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Decoupling the Effects of Wayfinding Competence, Trait-Anxiety and Subjective Well-Being from a GESIS German Sample

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Abstract The study examines how wayfinding competence coupled with predisposed trait-anxiety can produce negative daily experience in individuals' subjective well-being. The GESIS granted the permission to test this hypothesis using a sample of 7599 residents in Germany. A measure of wayfinding competence is based on the German Questionnaire of Spatial Strategies (GQSS). Trait-Anxiety is measured by a sub-domain of the Positive and Negative Affect Schedule (PANAS). Subjective well-being is an operationalization of the construct devised by the Organisation for Economic Co-operation and Development (OECD). In a hierarchical regression model, where demographic and other socio-economic variables are held constant, a mediating model linking the effect of wayfinding competence, trait-anxiety and subjective well-being were assessed. The data supports a direct and a mediated effect of wayfinding competence on subjective well-being via trait-anxiety. The mediating effect for the older age group was prominent.

Keywords Wayfinding · Trait anxiety · Subjective well-being · GESIS

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Introduction

Wayfinding is perhaps one of the necessary prerequisites to successful aging (Fornara and Manca 2017). Lawton (2010) defined wayfinding as the coordinated and step-by-step planned spatial cognition that guides one's movements. Successful aging can involve the achievement or continuation of daily activities such as buying groceries, managing personal finances, or maintaining contact with friends and family. Ongoing engagement in such activities may be compromised with feelings of fear or isolation if an elderly individual encounters barriers to wayfinding. Getting lost in familiar or unfamiliar places, for example, is often the reason why older people remain housebound, augmenting risks of depression (Biddle et al. 2016; Van Uffelen et al. 2013). Efforts to manipulate building environments to reduce the wayfinding barrier have significant implications for older people's subjective well-being (Andersson 2015; Czaja 2016; Fleming et al. 2016). What is also important is how individual differences in self-efficacy can play a role as well.

The study of spatial cognition has been examined from different traditions. For instance, Linn and Petersen (1985) distinguished between purely spatial tasks that require gestalt-like processing and tasks that can be resolved using visual and verbal strategies. These two sets of spatial tasks, mental rotation and spatial visualization (Voyer et al. 1995) were postulated as essential in solving spatial challenges. Hegarty et al. (2002) reported that a sense of direction is highly related to competency on tasks that depend on survey or configural knowledge of environments. Unlike the gestalt approach, a sense of direction is not tied to psychometric tests of spatial ability (Takeuchi 1992).

Spatial cognition can also be viewed as a) knowledge about the spatial relationship between locations and b) knowledge of places and routes that connect them. The former, known as the

orientation strategy (Lawton 1996), argues wayfinding is the ability to see and navigate like a bird, with a view from an 'eagle's view'. The latter, a route strategy, suggests wayfinding is all about following semantic instructions where places are connected via a series of salient landmarks (Evans 1980; Gärling and Golledge 1989; Russel and Ward 1982). Whereas the orientation strategy is based on global reference points such as compass directions in outdoor environments or the general building configuration in indoor environments, the route strategy is based on a sequence of instructions such as when and where to turn. Thorndyke and Hayes-Roth (1982) found individuals who acquire information about an environment from a map were more efficient in estimating straight-line distance – that is, as if a bird flies between landmarks – than individuals who physically navigated in it. For individuals who acquired the wayfinding routes by knowing when and where to turn, their judgments of the route distance between landmarks were more accurate than those who use the map. Similarly, Streeter et al. (1985) found individuals who used route instructions were more efficient in giving directions for long, non-linear routes than individuals who used orientation strategy. It is at this corner stone to introduce the loci of the present study, that is to examine differential aspects of spatial competencies and its impact on subjective well-being factors. The basis for the first hypothesis follows.

The ability to sense direction or mentally imagine one's place on the plane of a map may be tied to decreased anxiety and worries around navigating or reaching a destination, before the first step is even set foot. This is particularly reassuring to one's general subjective well-being. Yet, it is still possible that such an orientation strategy may be a source of misconceived esteem (Pierce and Gardner 2004; Pollack 2006). That is, even when one knows the straight-line distance between two landmarks this does not necessary mean the person can navigate a path between two places at ease. Such a false assumption may levitate one's self confidence beneath a false sense of efficacy. Unlike orientation strategy, the route-based strategy relies on past experience and insight skills that potentially pose a threat in maintaining independence in daily activities. As one ages, the ability to remember old routes, or devising ones from working memory becomes increasingly difficult (Brockmole and Logie 2013; Wilson et al. 2013). Unlike orientation strategy, which is a cognizant approach, route strategy may cause more stress because it involves actual encounters at street-level navigation. Route strategy may be more practical and efficient in solving actual navigational challenges but at the same time may lead to more anxiety-prevalent thoughts (e.g., "Where am I?", "Am I going the right way?", "Is this the corner store that the map refers to? "Do I turn here or when do I make the next turn?". In the present study, these ideas are tested in the first hypothesis which posits: the use of orientation strategy is positively related to positive evaluation of life (H_{1a}), and the use of route-based strategy is positively related to positive evaluation of life (H_{1b}).

