scores reflect more intense personality tendencies.

Positive and Negative Affect Schedule (PANAS) Scales. This is a 20-item measure of the amount of positive or negative mood than an individual experiences

(Watson, Clark, & Tellegen, 1998). It is divided into two sets of items. One 10-item set measures positive affect, or pleasant emotional states where people feel energetic and joyful. The other 10-item set measures negative affect, or aversive emotional states where people feel distressed and unhappy. For each item, participants indicate how much they have experienced a feeling over the past week using a 1-5 scale where 1="Very slightly or Not at all" to 5="Extremely." Here, items capturing negative affect (NA) and items capturing positive affect (PA) are mixed in their position in the survey rather than being blocked by mood sub-scale. Participant scores on this measure range from 10 to 50 for each affect type with higher scores reflecting greater levels of affect.

Manifest Anxiety Scale (MAS). The MAS is a 20-item measure of the degree of nervousness or distress experienced by the participant (Bendig, 1956). Each item is a statement about the test taker, which is rated as true or false. Other than for the four reverse-scored items, responding "True" indicates a higher level of anxiety. Participant scores on this measure range from 20 to 40 with higher scores reflecting a greater degree of anxiety and nervousness.

Note that each measure described above can be found in Appendix A. All comparative validity scales had acceptable Cronbach's alphas, indicating strong internal consistency. All Cronbach's alphas for these subscales of each measure in the study are shown in Table 4.

Table 4

Cronbach's Alpha for Comparative Measures

Subcale	Items	Cronbach's alpha		
		Young Adults	Middle-Aged Adults	Older Adults
EPQ Extraversion	12	.918	.946	.923
EPQ Neuroticism	12	.884	.929	.912
PANAS Positive Affect	10	.864	.900	.901
PANAS Negative Affect	10	.824	.921	.900
MAS Anxiety	20	.849	.911	.903

RESULTS

The data from the three samples were examined in three separate sets of analyses. First, participant responses to the measures are aggregated to investigate differences amongst the age groups for each. Second, the discriminant and convergent validity of the BIS/BAS subscales are examined across the entire sample of participants, characterizing differences in the relationships between the measures observed in each age group. Finally, the results of confirmatory factor analyses performed in LISREL are described to investigate the degree to which responding to the BIS/BAS scale is metrically invariant across the age groups.

Group Mean Differences

BIS/BAS. Means and standard deviation for each of the BIS/BAS sub-scales for each age group are shown in Table 5. The average participant ratings for each sub-scale of the BIS/BAS were submitted to a one-way analysis of variance with age group as a between-subjects factor. Post-hoc Tukey's tests were performed to compare the three groups when a significant outcome emerged. For the BIS subscale, there was a significant, although very small, effect of age group, $F(2, 972) = 3.65, p = .026, \eta_p^2 = .007$. Post hoc tests revealed that young adults had significantly greater average BIS scores than did middle-aged adults ($p = .021$). Older adults did not differ from either younger adults ($p = .195$) or middle-aged adults ($p = .586$) on average BIS scores.

The analysis of variance conducted on BAS Drive mean scores showed a small significant effect of age group, $F(2, 972) = 31.20, p < .001, \eta_p^2 = .066$. Post hoc analyses suggested significant differences between all age groups $ps \leq .012$, with young adults

having the highest mean score, followed by middle-aged adults, and older adults having the lowest mean score. The analysis of variance performed on BAS Fun mean scores showed a moderate significant effect of age group $F(2, 972) = 90.23, p < .001, \eta_p^2 = .157$. Tukey post-hoc analysis revealed that younger adults showed significantly greater mean scores than either middle-aged adults or older adults ($ps < .001$) did, while middle-aged and older adults showed no significant differences in mean scores from one another ($p = .818$). Finally, an analysis of variance on BAS Reward mean scores and showed a small, significant effect of age group $F(2, 972) = 16.23, p < .001, \eta_p^2 = .032$. Tukey post-hoc analysis showed that young adults had significantly greater average scores than either middle-aged adults or older adults ($ps < .001$) did, while no significant difference in mean scores was observed between middle-aged adults and older adults ($p = .999$).

Table 5

Descriptive Statistics for BIS/BAS by Age Group

Age Group	BIS		BAS-Drive		BAS-Fun		BAS-Reward	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Younger Adults	21.2	3.9	11.5	2.1	12.3	2.3	17.8	1.9
Middle-Aged adults	20.3	4.9	10.5	2.8	10.0	2.9	16.9	2.4
Older Adults	20.6	4.3	9.9	2.5	9.9	2.5	16.9	2.2

Other Measures. Means and standard deviations are shown for each of the other measures in Table 6. The average participant ratings for each subscale of the other measures were submitted to a one-way analysis of variance with age group as a between-subjects factor. Post-hoc Tukey’s tests were used to compare the three groups when significant differences were found.

Table 6

Descriptive Statistics for Comparative Measures by Age Group

Age Group	EPQ-BV				PANAS				MAS	
	Extraversion		Neuroticism		Positive		Negative		Anxiety	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
YA	38.8	9.8	32.2	9.4	34.3	7.3	21.2	6.7	28.8	4.9
MA	30.5	11.1	28.0	10.9	31.5	7.8	15.2	6.4	26.8	5.7
OA	30.1	9.2	26.0	9.3	31.3	7.6	15.7	6.2	25.7	5.2

Note: YA refers to Younger Adults, MA refers to Middle-Aged Adults, and OA refers to Older Adults

EPQ-BV. The Extraversion subscale of the EPQ-BV showed a significant, moderate effect of age group, $F(2, 972) = 77.72, p < .001, \eta_p^2 = .138$. Post-hoc analysis showed that young adults had significantly higher mean extraversion scores than middle-aged or older adults, $ps < .001$, while no significant mean differences were observed between middle-aged and older adults, $p = .851$. The Neuroticism subscale of the

EPQ-BV showed a small, significant effect of age group, $F(2, 972) = 32.83, p < .001, \eta_p^2 = .063$. Post-hoc analysis suggested that younger adults had significantly higher mean neuroticism scores than middle aged or older adults, $ps < .001$, and that middle aged adults had significantly greater mean neuroticism scores than older adults, $p = .026$.

PANAS. The Positive Affect subscale of the PANAS showed a small, significant effect of age group, $F(2, 972) = 15.83, p < .001, \eta_p^2 = .032$. Post-hoc analysis suggested that young adults had significantly higher average positive affect scores than middle aged or older adults did, $ps < .001$, while no significant mean differences were observed between middle-aged and older adults, $p = .890$. The Negative Affect subscale of the PANAS showed a moderate, significant effect of age group, $F(2, 972) = 85.45, p < .001, \eta_p^2 = .150$. Post-hoc analysis showed that young adults had significantly higher average negative affect scores than middle aged or older adults did, $ps < .001$, while no significant average differences were observed between middle-aged and older adults, $p = .607$.

