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BASIC RESEARCH ARTICLE

Understanding the long-term connections between posttraumatic stress, subjective age, and successful aging among midlife and older adults

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ABSTRACT

Background: The nature of the reciprocal relationships between posttraumatic stress disorder (PTSD) symptoms, proportional subjective age, and their effects on successful aging are important issues that have been so far under-studied. Clarifying the relationships between these variables has many theoretical and practical implications for the understanding of how individuals age in the shadow of traumatic exposure.
Objective: The present study examined the reciprocal relationships between PTSD symptoms and proportional subjective age in a longitudinal design, and how these variables predict successful aging.
Method: Using in-region random digit dialling, we collected a stratified sample of community-dwelling older adults residing in the south of Israel. Of that sample, 132 midlife and older adults (T1 age range = 50–87, mean age = 65.84, *SD* = 9.12) were interviewed three times across a period of two years and four months (2014–2016). Participants completed measures of PTSD symptoms and proportional subjective age in the first two interviews (T1 and T2) and successful aging indices in the third interview (T3). PTSD symptoms and proportional subjective age measured at both T1 and T2 served as predictors and outcomes in a cross-lagged model and as predictors of successful aging at T3.
Results: T1 PTSD symptoms predicted an older proportional subjective age at T2, whereas the reverse relationship (i.e. T1 proportional subjective age to T2 PTSD symptoms) was non-significant. Moreover, higher PTSD symptoms and an older proportional subjective age at T2 predicted lower successful aging at T3.
Conclusions: In addition to clarifying the temporal sequencing of PTSD and proportional subjective age, the study further suggests that PTSD and proportional subjective age identity could each render midlife and older adults more susceptible to less successful aging. Accordingly, we advocate to further explore the mechanisms underlining these complicated relationships.

Comprendiendo las conexiones a largo plazo entre el estrés postraumatico, edad subjetiva y envejecimiento exitoso entre adultos en la edad media de la vida y tercera edad

La naturaleza de las relaciones recíprocas entre el trastorno de estrés postraumático (TEPT) y los efectos de la edad subjetiva proporcional sobre el envejecimiento exitoso son asuntos importantes que, a la fecha, han sido poco estudiados. El esclarecer las relaciones entre estas variables tiene muchas repercusiones teóricas y prácticas para la comprensión de cómo envejecen las personas bajo la sombra de la exposición traumática.
Objetivo: El presente estudio evaluó las relaciones recíprocas entre los síntomas del TEPT y la edad subjetiva proporcional mediante un diseño longitudinal, además de evaluar cómo estas variables predicen el envejecimiento exitoso.
Métodos: Mediante un proceso de marcación aleatoria de números telefónicos, se recolectó una muestra estratificada de adultos mayores residentes en comunidades al sur de Israel. De aquella muestra, se entrevistó a 132 adultos en la edad media y a adultos mayores (rango de edad en T1 = 50 – 87 años, edad promedio = 65,84 años, desviación estándar = 9,12), los cuales fueron entrevistados en tres oportunidades a lo largo de un periodo de dos años y cuatro meses (2014 – 2016). Los participantes completaron mediciones para síntomas de TEPT y para la edad subjetiva proporcional en las primeras dos entrevistas (T1 y T2), e índices para envejecimiento exitoso en la tercera entrevista (T3). Los síntomas del TEPT y la edad subjetiva proporcional medidas tanto en T1 como en T2 fueron usados como predictores y como resultados empleando un modelo de referencias cruzadas, y en T3 ambos fueron usados como predictores de envejecimiento exitoso.
Resultados: Los síntomas de TEPT en T1 predijeron una edad subjetiva proporcional mayor en T2, mientras que la relación inversa (esto es, partir de una edad subjetiva proporcional en T1 y correlacionarlo con los síntomas del TEPT en T2) no fue significativa. Asimismo, una

HIGHLIGHTS
• Higher levels of PTSD symptoms were related to higher level of PTSD symptoms a year later.
• Older subjective age was related to older subjective age a year later.
• PTSD symptoms predict subjective age, but subjective age does not predict PTSD symptoms.
• PTSD symptoms and subjective age at T2 mediated the relations between PTSD symptoms in T1 and successful aging in T3.
• Subjective age at T2 mediated the relations between subjective age in T1 and successful aging in T3.

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mayor cantidad de síntomas del TEPT y una mayor edad subjetiva proporcional en T2 predijeron un envejecimiento exitoso menor en T3.