The belief that one could accomplish daily spatial challenges is associated with satisfaction with major life priorities and human development (Catalano et al. 2004). This belief, also referred to as self-efficacy, was found to be a mediator between physical activity and daily activities (McAuley et al. 2006, 2007). Self-efficacy, as the key factor in social cognitive theory (Bandura 1997), reflects the individual's beliefs in his or her capabilities to carry out a course of action, or task, successfully. High self-efficacious individuals perceive demands as challenging, not as threatening (Jerusalem and Schwarzer 1992). Initial evidence has shown that global life satisfaction, the cognitive component of subjective well-being (Diener et al. 1999), was most highly correlated with characteristics analogous to self-efficacy – that is, strengths like zest, love, gratitude, and hope (e.g., Park and Peterson 2006; Weber et al. 2013). People who are confident in achieving what they want have been found to experience higher subjective well-being than people who are less confident (i.e., are low in self-efficacy) (Carver and Scheier 1999; Luszczynska et al. 2005; McGregor and Little 1998; Strobel et al. 2011). Research efforts indicate that prolonged threatening or overwhelming circumstances are associated with stress and fatigue, leading to mental and physical exhaustion and helplessness (Pamplona et al. 2011; Salcioglu et al. 2017).

The present study focuses on if (or how) different spatial cognitions play differentiated roles in subjective well-being and also as possible mediators facilitating their link. The literature contains little evidence on how the impact of wayfinding is mediated by individual predisposition, such as the tendency to feel guilty, scared, irritable, or afraid. There is good reason to suspect the mediating role that trait-related anxiety plays on the well-being outcome. First, it is conceptually similar to trait emotional intelligence which refers to individuals' subjective evaluation of their ability to understand emotion (Mikolajczak et al. 2007). Trait emotional intelligence appears to mediate the influence of core traits on well-being outcomes (Johnson et al. 2009). Second, self-efficacy also has been shown substantially to relate negatively to neuroticism (Judge and Ilies 2002). Individuals high in neuroticism are characterized by emotional instability, lacking in confidence, anxiety, etc. (Scheier et al. 1994). Self-efficacy and neuroticism belong to a group of stable self-evaluation judgments about oneself (Judge et al. 1998). Kammeyer-Mueller et al. (2009)demonstrated that the resultant judgments, afforded by self-efficacy and neuroticism, are positively related to problem-solving coping and negatively with avoidance coping. The present study uses a measure of trait-anxiety as a proxy variable representing efficacy and neurotic characteristics. The author argues the less one is confident about performing well in navigation tasks (the mediator), due to lack of wayfinding skills or strategies (the independent variable), the worse one judges on the state of their well-being (the dependent variable). In other words, trait anxiety mediates the effect of wayfinding strategies on evaluation of life (H_2).

For an older person, moving about may be stressful because gradual age-related deteriorations in spatial functioning impact their ability to overcome obstacles. For instance, the deterioration in spatial functioning comes from several domains of cognition, which include processing speed, attention, visual-spatial ability, memory, and executive functions. There is a biological link that explains why wayfinding behaviors are challenging as one ages. Wayfinding performance is poor among individuals with dementia (Sheehan et al. 2006) and has been linked to the hippocampus (Head and Isom 2010), a brain region associated with structural and functional decline in aging populations (Driscoll et al. 2009; Raz et al. 2005). Because participation in daily physical activities has implications for quality of life (Rejeski and Mihalko 2001; Stuifbergen et al. 2006), some of which requires overcoming spatial obstacles, the above cognitive and physical limitations can be determined to be risk factors for subsequent disability and institutionalization (Onder et al. 2005; Paterson et al. 2004). The third hypothesis assesses the extent to which trait-anxiety mediates across age cohorts. That is, trait-anxiety is more likely to mediate the effect of wayfinding strategy on evaluation of life for older cohorts (H_3).