MAS. The MAS showed a small, significant effect of age group on manifest anxiety, $F(2, 972) = 28.45, p < .001, \eta_p^2 = .055$. Post-hoc analysis suggested that young adults had significantly greater mean scores than middle-aged or older adults did, $ps \leq .001$. Middle-aged adults showed significantly greater mean scores than older adults did, $p = .034$.

Convergent and Discriminant Validity

Convergent and discriminant validity of the BIS/BAS subscales were examined by comparing the correlations of each subscale to one another and to comparative

measures that are supposed to measure similar (or convergent) psychological constructs or differing (or discriminant) psychological constructs. In this section, I will summarize Carver and White's findings (1994). Carver and White did not examine data from multiple age groups, unlike the current study. After this summary, I will describe the outcome of analyses performed separately by age group to examine whether similar patterns emerged across the lifespan.

Although Carver and White (1994) intended for the BIS/BAS to consist of independent (orthogonal) subscales, the BAS subscales were found to have moderate positive correlations with one another (e.g., $r = .20$ to $.30$) and BAS-Reward showed a moderate positive correlation with BIS, while BAS-Drive and BAS-Fun showed very weak, negative correlations with BIS. While Carver and White did not report significance values for correlations among the BIS/BAS subscales, BIS was found to have a moderate positive correlation to BAS-Reward, and very weak, negative correlations to BAS-Drive and BAS-Fun. The BIS was also found to relate strongly and positively to the MAS and moderately and positively to the PANAS Negative Affect subscale. BIS was not found to have a significant relationship to EPQ Extraversion or PANAS Positive Affect. These findings are consistent with the idea that the BIS is assessing sensitivity to negativity in one's environment, as people who report greater anxiety and negative affect also report higher BIS scores. Additionally, these findings suggest that the BIS is independent from measures of social interest and positive emotionality. Although not assessed in Carver and White's study, in the current study, the relationship between the EPQ Neuroticism scale and the BIS/BAS subscales were also examined. I expected that the relationships

between the BIS/BAS factors and neuroticism would resemble what is observed when examining the relationships between the BIS/BAS factors and anxiety scores.

The three BAS subscales were found to relate significantly and positively to the Eysenck measure of Extraversion and to the PANAS measure of positive affectivity. The Reward Responsiveness subscale showed a somewhat weaker correlation to the PANAS positive affect subscale, but a stronger correlation to the EPQ-Extraversion subscale than the other two BAS subscales did, along with being the only BAS subscale to show a moderate positive correlation to BIS. The BAS subscales were not found to have any significant relationship to PANAS Negative Affect, nor to the MAS, and BAS-Fun and BAS-Drive should not show any strong relationship to the BIS. This supports the idea that the BAS is sensitive to positive qualities of one's environment, as people who report greater positive emotionality or social desires. In addition, these findings suggest that the BAS is relatively independent from measures of anxiety or negative emotionality.

In what follows, evidence for convergent and discriminant validity will be discussed for each age group separately. For the current study, correlations between the BIS/BAS subscales as well as other measures are shown in Tables 7, 8, and 9, for younger, middle-aged, and older adults, respectively.

Younger Adults. In the younger adult sample, the BIS does display its expected relationships, showing a strong, positive correlation with MAS, and moderate, positive correlations with PANAS Negative Affect and BAS Reward, consistent with expectations for convergent validity. However, it also shows some weak, but significant negative correlations with BAS Drive, BAS Fun, EPQ Extraversion and PANAS Positive Affect,

which is not consistent with expectations for discriminant validity, where the BIS should show no significant relationship to any of those measures. This seems to indicate that, while the BIS demonstrates good convergent validity in the young adult sample, that its discriminant validity is only partially supported by the data. Although it only displays weak relationships with the unexpected measures, BIS should not show any relationship to measures of sociability or positive affectivity.

The BAS subscales show their expected moderate, significant, positive correlations to one another and to the EPQ Extraversion and PANAS Positive Affect subscales. BAS-Reward also has a moderate, significant, positive correlation with the BIS, as expected. BIS-Fun and BIS-Drive showing a significant, weak, negative correlation with the BIS is again inconsistent with expectations for these measures. The BAS subscales seem to show good convergent validity in the young adult sample. There are some obstacles to demonstrating discriminant validity for the BAS-Fun and BAS-Drive subscales, as these were unexpectedly related to measures of behavioral inhibition.

Middle-Aged Adults. In the middle-aged sample, BIS also shows its expected significant relationships, showing a strong positive correlation with MAS and moderate positive correlations with BAS-Reward, which is consistent with all expectations for its convergent validity. However, it also continues to show an unexpected, significant, negative correlations with EPQ Extraversion, PANAS Positive Affect, and BAS Reward. These relationships are inconsistent with expectations for the discriminant validity of the BIS. This seems to show that, again, the BIS shows good convergent validity but only partial support for its discriminant validity.

Table 7

Correlations of the BIS/BAS for Young Adult Sample

Subscale	BIS		BAS-Drive		BAS-Fun		BAS-Reward	
	<i>r</i>	<i>p</i>	<i>r</i>	<i>p</i>	<i>r</i>	<i>p</i>	<i>r</i>	<i>p</i>
BIS	1		-.195	.001	-.129	.023	.276	<.001
BAS-Drive	-.195	.001	1		.481	<.001	.318	<.001
BAS-Fun	-.129	.023	.481	<.001	1		.328	<.001
BAS-Reward	.276	<.001	.318	<.001	.328	<.001	1	
EPQ-Extraversion	-.161	.004	.384	<.001	.449	<.001	.237	<.001
EPQ-Neuroticism	.384	<.001	-.087	.125	-.008	.889	.147	.009
PANAS-Positive	-.152	.007	.306	<.001	.244	<.001	.245	<.001
PANAS-Negative	.396	<.001	-.007	.905	.089	.116	.049	.386
MAS	.554	<.001	-.101	.074	-.021	.710	.055	.336

The BAS subscales again show their expected relationships as well. Each displayed significant positive correlations to one another as well as to Positive Affect from the PANAS and Extraversion from the EPQ. These relationships confirm the convergent validity of the BAS subscales. BAS Reward also displayed the expected significant, moderate, positive correlation with BIS, as observed in Carver and White (1994). However, some unexpected relationships were observed for the BAS Fun and BAS Drive subscales. BAS Fun had an unexpected weak, significant, negative correlation with BIS, and BAS Drive had unexpected, weak, significant, negative correlations with

EPQ Neuroticism and the MAS. These relationships suggest that, while all three BAS subscales show convergent validity and BAS Reward shows good discriminant validity, the BAS Fun and BAS Drive subscales only partly show the relationships needed to support their discriminant validity.

Older Adults. Lastly, in the older adult sample, BIS again shows its expected significant, strong, positive correlation with MAS, and its significant, moderate positive correlations with BAS Reward and PANAS Negative Affect, consistent with all expectations for the convergent validity of the BIS. However, it shows unexpected, significant, moderate, negative correlations with the PANAS Positive Affect and EPQ Extraversion, which is not fully consistent with expectations for the discriminant validity of the BIS. It appears that, similar to the other two samples, BIS shows good convergent validity in the older adult sample, but there are some concerns for its discriminant validity.

The BAS subscales again show their expected relationships in the older adult sample, with all of the BAS subscales showing strong, positive, significant relationships to one another, and positive, significant relationships to EPQ Extraversion and PANAS Positive Affect, consistent with expectations for the convergent validity of the BAS subscales. However, the relationship of the BAS subscales with PANAS Positive Affect seems somewhat weaker than expected, which may be a slight concern for the convergent validity of the BAS subscales, especially BAS Fun. BAS Reward shows its expected moderate, significant, positive correlation with BIS, consistent with expectations for the convergent validity of BAS Reward. The only unexpected significant correlation that any

Table 8

Correlations of BIS/BAS for the Middle-Aged Adult Sample

Subscale	BIS		BAS-Drive		BAS-Fun		BAS-Reward	
	<i>r</i>	<i>p</i>	<i>r</i>	<i>p</i>	<i>r</i>	<i>p</i>	<i>r</i>	<i>p</i>
BIS	1		-.099	.078	-.167	.003	.262	<.001
BAS-Drive	-.099	.078	1		.394	<.001	.431	<.001
BAS-Fun	-.167	.003	.394	<.001	1		.324	<.001
BAS-Reward	.262	<.001	.431	<.001	.324	<.001	1	
EPQ-Extraversion	-.286	<.001	.448	<.001	.422	<.001	.306	<.001
EPQ-Neuroticism	.701	<.001	-.061	.275	-.031	.576	.112	.045
PANAS-Positive	-.217	<.001	.401	<.001	.252	<.001	.346	<.001
PANAS-Negative	.424	<.001	-.137	.014	-.020	.728	-.020	.723
MAS	.641	<.001	-.145	.009	-.037	.506	.050	.374

of the BAS subscales show is that BAS Reward shows a significant, weak, negative correlation with the MAS, which is not consistent with expectations for the discriminant validity of the BAS Reward subscale. The overall convergent validity of the BAS subscales seems to be mostly supported by the data. The discriminant validity of the BAS subscales also seems to be supported by the data, with minor deviations for BAS Reward, which displayed a significant but weak correlation with the MAS.

Table 9

Correlations of BIS/BAS for the Older Adult Sample

Subscales	BIS		BAS-Drive		BAS-Fun		BAS-Reward	
	<i>r</i>	<i>p</i>	<i>r</i>	<i>p</i>	<i>r</i>	<i>p</i>	<i>r</i>	<i>p</i>
BIS	1		-.020	.710	-.038	.487	.329	<.001
BAS-Drive	-.020	.710	1		.453	<.001	.431	<.001
BAS-Fun	-.038	.487	.453	<.001	1		.324	<.001
BAS-Reward	.329	<.001	.431	<.001	.324	<.001	1	
EPQ-Extraversion	-.268	<.001	.313	<.001	.383	<.001	.216	<.001
EPQ-Neuroticism	.709	<.001	-.007	.891	.005	.922	.155	.004
PANAS-Positive	-.250	<.001	.232	<.001	.142	.009	.283	<.001
PANAS-Negative	.460	<.001	-.046	.401	.010	.859	.094	.084
MAS	.586	<.001	-.048	.382	.026	.626	.117	.030

Confirmatory Factor Analysis to Test Metric Invariance

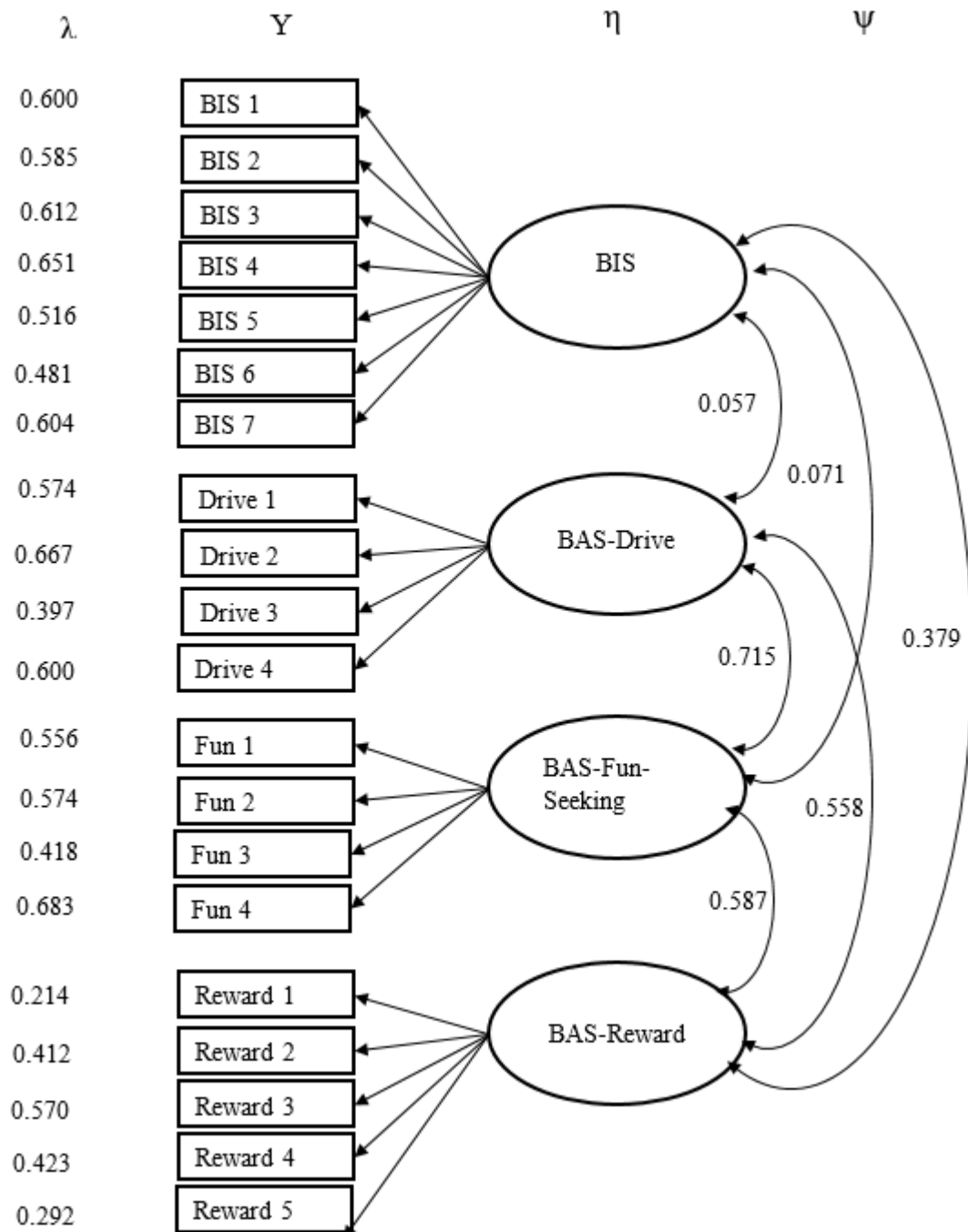
Confirmatory factor analysis (CFA) was used to examine the four-factor model of the BIS/BAS used by Carver & White, with the three samples I recruited being treated as three groups in the LISREL analysis, which are required to use the same model specifications (i.e., configural invariance), but which are not otherwise required to be similar to one another. The four factors in the model match the four subscales reported earlier: BIS, BAS-Drive, BAS-Fun, and BAS-Reward. Each item in the survey loaded onto one of the factors, with the first item in each factor having a fixed loading of 1.0 to