Methods

Participants

The study sample consists of a German-speaking population who resided in Germany. The total sample provided by GESIS was 7599 respondents. Respondents were aged between 18 and 70 years. According to the GESIS, all the participants were invited to participate by mail and were offered a monetary incentive of five Euros. The data was made available to the author by the GESIS Panel Longitudinal Core Study, located at GESIS Leibniz Institute for the Social Sciences in Mannheim, Germany. To obtain the data, the author applied to the GESIS panel under a data access proposal titled “Life satisfaction and personality correlates: the role of moderators” (study number ZA5665; persistent identifier/DOI: 10.4232/1.12116). Only the author had access to the data in this study. The approval process involved the ethics committee of the GESIS, which scrutinized the use of data for ethical research purposes. The entire data structure collected respondents’ personality traits, personal values, political behavior and orientations, well-being, environmental attitudes and behavior, and IT usage.

Data Collection

The data collection took place in multiple phases. In total, there were seven waves of collection spanning thirty-one studies from August, 2013 to October, 2014. The respondents completed the self-administered survey in either the online or offline mode. The sample size for the online and the traditional mail service was 3996 and 1151, respectively. There were 2452 cases without either classification. Details of the recruitment process can be found in the methods report written by the GESIS. Note that informed consent was obtained from all respondents for inclusion in this study.

Measures

1. Wayfinding / Cognitive Elements of Navigation. Measures of competence in navigational and spatial orientation were represented by the German Questionnaire of Spatial Strategies (GQSS) (Münzer and Hölscher 2011). The GQSS is comprised of three facets with incremental validity on predictors of cognitive and spatial orientation. The first self-reported measure refers to global belief in competence to orient oneself related to directional and route-based strategies (GQSS-1). It consists of knowledge of directions and knowledge of routes. The second self-reported measure refers to survey-based strategies, or indicators of mental-map competence (GQSS-2). The third self-reported measure refers to cardinal directions such as the ability to point and distinguish between north, south, east, and west (GQSS-3). The fourth and final self-reported measure refers to the use of technology to aid navigation (GQSS-4). Sample items for the first facet asked: "I can easily find my way in a new environment," "in my hometown, I can point quite accurately towards prominent buildings and other points of interest.” The second facet included items such as: "if somebody were to ask me for directions in my hometown, I would picture a town map and describe the route based on that map;" "I can picture my hometown very well from a bird's-eye view, as if it were shown on a map." The third facet included items such as: "I can spontaneously point towards north, south, east and west." The fourth facet included items such as: "when I am traveling to somewhere new with a car, I normally use a navigation system." Unless specified, participants rated the item on a 5-point Likert-scale ranging from 1 = not at all to 5 = extremely. This applies to the GQSS and others described below.
2. PANAS. Used in theoretical work on emotion, the Positive and Negative Affect Schedule (PANAS) is a self-rated measure of mood. PANAS conceptualizes subjective experience as belonging to two broad emotional dimensions, referred to as positive affect (PA) and negative affect (NA) (Diener and Emmons 1984; Watson and Tellegen 1985). PA is related to experiencing a positive mood, with feelings such as joy, interest, enthusiasm, and alertness (Watson et al. 1988). NA is a general dimension of subjective distress and unpleasurable engagement that includes a variety of aversive mood states such as anger, contempt, disgust, guilt, fear, and nervousness (Watson et al. 1988). PA and NA are strongly related to Extraversion and Neuroticism personality factors,

respectively (Costa and McCrae 1980; Watson and Clark 1992), and represent core components of the two broad personality dimensions (see also Yik, Russell, Oceja, and Dols 2000). Originally, Watson and colleagues (Watson and Tellegen 1985; Watson et al. 1988) conceptualized PA and NA as comprising of two distinct constructs that were independent of one another and shared unique relationships with relevant predictor variables. The 20-item PANAS with its 10-item PA and NA subscales has been validated across multicultural settings (DePaoli and Sweeney 2000; Melvin and Molloy 2000). The German PANAS was adapted from the original English PANAS (Krohne et al. 1996). Subsequent validation studies addressed structural and psychometric criteria (Egloff et al. 2003; Leue and Beauducel 2011). The present study used only words related to the variable of concern (i.e., guilty, scared, irritable, ashamed, nervous, jittery, afraid). Hence, the abbreviation PANAS-anx is used to represent a subscale of PANAS. From here onwards, this measure is referred to as trait-anxiety.

With work by Tellegen (1985), the notion of trait positive and negative affectivity in PA and NA were related to corresponding affective trait dimensions of positive and negative emotionality (i.e., individual differences in positive and negative emotional reactivity). Trait PA and NA roughly correspond to the dominant personality factors of extraversion and anxiety/neuroticism, respectively (Tellegen 1985; Watson and Clark 1984). Drawing on these and other findings, Tellegen has linked trait NA and PA to psychobiological and psychodynamic constructs of sensitivity to signals of reward and punishment. Tellegen also suggested that low PA and high NA (both state and trait) are major distinguishing features of depression and anxiety, respectively (Tellegen 1985).