provide a reference point to compare the loadings of the other items to, as the other items did not have a fixed loading on their factor. I allowed the factors to relate to one another freely, as covariance between the factors of the BIS/BAS was expected. To investigate fit of models with different types of invariance, goodness of fit indices were used to capture model fit. These included the maximum likelihood ratio chi-square, the comparative fit index (CFI), and the root mean square error of approximation (RMSEA). With respect to RMSEA, values ≤ 0.10 show tolerable fit, with lower reflecting better model fit (Kenny, 2015). For the CFI, values ≥ 0.9 generally indicate good fit (Kelloway, 1998).

The four-factor measurement model of the BIS/BAS appears to show tolerable overall. This model includes all participants and does not separate them into the three different age groups. Figure 1 shows a path diagram of the measurement model, using the standardized solution coefficients for λ and ψ s. The path diagram shows how each item (Y) of the BIS/BAS loads only onto its corresponding factor, or η , and allows for comparison of the relative strengths of these loadings, or λ s. Additionally, it shows that the factors of the BIS/BAS are allowed to freely vary with one another, and shows the strengths of these covariances, or ψ s. The Chi-Square reported, 1237.898, is significant, with $p < .001$, although chi-square is biased towards significance with large samples (Kenny, 2015), and the total sample size is $N = 975$, so it is not surprising that the Chi-Square is significant. The CFI is 0.849, which is less than .9, which does not indicate good overall fit, although it could be much worse. The RMSEA is 0.0820, with a 90% confidence interval between 0.0777 and 0.0863, which is within the tolerable region, at less than 0.1, although lower values than would be preferable.

Figure 1

Path Diagram for the Measurement Model



Measurement Invariance

Structural equation modeling using the framework from the CFA was used to examine age group differences to observe whether the BIS/BAS was invariant across age groups. In order to identify the degree of metric invariance in a model, increasingly more constrained structural models are tested to observe whether there is a significant decrease in fit (Timmons, 2010). When increasing the constraints fails to significantly reduce model fit, the more parsimonious model constraining similar loadings and relationships across groups is accepted.

I began by testing a configurally invariant model. If configural invariance is supported, then the factor structure is similar between groups, although the items may have different loadings onto the factors and the mean scores are not comparable. In this model, all three samples were used as a separate group in the analysis and the covariance matrices for each group were first set to estimate the four-factor model from the CFA with no constraints on the item intercepts and factor loadings, with the exception of the first item loading on each factor being constrained to be 1.0. In other words, for each age group, item loadings on each BIS/BAS factor were estimated separately and the pattern matrix of the loadings was constrained to not deviate from the four-factor model. This model's path diagram, using within-group standardized coefficients is depicted in Figure 2. This path diagram reports the factor loadings and covariances of each group independently, but shows that each group is constrained to use the same model.

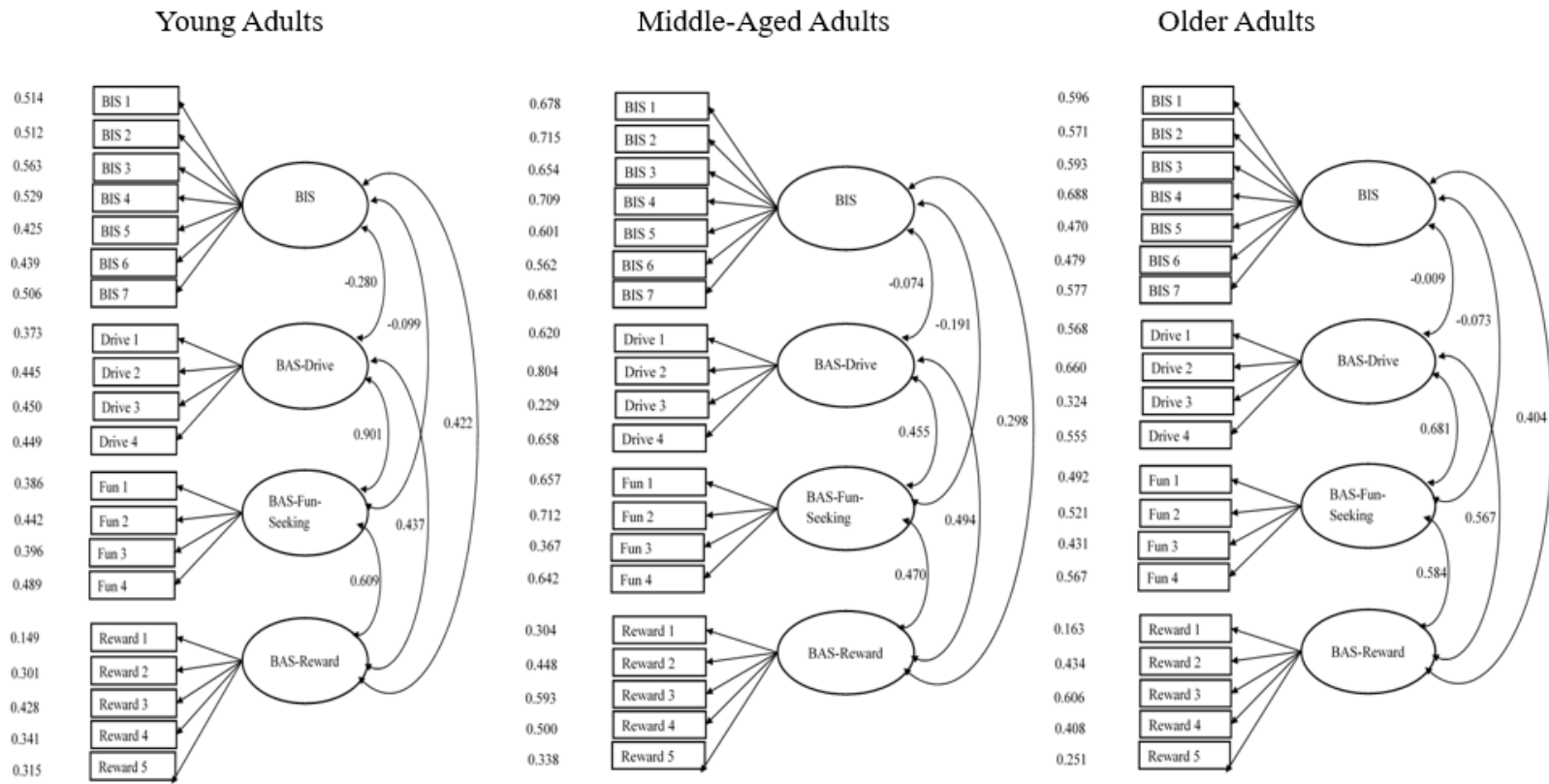
The configural model was observed to fit better than the measurement model, supporting configural invariance. Measures of model fit of the configurally invariant

model, as well as other models of invariance are shown in Table 10. In the configurally invariant model, the Chi-Square was significant, although the configural model has the same total sample size as the measurement model, so again, it is not surprising that for $N = 975$, that the Chi-Square test is significant. It is worth noting that the configurally invariant model had an increase of 313.033 Chi-Square and an increase of 328 degrees of freedom, relative to the measurement model, which is not a significant increase, $p = 0.715$. The CFI showed greatly improved fit with a value of 0.916, which is both above the 0.9 threshold for good fit and .067 above that reported in the measurement model, a significant increase by the standard of a change in CFI above 0.01 being significant. The RMSEA was nearly identical to that of the measurement model at 0.082. As the data supported configural invariance, I tested the next level of invariance, weak factorial invariance.

Figure 2

Configural Invariance Path Diagram

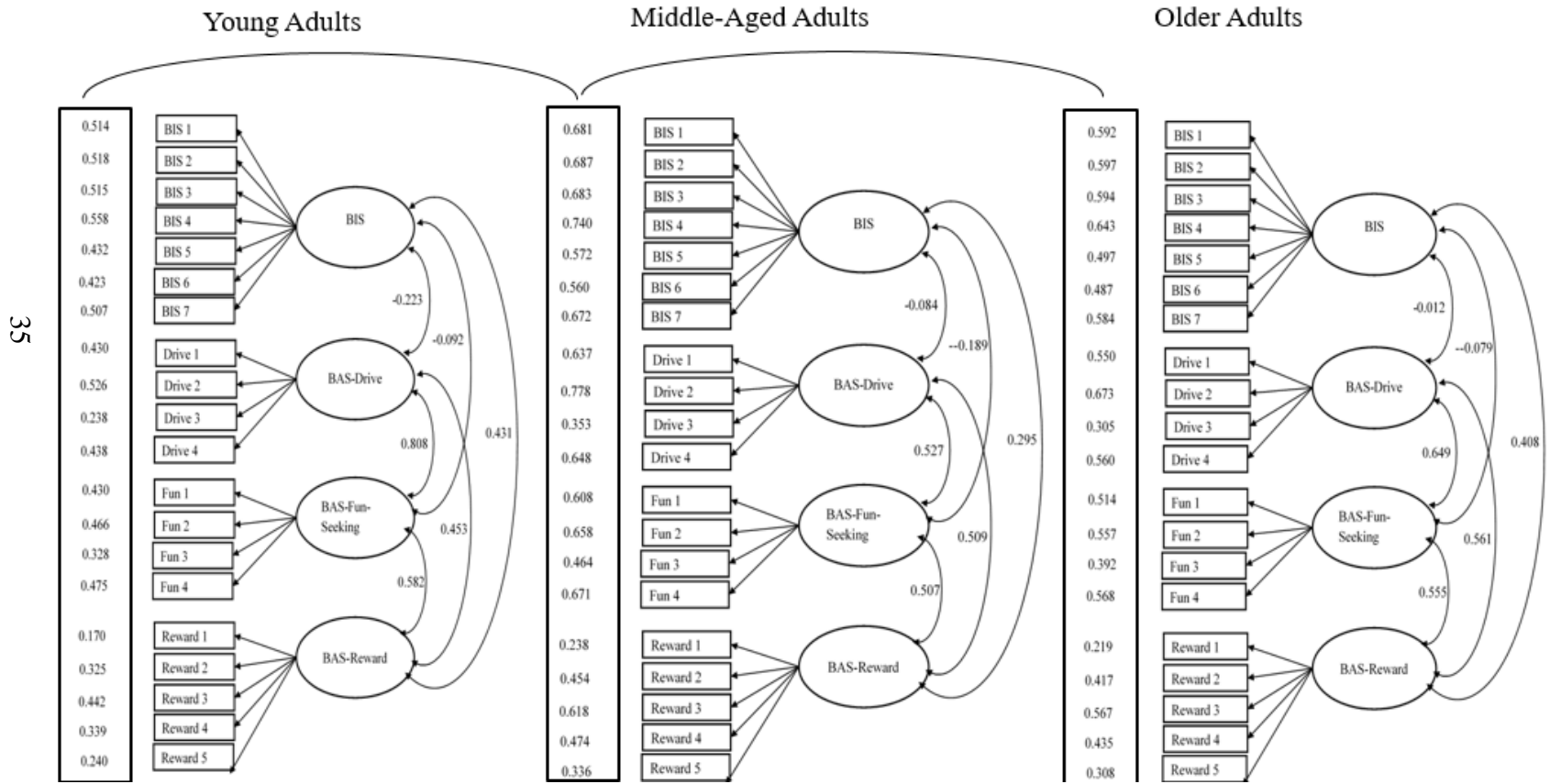
33



In this weak metric invariance model, all groups were constrained to have identical factor loadings, but the item intercepts were not constrained between samples. The path diagram for this weak invariance model, using within-group standardized coefficients, is shown in Figure 3. This path diagram shows that the factor loadings in each group are constrained to be equal, although the within-groups standardization may result in some appearing different. If the weakly invariant model does not fit significantly worse than the configurally invariant model, then weak invariance may be assumed (Timmons, 2010). This means that the latent factor scores share a unit of measurement in all groups, and participants in all groups are likely responding to the questionnaire in a similar manner. However, with this model, scores on measures are not directly comparable between participants in different groups because there may be different average scores between groups. If there is not a significant change in the Chi-Square, less than a 0.01 change in the CFI, and the RMSEAs remain within each other's 90% confidence interval (Timmons, 2010), then the models can be assumed to have no significant difference in their goodness of fit, allowing us to tell whether an increased level of invariance can be assumed. I found that while there was a significant change in Chi-Square, $p < .001$, that the change in CFI was only 0.002, and that the RMSEA was within the 90% CI of the configural invariance model, suggesting that overall, the data supports weak invariance with respect to participant age group.