2. Subjective Well-Being. The measure of subjective well-being in this study adhered to the guidelines by the Organisation for Economic Co-operation and Development (Smith and Exton 2013) which included a life-evaluation measure (SWB-1) and an affective measure (SWB-2). The life-evaluation measure refers to how much one is happy and satisfied with their life (including past, present and future). It also probes into specific domains in terms of importance and satisfaction on specific life facets (e.g., family, work, leisure, friends, neighbors and financial situation). The affective measure refers to eight affective time-dependent states (i.e., depress, exhausted, restless, happy, lonely, enjoyed life, sadness, sluggish).

Results

Descriptive statistics and inter-correlations for the main variables are shown in Table 1. The Cronbach's α for all variables were acceptable based on guidelines by Nunnally (1978, p245). One exception was SWB-2 (Cronbach's $\alpha = .46$), which was lower than the acceptable threshold of 0.7. Overall, all of the variables were correlated at varying levels of significance with coefficients ranging from .03 to .72. Of particular interest were the correlations between the mediator, and the independent and dependent variables (see last row of table beginning with PANAS-anx). As shown in Table 1, SWB is linearly related to most measures of GQSS. In particular, GQSS-1 and -3 are significantly correlated to both measures of SWB. GQSS-2 is only correlated to SWB-1, not SWB-2. PANAS-anx was correlated to three of the four measures of spatial cognition. In sum, H_{1a} and H_{1b} were partially confirmed given the correlation coefficients between spatial cognitions (i.e., GQSS1, 2 & 3) and life evaluation scores (i.e., SWB-1).

The mediating models were assessed according to the procedures outlined by Baron and Kenny (1986). The

Table 1 Means, standard deviations and inter-correlations among variables

	Mean	S.D.	SWB-1	SWB-2	GQSS-1	GQSS-2	GQSS-3	GQSS-4	PANAS-anx
SWB-1	5.28	0.75	.87						
SWB-2	2.83	0.50	−.29**	.46					
GQSS-1	4.78	1.40	.13**	−.09**	.96				
GQSS-2	4.06	1.54	.08**	−.03	.72**	.92			
GQSS-3	4.06	1.93	.09**	−.11**	.63**	.59**	.94		
GQSS-4	-12.39	16.43	.03	.00	.03*	.02	−.04**	.93	
PANAS-anx	1.65	0.59	−.26**	.40**	−.12**	−.06**	−.11**	−.02	.82

Note: Diagonal cells contain Cronbach's α; Coefficient with zero Pearson value due to round-off error; SWB-1: Life Evaluation Measure; SWB-2: Time Dependent affect measure; GQSS-1: Sense of Direction; GQSS-2: Mental Map; GQSS-3: Cardinal direction; GQSS-4: Technology for directions; PANAS-anx: guilty, scared, irritable, ashamed, nervous, jittery, afraid;

*Correlation is significant at the 0.05 level (2-tailed); **Correlation is significant at the 0.01 level (2-tailed); ***Correlation is significant at the 0.001 level (2-tailed)

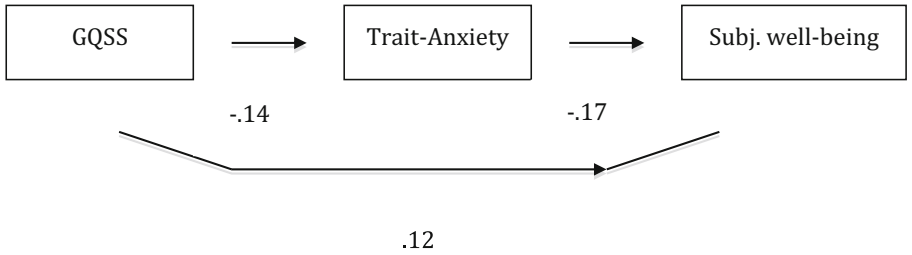

Fig. 1 The mediating effects of trait-anxiety between GQSS and subjective well-being. Values below arrows refer to standardized beta results derived from mediated regression model for SWB-1 and GQSS-1

procedures involved three regression models with test-1 regressing the mediator on the independent variable, test-2 regressing the dependent variable on the independent variable, and test-3 regressing the dependent variable on both the independent variable and on the mediator. In order to demonstrate whether trait-anxiety mediated the effects of the wayfinding competences on subjective well-being (i.e., H_2), the standardized ß value for GQSS-1 to −4 in test-2 must be substantially larger than the same variable in test-3. Fig. 1 shows a graphical illustration of the effects in terms of standardized beta weights. The values in the figure apply to GQSS-1.

Table 2 Testing procedures for the mediating effects of trait-anxiety (SWB-1)

Independent variable	Mediation tests (results)	Criteria	Predictors	Adjusted R^2	ΔF	*p*
Sense of Direction (GQSS-1)						
	Test 1	PANAS-anx	Step1: Demographics, GQSS-2,-3,-4, SWB-2	.03	5.81	.0005
			Step2: Demographics, GQSS-2,-3,-4, SWB-2, GQSS-1	.04	31.02	.0005
	Test 2	SWB-1	Step1: Demographics, GQSS-2,-3,-4, SWB-2	.12	21.81	.0005
			Step2: Demographics, GQSS-2,-3,-4, SWB-2, GQSS-1	.13	36.26	.0005
	Test 3	SWB-1	Step1: Demographics, GQSS-2,-3,-4, SWB-2	.13	21.51	.0005
			Step2: Demographics, GQSS-2,-3,-4, SWB-2, GQSS-1, PANAS-anx	.16	71.58	.0005
Mental Map (GQSS-2)						
	Test 1	PANAS-anx	Step1: Demographics, GQSS-2,-3,-4, SWB-2	.04	6.51	.0005
			Step2: Demographics, GQSS-2,-3,-4, SWB-2, GQSS-2	.04	12.08	.001
	Test 2	SWB-1	Step1: Demographics, GQSS-2,-3,-4, SWB-2	.13	23.24	.0005
			Step2: Demographics, GQSS-2,-3,-4, SWB-2, GQSS-2	.13	.33	n.s.
	Test 3	SWB-1	Step1: Demographics, GQSS-2,-3,-4, SWB-2	.14	22.84	.0005
			Step2: Demographics, GQSS-2,-3,-4, SWB-2, GQSS-2, PANAS-anx	.16	54.5	.0005
Cardinal direction (GQSS-3)						
	Test 1	PANAS-anx	Step1: Demographics, GQSS-2,-3,-4, SWB-2	.04	6.84	.0005
			Step2: Demographics, GQSS-2,-3,-4, SWB-2, GQSS-3	.04	3.28	n.s.
	Test 2	SWB-1	Step1: Demographics, GQSS-2,-3,-4, SWB-2	.13	23.25	.0005
			Step2: Demographics, GQSS-2,-3,-4, SWB-2, GQSS-3	.13	.001	n.s.
	Test 3	SWB-1	Step1: Demographics, GQSS-2,-3,-4, SWB-2	.14	22.87	.0005
			Step2: Demographics, GQSS-2,-3,-4, SWB-2, GQSS-3, PANAS-anx	.16	54.03	.0005
Technology for direction (GQSS-4)						
	Test 1	PANAS-anx	Step1: Demographics, GQSS-2,-3,-4, SWB-2	.04	6.95	.0005
			Step2: Demographics, GQSS-2,-3,-4, SWB-2, GQSS-4	.04	.50	n.s.
	Test 2	SWB-1	Step1: Demographics, GQSS-2,-3,-4, SWB-2	.14	23.2	.0005
			Step2: Demographics, GQSS-2,-3,-4, SWB-2, GQSS-4	.14	1.31	n.s.
	Test 3	SWB-1	Step1: Demographics, GQSS-2,-3,-4, SWB-2	.14	22.82	.0005
			Step2: Demographics, GQSS-2,-3,-4, SWB-2, GQSS-4, PANAS-anx	.16	54.69	.0005

Table 3 Regression coefficients for the mediation testing models (SWB-1)

Independent variable	Mediation tests	Criteria	Predictors	*B*	SE (*B*)	ß	*p*
Sense of Direction (GQSS-1)							
	Test 1	PANAS-anx	GQSS-1	−.06	.01	−.14	.0005
	Test 2	SWB-1	GQSS-1	.07	.01	.14	.0005
	Test 3	SWB-1	GQSS-1	.06	.01	.12	.0005
			PANAS-anx	−.21	.02	−.17	.0005
Mental Map (GQSS-2)							
	Test 1	PANAS-anx	GQSS-2	.03	.01	.08	.001
	Test 2	SWB-1	GQSS-2	.01	.01	.01	n.s.
	Test 3	SWB-1	GQSS-2	.02	.01	.03	n.s.
			PANAS-anx	−.21	.02	−.17	.0005
Cardinal direction (GQSS-3)							
	Test 1	PANAS-anx	GQSS-3	−.01	.01	−.04	n.s.
	Test 2	SWB-1	GQSS-3	0	.01	0	n.s.
	Test 3	SWB-1	GQSS-3	0	.01	−.01	.0005
			PANAS-anx	−.21	.02	−.17	n.s.
Technology for direction (GQSS-4)							
	Test 1	PANAS-anx	GQSS-4	0	0	.01	n.s.
	Test 2	SWB-1	GQSS-4	0	0	.02	n.s.
	Test 3	SWB-1	GQSS-4	0	0	.02	n.s.
			PANAS-anx	−.21	.02	−.17	.0005