Figure 3

Weak Invariance Path Diagram



Finally, I tested a strongly invariant model where the indicator means were constrained to be equal in all three samples. If the strongly invariant model does not fit significantly worse than the weakly invariant model, then strong invariance may be assumed where in addition to sharing a unit of measurement, the groups also have comparable latent means on the factors, allowing for meaningful direct comparison of scores in one group to the others. Another significant change in Chi-Square was found, $p < .001$, the CFI decreased by 0.025, and the RMSEA greater than the 90% CI upper bound of the weak invariance model RMSEA. These suggest that overall; the data does not support strong invariance with respect to participant age group, as the model fits significantly worse than the weakly invariant model.

Table 10

Goodness of Fit Statistics for Models of Invariance

Statistic	Configural	Weak	Weak -		Strong -
			Configural	Strong	Weak
Chi-Square	1550.931	1614.849	63.918	1953.603	338.754
Chi-Square Df	492	524	32	556	32
CFI	0.916	0.914	0.002	0.889	0.025
RMSEA	0.0815	0.0801	0.0014	0.0880	0.0079
90% RMSEA					
Lower Bound	0.0769	0.0757		0.0838	
90% RMSEA					
Upper Bound	0.0861	0.0846		0.0923	

Summary of Results

First, the mean scores on each of the scales administered to the participants were observed for differences between the samples using one-way ANOVAs with age group as a factor. A significant, although small effect of age was observed in all of the measures used. Young adults had higher mean scores on all of the measures than older or middle-aged adults did, with the exception of the BIS, where younger adults had significantly higher mean scores than middle-aged adults, but not older adults. Middle-aged adults typically showed no significant differences in mean score relative to older adults, with the

exception of the BAS-Drive, EPQ-Neuroticism, and MAS subscales, where middle-aged adults showed significantly greater levels of the trait than older adults did.

Next, the convergent and discriminant validity of the BIS/BAS subscales was observed in each sample by comparing the correlations found in the sample to those originally observed by Carver and White (1994). In general, the convergent validity of each of the BIS/BAS subscales was supported by the data, but there were some concerns for the discriminant validity, due to the subscales showing small, significant correlations with unexpected subscales of the comparative measures.

Finally, using LISREL, the invariance of the BIS/BAS across age groups was examined. The four-factor model of the BIS/BAS, using the subscales defined by Carver and White (1990) showed at best a tolerable fit for when all three samples' data were aggregated, however it showed much improvement when the three samples were freed to have independent pattern matrices, factor correlation matrices, and indicator and factor means.

As this was done using the same four-factor model, with the only difference being that the data were broken into the samples, it can be observed that the four-factor model does fit the data acceptably if the groups are considered independently. This suggests that the data support configural invariance, where the model factors and pattern matrix are identical in all three samples. Next, a weakly invariant model was tested, meaning that the factor loadings were constrained to be identical in all three groups, and this was observed to not fit significantly worse than the configural model, suggesting that the data also supports weak invariance of the BIS/BAS, meaning that the BIS/BAS shares a unit

of measurement in all age groups. Finally, a strongly invariant model where the mean score on each item was constrained to be equal in all groups was tested, and this was observed to fit significantly worse than the weakly invariant model, suggesting that the data does not support strong invariance, that the factors do not have identical means in each sample, and that the scores of the different samples are not directly comparable.

DISCUSSION

In this study, I examined potential differences in how adults of different ages responded to the BIS/BAS scales. I investigated what mean differences I might find between the age groups and whether differences on the BIS/BAS subscales might relate to predictions stemming from lifespan developmental theories of emotion experience, such as socioemotional selectivity theory. This theory predicts that younger adults experience time as expansive and are expected to focus more on negative things than on positive and on potential long-term rewards rather than only immediate rewards. Older adults, however, have a limited future time orientation and should show more of an interest in positive or enjoyable things and social engagement. In addition, I looked at whether the BIS/BAS would demonstrate acceptable construct validity between age groups, by observing its relationship to some of the scales that Carver & White (1994) used, in each sample. Finally, I was interested in whether the results suggested that the four-factor model of the BIS/BAS was appropriate for all age groups, and which forms of invariance, if any, the four-factor model might show between age groups.

On the BIS, younger adults were expected to score higher than middle aged and older adults. On the BAS, older adults were expected to score higher than younger adults. These hypotheses were only partly supported. Older adults did not show significantly greater scores on BAS-Fun or BAS-Drive than younger adults, which are the scales of the BIS/BAS most strongly linked with the pursuit of positive emotionality in the present and near future, which is predicted to be an increased focus in older adults, according to Carstensen's (1995) socioemotional selectivity theory (SST). While younger adults did

show significantly higher scores on BAS-Drive and BIS than older or middle-aged adults, they showed a significantly higher scores on all other subscales of the surveys administered, with the exception of BIS, where young adults did not score significantly differently than older adults. The mean differences between age groups on the scales administered do not seem to be overall, consistent with SST, given that older adults do not show increased scores on any measures associated with pursuit of positive emotionality, such as BAS-fun or BAS-Drive. Older adults also do not show higher self-reported positive emotionality on associated measures such as the positive affect scale of the PANAS. However, it is possible that, given that the survey does not ask about future time, future time perception may be less salient to participants despite differences in age.

Perhaps the age differences observed in the mean levels of the BIS/BAS and other scales emerged due to the focus that these measures have on assessing emotionality in connection with relatively high arousal emotions, such as excitement or anxiety. In particular, Kessler and Staudinger (2009) argued that the PANAS shows an excessive focus on high arousal emotional states, and suggest that the expanded version of the PANAS may allow for a more thorough understanding of affectivity with aging. This expanded version includes more affective states, including low arousal positive and negative affect (e.g., contentment and sadness, respectively). Bendig's (1956) revision of the MAS was designed to assess strong anxiety in a clinical setting originally, so it places a large focus on intense feelings of anxiety as well. The EPQ's extraversion subscale focuses on the participant's excitement and liveliness, while its neuroticism subscale focuses on anxious feelings. Even in the BIS/BAS, the BIS focuses on anxious feelings

and guilt, while the BAS subscales focus on intense positive experiences or emotions. Of the 13 items in the BAS subscales, four use some form of the word “excite.”

Other theories of emotion regulation, such as the Strength and Vulnerability Integration framework (SAVI) (Sands, Garbacz, & Isaacowitz, 2016), suggest that there is an increased effort to remain in a low-arousal state in older age, and that the positivity bias observed in older age is partly a result of this desire for a low arousal state. However, Sands et al. (2016) noted that, while older adults do show an increased positivity bias, older adults show less of a preference for high arousal positive emotional states than younger adults do. This may provide an alternative explanation for why younger adults had higher scores on nearly all the measures I administered, given that our measures tended to show a focus on high arousal states. Future studies should investigate how desire for high or low arousal levels relate to the BIS/BAS and include measures, which are better able to examine low arousal states and preferences for low arousal states.