The above tests on mediation were conducted separately for the two SWB measures (i.e., SWB-1 and -2). Tables 2, 3, 4, and 5 refer to regression statistics for SWB-1 and SWB-2, respectively. Table 2 shows the adjusted R^2, F-change and *p* value. Table 3 shows specific ß values for each variable.

The effect for each independent variable was tested individually. The first step (Step-1) in Test-1 of the mediating model included variables that represented the respondents' biodata and other non-testing GQSS variables (to be explained below). The biodata was included in Step-1 to control for any confined effects. It included data on the respondents' gender, age, nationality, marital status, household size, income, and occupation. Because the data was entered in a hierarchical regression analysis, ordinal and nominal variables were dummy-coded according to methods described by Frazier et al. (2004).

The four independent variables —sense of direction (GQSS1), mental map (GQSS2), cardinal direction (GQSS3), and technology for directions (GQSS4) — were all included in the mediated regression model to ensure that common covariance among them did not produce misleading findings. The non-testing GQSS was also entered in Step-1 of the regression model. If, for example, GQSS-1 was assessed (Tables 2 and 3), then the remaining three variables (GQSS-2, −3 & -4) were entered along with the biodata variables in Step-1. The variable to be assessed (i.e., GQSS-1) was entered at the second stage of the mediating model (i.e., Step-2). Note in Table 3 for SWB-1 (and Table 5 for SWB-2), only variables relevant to the mediation model were shown to simplify interpretation.

SWB-1: Life-Evaluation

Tables 2 and 3 outline the three tests involved when assessing for mediation effect of trait-anxiety for each GQSS facet. The first column of Tables 2 and 3 indicate that the GQSS facet is entered as the independent variable. The second column refers to the type of mediation test and the third column refers to the criteria being regressed. For Table 2, the effects of the non-testing GQSS variables were held constant along with biodata variables in Step-1. In Step-2, the assessed GQSS variable was entered in the regression model.

In the case of GQSS-1, figures in Tables 2 and 3 support Baron and Kenny's (1986) criteria for mediation. Specifically, in Test-1, GQSS-1 is significantly related to PANAS-anx (ß = −.14, $p < .0005$); in Test-2 GQSS-1 is significantly related to SWB-1 (ß = .14, $p < .0005$); in Test-3 the effect size 'ß' for GQSS-1 is either insignificant or smaller than that in Test-2 (ß = .12, $p < .0005$). Similar tests were repeated to test whether the effects of GQSS-2, −3 and −4 were mediated by PANAS-anx (see Tables 2 and 3). The results indicate that only GQSS-

Table 4 Testing procedures for the mediating effects of trait-anxiety (SWB-2)

Independent variable	Mediation tests	Criteria	Predictors	Adjusted R^2	ΔF	*p*
Sense of Direction (GQSS-1)						
	Test 1	PANAS-anx	Step1: Demographics, GQSS-2,-3,-4, SWB-2	0.03	5.81	0.0005
			Step2: Demographics, GQSS-2,-3,-4, SWB-2, GQSS-1	0.04	31.02	0.0005
	Test 2	SWB-2	Step1: Demographics, GQSS-2,-3,-4, SWB-2	0.13	23.02	0.0005
			Step2: Demographics, GQSS-2,-3,-4, SWB-2, GQSS-1	0.13	5.29	0.02
	Test 3	SWB-2	Step1: Demographics, GQSS-2,-3,-4, SWB-2	0.14	22.56	0.0005
			Step2: Demographics, GQSS-2,-3,-4, SWB-2, GQSS-1, PANAS-anx	0.23	240.29	0.0005
Mental Map (GQSS-2)						
	Test 1	PANAS-anx	Step1: Demographics, GQSS-2,-3,-4, SWB-2	0.04	6.51	0.0005
			Step2: Demographics, GQSS-2,-3,-4, SWB-2, GQSS-2	0.04	12.08	0.001
	Test 2	SWB-2	Step1: Demographics, GQSS-2,-3,-4, SWB-2	0.13	22.27	0.0005
			Step2: Demographics, GQSS-2,-3,-4, SWB-2, GQSS-2	0.14	24.39	0.0005
	Test 3	SWB-2	Step1: Demographics, GQSS-2,-3,-4, SWB-2	0.13	21.79	0.0005
			Step2: Demographics, GQSS-2,-3,-4, SWB-2, GQSS-2, PANAS-anx	0.23	251.12	0.0005
Cardinal direction (GQSS-3)						
	Test 1	PANAS-anx	Step1: Demographics, GQSS-2,-3,-4, SWB-2	0.04	6.84	0.0005
			Step2: Demographics, GQSS-2,-3,-4, SWB-2, GQSS-3	0.04	3.28	n.s.
	Test 2	SWB-2	Step1: Demographics, GQSS-2,-3,-4, SWB-2	0.13	22.78	0.0005
			Step2: Demographics, GQSS-2,-3,-4, SWB-2, GQSS-3	0.13	11.34	0.001
	Test 3	SWB-2	Step1: Demographics, GQSS-2,-3,-4, SWB-2	0.14	22.22	0.0005
			Step2: Demographics, GQSS-2,-3,-4, SWB-2, GQSS-3, PANAS-anx	0.23	245.17	0.0005
Technology for direction (GQSS-4)						
	Test 1	PANAS-anx	Step1: Demographics, GQSS-2,-3,-4, SWB-2	0.04	6.95	0.0005
			Step2: Demographics, GQSS-2,-3,-4, SWB-2, GQSS-4	0.04	0.5	n.s.
	Test 2	SWB-2	Step1: Demographics, GQSS-2,-3,-4, SWB-2	0.13	23.07	0.0005
			Step2: Demographics, GQSS-2,-3,-4, SWB-2, GQSS-4	0.13	4.22	0.04
	Test 3	SWB-2	Step1: Demographics, GQSS-2,-3,-4, SWB-2	0.14	22.58	0.0005
			Step2: Demographics, GQSS-2,-3,-4, SWB-2, GQSS-4, PANAS-anx	0.23	240.02	0.0005

1 met the criteria for mediation effect. The results partially support H_2.

Effect of age on Mediation Effect (SWB-1)

Using the same hierarchical regression steps required to test the mediation effect on SWB-1, the effect of age on mediation effect was examined. The age cohort was created by making three divisions by percentile. The three age divisions were: less than or equal to 38 years old (< 38 yrs); over 38 and up to 53 years; and over 53 years (> 53 yrs). For the four facets of GQSS, only the effect of GQSS-1 for the oldest cohort was mediated (step-2: ß = .18, $p < .0005$; step-3: ß = .15, $p < .0005$). The results partially meet the expectations of H_3.

SWB-2: Time-Dependent-Affect

Two concerns about this measure will be reported before proceeding to the mediation analysis. The first issue concerns internal consistency of the measure. The reliability coefficient for this measure was low (Cronbach's $\alpha = .46$). Dependent variables with a low reliability coefficient may lead to erroneous claims of significant findings (i.e., Type-I error; Osborne and Waters 2002). The second concern outlines the different mode of surveying the responses (i.e., online vs. offline

Table 5 Regression coefficients for the mediation testing models (SWB-2)

Independent variable	Mediation tests	Criteria	Predictors	*B*	SE (*B*)	ß	*p*
Sense of Direction (GQSS-1)							
	Step 1	PANAS-anx	GQSS-1	−.06	.01	−.14	.0005
	Step 2	SWB-2	GQSS-1	−.02	.01	−.05	.02
	Step 3	SWB-2	GQSS-1	0	.01	0	n.s.
			PANAS-anx	.27	.01	.32	.0005
Mental Map (GQSS-2)							
	Step 1	PANAS-anx	GQSS-2	.03	.01	.08	.001
	Step 2	SWB-2	GQSS-2	.03	.01	.11	.0005
	Step 3	SWB-2	GQSS-2	.03	.01	.08	.0005
			PANAS-anx	.27	.01	.32	.0005
Cardinal direction (GQSS-3)							
	Step 1	PANAS-anx	GQSS-3	−.01	.01	−.04	n.s.
	Step 2	SWB-2	GQSS-3	−.02	.01	−.07	.001
	Step 3	SWB-2	GQSS-3	−.02	.01	−.06	.003
			PANAS-anx	.27	.01	.32	.0005
Technology for direction (GQSS-4)							
	Step 1	PANAS-anx	GQSS-4	0	0	.01	n.s.
	Step 2	SWB-2	GQSS-4	0	0	.03	.04
	Step 3	SWB-2	GQSS-4	0	0	.02	n.s.
			PANAS-anx	.27	.01	.32	.0005

mode). When all relevant variables (except covariates) were compared along the mode of survey, SWB-2 is significantly different across groups (F = 7.78, df = $p < .005$). By contrast, SWB-1 was insignificant.