In all age groups, I found evidence to support the construct validity of the BIS and the BAS subscales as a group. This, along with the weak invariance I observed, suggests that, while scores between people of different age groups on the BIS/BAS should not be directly compared, the BIS/BAS should be valid and appropriate for participants of all adult ages. Future studies exploring the construct validity of the BIS/BAS in participants of different ages in more detail would still be desirable, especially attempting to explore the construct validity of the BAS subscales, as this study did not include any measures expected to relate differently to each BAS subscale individually, such as Cloninger’s Tridimensional Personality Questionnaire.

The results do support our expectation that weak invariance between age groups would be observed, and that the four-factor model would provide an adequate fit to the data I collected. While the four-factor model does not show an ideal fit to the data, it provides an acceptable fit for all of the samples, especially when the samples are considered as different groups in the analysis. This somewhat contrasts with other studies on the invariance of the BIS/BAS, which have usually required modifications to the factors in order to observe weak invariance or partial weak invariance. Windsor et al. (2012), for example, allowed correlated residuals for a few items, and freed some item intercepts across age, in order to observe partial weak invariance, and did not include the BAS Fun Seeking scale in the model. As the four-factor model demonstrated acceptable fit, this study did not attempt to explore alternative models. In particular, future attempts to explore the existence of a general BAS as a second order factor would be of interest. While the existence of the general BAS factor is suggested by Carver and White, previous studies, such as Voigt et al. (2009), have questioned whether a general BAS factor does exist. This study did, however, suggest that the BAS subscales may not show parallelism, an indication of whether a second order factor may be present, as the BAS reward subscale shows a different sign in a few correlations than the other two BAS factors, most notably with BIS.

It is difficult to judge how these results may relate to Gray's theory of personality, especially the revised version of Gray's theory (McNaughton & Gray, 2000; Smillie, Pickering, & Jackson, 2006) which adds the Fight-Flight Freeze System (FFFS), which is wholly unrepresented in the BIS/BAS. The BIS/BAS may also not be an ideal metric of

Gray's personality traits, as it is based upon an older version of Gray's theory, and lacks a scale for the FFFS. Due to the addition of the FFFS to newer theories, the BIS is thought to play a less direct role in the inhibition of behavior. Finally, the BIS/BAS has never had a scale for BAS as a whole, and may not even show BAS as a second order factor of the BAS subscales.

Due to the design of the study, there are some further limitations of the results. As the study was cross-sectional, it is impossible to separate age effects (i.e., participants' progression through the years) from cohort effects in the result, and this is further compounded by the young adults having been recruited by a different method than the older cohorts. Younger adults were recruited for a different incentive than older adults, and were not recruited via Mechanical Turk. Younger adults also took a version of the survey with different attention checks than older adults did. While these differences in recruitment conditions were not considered likely to themselves create significant differences between the samples, future studies would ideally recruit all participants identically. In addition, as the study was conducted electronically, it is possible that some participants misrepresented their age, or other demographic characteristics, although the moderate reward of the study should not have been enough to encourage such behavior. Furthermore, some participants may have participated multiple times in a sample, or have been bots (i.e., non-human responders with the purpose of completing tasks to generate revenue in MTurk). However, this seems unlikely, as while five repeat attempts were identified and removed from the data collected, no signs of automated activity, such as many attempts from the same IP address or attempts with identical responses, were

found. It is also possible that some participants may have responded inattentively, although attention checks were provided during the survey to each of the samples.

Conclusion

Our initial hypotheses on mean age group differences based on the predictions of SST were not supported by our results, as older adults did not show higher scores on BIS/BAS subscales conceptually related to immediate positive affectivity (BAS Fun, and BAS Reward). I observed that younger adults showed significantly higher scores on nearly all of the subscales in the survey. Given that all of the scales used in the survey show a focus on high arousal emotions, this may instead suggest an age-related preference for low-arousal emotions and situations as people age, as suggested by Sands et al. (2016)'s Strength and Vulnerability Integration framework.

However, the BIS/BAS should be appropriate for use in participants of all ages, provided that numeric scores on the BIS/BAS do not need to be directly compared between people in different age cohorts. Evidence supporting the construct validity of the BIS/BAS was observed when it was administered to participants of different ages. In addition, using Carver and White (1994's) four-factor model of the BIS/BAS, I observed weak invariance between age groups, supporting the use of the four-factor model for the BIS/BAS. Weak invariance being observed indicates that in all age groups, there is a common unit of scale for items on the BIS/BAS, and that factor loadings of the items are the same in all groups. I did not observe strong invariance, which suggests that scores on the BIS/BAS items are not meaningfully comparable between different age groups. This might be consistent with SAVI, as if younger adults show a greater preference for high

arousal situations, as mentioned in most of the BIS/BAS, even if younger and older adults show similar item interpretations, that I might expect to see differences in item responses, as many items of the BIS/BAS focus on high arousal situations.

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APPENDIX: SURVEY ITEMS

BIS/BAS

Each statement was presented with the following four answer choices:

“very false for me”

“somewhat false for me”

“somewhat true for me”

“very true for me”

Very false for me is scored as a one, somewhat false for me is scored as a two, somewhat true for me is scored as a three, and very true for me is scored as a four. The scores on each item of a subscale are summed to create the overall score on the subscale.

Items 2, 8, 13, 16, 19, 22, and 24 are the BIS subscale, with items 2 and 22 being reverse scored.

Items 3, 9, 12, and 21 are the BAS-Drive subscale.

Items 5, 10, 15, and 20 are the BAS Fun-Seeking subscale.

Items 4, 7, 14, 18, and 23 are the BAS-Reward subscale.

Items 1, 6, 11, and 17 are “filler” items and are not counted as part of any subscale.

1. A person’s family is the most important thing in life.
2. Even if something bad is about to happen to me, I rarely experience fear or nervousness.
3. I go out of my way to get the things I want.

4. When I'm doing well at something, I love to keep at it.
5. I'm always willing to try something new if I think it will be fun.
6. How I dress is important to me.
7. When I get something I want I feel excited and energized.
8. Criticism or scolding hurts me quite a bit.
9. When I want something, I usually go all-out to get it.
10. I will do things for no other reason than that I think they might be fun.
11. It's hard for me to find the time to do things such as get a haircut.
12. If I see a chance to get something I want I move on it right away.
13. I feel pretty worried or upset when I think or know somebody is angry at me.
14. When I see an opportunity for something I like, I get excited right away.
15. I often act on the spur of the moment
16. If I think something unpleasant is going to happen, I get pretty "worked up."
17. I often wonder why people act the way they do
18. When good things happen to me, it affects me strongly
19. I feel worried when I think I have done poorly at something important.
20. I crave excitement and new sensations.
21. When I go after something, I use a "no holds barred" approach.
22. I have very few fears compared to my friends.
23. It would excite me to win a contest.
24. I worry about making mistakes.

EPQ-BV

All items were presented with the following five answer choices:

“Not at all”

“Slightly”

“Moderately”

“Very much”

“Extremely”

“Not at all” is scored as a one, “Slightly” is scored as a two, “Moderately” is scored as a three, “Very much” is scored as a four, and “Extremely” is scored as a five. All of the odd items are on the Extraversion subscale, and all of the even items are on the Neuroticism subscale. Items 13 and 19 are reverse scored. The score on each subscale is created by adding all the item scores.

1. Are you a talkative person?
2. Does your mood often go up and down?
3. Are you rather lively?
4. Do you ever feel miserable for no reason?
5. Do you enjoy meeting new people?
6. Are you an irritable person?
7. Can you usually let yourself go and enjoy yourself at a lively party?
8. Are your feelings easily hurt?
9. Do you usually take the initiative in making new friends?
10. Do you often feel fed-up?

11. Can you easily get some life into a rather dull party?
12. Would you call yourself a nervous person?
13. Do you tend to keep in the background on social occasions?
14. Are you a worrier?
15. Do you like mixing with people?
16. Would you call yourself tense or “highly strung”?
17. Do you like to have plenty of excitement and action around you?
18. Do you worry too long after an embarrassing episode?
19. Are you mostly quiet when you are with other people?
20. Do you suffer from nerves?
21. Do other people think of you as being very lively?
22. Do you often feel lonely?
23. Can you get a party going?
24. Are you often troubled by feelings of guilt?

PANAS

All items were presented with the following answer choices:

“Very slightly or not at all”

“A little”

“Moderately”

“Quite a Bit”

“Extremely”

These were rated from 1 to 5, with “Very slightly or not at all” being 1 and “Extremely” being 5. Items 1, 3, 5, 9, 10, 12, 14, 16, 17, and 19 are scored as part of the positive affect subscale. Items 2, 4, 6, 7, 8, 11, 13, 15, 18, and 20 are scored as part of the negative affect subscale. The subscale scores are the sum of all the items in the subscale’s item scores. Participants are asked to respond to how much they have felt each item over the past week.

1. Interested
2. Distressed
3. Excited
4. Upset
5. Strong
6. Guilty
7. Scared
8. Hostile
9. Enthusiastic
10. Proud
11. Irritable
12. Alert
13. Ashamed
14. Inspired
15. Nervous

16. Determined
17. Attentive
18. Jittery
19. Active
20. Afraid

MAS

All items were presented with the answer choices “True” and “False.” True was scored as a two and false was scored as a one, so that higher scores on the MAS indicate greater levels of anxiety. The score on the MAS scale is the sum of the item scores.. The MAS does not have any subscales, although Items 1, 6, 8, and 12 are reverse scored.

Items

1. I believe I am no more nervous than most others.
2. I work under a great deal of tension.
3. I cannot keep my mind on one thing.
4. I am more sensitive than most other people.
5. I frequently find myself worrying about something.
6. I am usually calm and not easily upset.
7. I feel anxiety about something or someone almost all the time.
8. I am happy most of the time.
9. I have periods of great restlessness that I cannot sit long in a chair.

10. I have sometimes felt that difficulties were piling up so high that I could not overcome them.
11. I find it hard to keep my mind on a task or job.
12. I am not unusually self-conscious.
13. I am inclined to take things hard.
14. Life is a strain for me much of the time.
15. At times I think I am no good at all.
16. I am certainly lacking in self-confidence.
17. I certainly feel useless at times.
18. I am a high-strung person.
19. I sometimes feel that I am about to go to pieces
20. I shrink from facing a crisis or difficulty.

APPENDIX: IRB Consent Document



INFORMED CONSENT DOCUMENT

Project Title: BIS/BAS Assessing Personality
Investigator: Dr. Andrew Mienaltowski, Psychological Sciences, WKU, (270) 745-2353

You are being asked to participate in a project conducted through Western Kentucky University. The University requires that you give your agreement to participate in this project.

You must be 18 years old or older to participate in this research study.

The investigator will explain to you in detail the purpose of the project, the procedures to be used, and the potential benefits and possible risks of participation. You may ask any questions you have to help you understand the project. A basic explanation of the project is written below. Please read this explanation and discuss with the researcher any questions you may have. You should keep a copy of this form for your records.

1. **Nature and Purpose of the Project:** This project is investigating the relationship between multiple measures of personality and mood to see if the way that we think about these tests change with age.

2. **Explanation of Procedures:** The purpose of this research is to investigate how mood and motivation may change with age. During this task, you will complete a number of multiple choice questions, which include a short demographic survey. The entire survey is predicted to take approximately fifteen to twenty minutes. The purpose of the questions is to relate multiple measures of mood to one another and to age. You will be asked about how you feel, your personality, and issues associated with motivation.

3. **Discomfort and Risks:** There are no known or anticipated risks to the subject for participating. Participants are free to end an experimental session at any time, in the event that they experience fatigue or boredom.

4. **Benefits:** Your participation will help us understand how mood and motivation change with age. Once the study is completed, we would be able to share the results with you.

If you are participating in this study via Study Board, you will receive Study Board credits for your time, 1 credit for each 15 minutes. Because the survey should not take longer than 30 minutes, 2 credits are awarded.

If you are participating in this study via Amazon Mechanical Turk, then you will receive \$1.45 for completing the study provided that you pass all attention checks.

5. **Confidentiality:** During this study, you will be asked for some personal information (name, age, gender, etc.). This information will be confidential and will only be used by the experimenter. The data that is collected about you will be kept private. To protect your privacy, your records will be kept under a code number rather than by name. Your records will be kept in locked files and only study staff will be allowed to look at them.

6. **Refusal/Withdrawal:** Refusal to participate in this study will have no effect on any future services you may be entitled to from the University. Anyone who agrees to participate in this study is free to withdraw from the study at any time with no penalty.

You understand also that it is not possible to identify all potential risks in an experimental procedure, and you believe that reasonable safeguards have been taken to minimize both the known and potential but unknown risks.

Your continued cooperation with the following research implies your consent.

THE DATED APPROVAL ON THIS CONSENT FORM INDICATES THAT
THIS PROJECT HAS BEEN REVIEWED AND APPROVED BY
THE WESTERN KENTUCKY UNIVERSITY INSTITUTIONAL REVIEW BOARD
Paul Mooney, Human Protections Administrator
TELEPHONE: (270) 745-2129

WKU IRB# 17-265
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