Based on Tables 4 and 5, GQSS-1 and GQSS-2, representing sense of direction and mental map, met the mediating model requirement for step-1. That is, they impact PANAS-anx moderately and significantly (ß = −.14, $p < .0005$ for GQSS-1; ß = .08, $p < .001$ for GQSS-2). These two facets of spatial cognition also met Step-2 and Step-3 of the mediation requirement. GQSS-1 met a full mediation model because the effect size in Step-3 for GQSS-1 was insignificant (ß = 0, $p > .05$) when the mediator was entered in the model. GQSS-1 was significant in Step-2 (ß = −.05, $p < .05$). GQSS-2 met a partial model because the effect size in Step-2 was larger than in Step-3. Both remained statistically significant (Step-2: ß = .11, $p < .0005$; Step-3: ß = .08, $p < .0005$). Note that the score of zero is due to a rounding error and the ß score is not absolute zero. The results partially support H_2.

Effect of age on Mediation Effect (SWB-2)

Using the same methods as SWB-2: Time-Dependent-Affect, the regression analysis for the mediation effect on SWB-2 was examined. Two GQSS facets (GQSS-1 and -2) across the two age cohorts were mediated. For GQSS-1, the second age group (over 38 and up to 53 years old) showed mediation effect (step-2: ß = −.12, $p < .0005$; step-3: ß = −.09, $p < .05$). This is a partial mediation effect. For GQSS-2, the second and oldest age groups were mediated by trait-anxiety. For the oldest group, the effect was a full mediation (step-2: ß = .08, $p < .05$; step-3: ß = .05, $p > .05$). Overall, the results partially meet the expectations of H_3.

Discussion

The correlation coefficients linking the mediator to and from the dependent and independent variables, respectively, suggest there are many paths between them and possibly playing a partial or a fully mediating role. The results indicate (with the exception of technology-assisted aid), knowledge of directions and knowledge of routes, mental-map competence, cardinal directions correlated with life-evaluation facet of subjective well-being. In other words, all GQSS variables (except technology for direction) correlated with PANAS-anx and SWB-1. Similar results applied to SWB-2, although readers should take caution that, due to its low Cronbach's alpha coefficient, further analyses in future studies are needed to add validity to these results.

The results of the mediating model across the four GQSS facets showed mixed results. Only the effect of GQSS-1 (i.e., sense of direction) was mediated and only for the life-evaluation facet of subjective well-being (SWB-1). This confirms H_2 in that anxiety arising from not knowing how to meet spatial challenges undermines subjective life evaluation. The

findings support the position that subjective well-being is influenced by anxiety arising from strategies used in spatial cognition. In particular, subjective well-being is poorer if one is anxious about finding routes (or getting lost) and it becomes worse if one lacks the necessary wayfinding competence. Though the effect size was modest, it was statistically significant, and it applies irrespective of biodata such as gender, age, nationality, marital status, household size, income, and occupation.

Although previous research did not make a conceptual distinction or discriminative validity on facets of spatial cognition on well-being measures, the hypotheses posit that there may be facets that are tied to efficacy in navigation. Further, there may be other facets that are tied to actual functional performance in navigation on the other. Because the developers of GQSS (or similar scales) did not specify assumptions underlying the facets, future research and theoretical development should find the mediator models useful. The results support the idea that orientation strategy may also refer to perceived confidence and general belief in meeting navigational challenges. Even when one knows the straight line distance between two landmarks, it is unlikely to contribute to people's daily activities but it may be reassuring to know with respect to the view of a map.

Results of the mediation models by age cohort point to some interesting speculations – namely, the mediation effect is more prominent in older groups. The mediation effects were still confined to GQSS-1 and -2 for SWB-1 and SWB-2. As one progresses into the older age group, predisposed trait-anxiety appears to play a detrimental role in one's well-being by exasperating any negative effects from the spatial cognition. Given that wayfinding performance is progressively poorer as one becomes susceptible to the effects of aging (Driscoll et al. 2009; Head and Isom 2010; Raz et al. 2005; Sheehan et al. 2006), the findings in this study offer further support into the psychological effects of aging.

Compliance with Ethical Standards This manuscript involves human participants research based on data collected by the GESIS. The GESIS was designed to comport with ethical standards for social research.

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