Conclusiones: Además de esclarecer la secuencia temporal del TEPT y la edad subjetiva proporcional, el estudio también sugiere que el TEPT y la edad subjetiva proporcional podrían, cada una, predisponer a adultos en la edad media y a adultos mayores a ser más susceptibles a un envejecimiento menos exitoso. Consecuentemente, abogamos por explorar con mayor profundidad los mecanismos subyacentes a estas complicadas relaciones.

理解中老年人中创伤后应激，主观年龄和成功老龄化之间的长期关系

背景：创伤后应激障碍症状与比例主观年龄之间的相互关系的性质，及其对成功老龄化的影响是迄今为止尚缺乏研究的重要问题。澄清这些变量之间的关系对于理解在创伤暴露的阴影下的个体衰老具有理论和实践意义。

目的：本研究检查纵向设计中PTSD症状与比例主观年龄之间的相互关系，以及这些变量如何预测成功老龄化。

方法：使用区域内随机数字拨号，我们收集了居住在以色列南部社区的中老年人的分层样本。该样本中的132名中年和老年人（T1年龄范围= 50-87，平均年龄= 65.84，SD = 9.12）在两年零四个月期间（2014-2016）接受了三次访谈。被试在前两次访谈（T1和T2）中完成了PTSD症状和比例主观年龄的测量，并在第三次访谈（T3）中完成了成功老龄化指数。在T1和T2测量的创伤后应激障碍症状和比例主观年龄在交叉滞后模型中作为预测和结果变量，并作为T3成功老龄化的预测因子。

结果：T1的PTSD症状可以预测T2更大的比例主观年龄，而反之（即，T1比例主观年龄对T2 PTSD症状）无显著预测。此外，T2时较多的PTSD症状和较老的比例主观年龄可以预测T3较差的成功老龄化。

结论：除了阐明PTSD和比例主观年龄的时序关系之外，该研究进一步表明PTSD和比例主观年龄认同可以使中老年人更容易实现成功老龄化。因此，我们主张进一步探索强调这些复杂关系的机制。

1. Introduction

In recent years, a plethora of studies has shown the importance of subjective age – the age an individual perceives oneself to be – to many cardinal factors associated with health and functioning (Hubley & Russell, 2009; Montepare, 2009). In the second half of life, a relatively youthful age identity has become a strong marker indicating that the individual is aging well (Montepare, 2009). Recently, several studies have shown that subjective age is also a predictor of physical and mental health (Stephan, Chalabaev, Kotter-Grühn, & Jaconelli, 2013; Westerhof et al., 2014). Thus, subjective age can be regarded as an important concomitant of adjustment to- and coping with- distress in later life. In the present study we examined the nature of the relationships between subjective age and post-traumatic stress disorder (PTSD) symptoms among individuals in the second half of life.

1.1. PTSD symptoms and subjective age

Research on PTSD in later life focuses on the factors that contribute to the development or exacerbation of the disorder (Avril & Beck, 2000; Böttche, Kuwert, & Knaevelsrud, 2012; Lapp, Agbokou, & Ferreri, 2011), as well as examining how the traumatic experience affects one's identity as an older adult (Palgi, Shrira, & Shmotkin, 2015). Previous studies have shown that PTSD symptoms in later life can reflect both traumatic events occurring at a younger age as well as those occurring later in life (Lapp et al., 2011). Recently, a few studies have examined how perceptions of aging, i.e. subjective age, are related to PTSD symptoms (Palgi, 2017; Shrira, Palgi, Ben-Ezra, Hoffman, & Bodner, 2016). Findings suggest that higher PTSD symptoms are associated with an older age identity. Some of these studies showed, for example, that veterans suffering from PTSD reported an older subjective age in comparison to veterans without PTSD (Solomon, Helvitz, & Zerach, 2009) and that among older veterans suffering from PTSD symptoms, worse physical health was also connected to an older subjective age (Avidor, Benyamini, & Solomon, 2014).

These results are in line with the subjective weathering hypothesis (Benson, 2014), and with Palgi's (2016) extension of this hypothesis. The original hypothesis postulates that traumatic exposure may lead to negative perceptions of older age identity, when emotional and cognitive levels of maturity under-match the surrounding demands (Benson, 2014). Palgi's (2016) extension suggests that an older subjective age may reflect a situation whereby the level of traumatic exposure endured later in life demands social, cognitive, physical, or mental resources that are currently beyond one's resource level (for similar concepts see also Hoffman, Shrira, Cohen-Fridel, Grossman, & Bodner, 2016; Stephan, Caudroit, & Chalabaev, 2011). According to this approach, when these demands are compounded with the difficulties typically involved in the aging process, the management of PTSD symptoms becomes more difficult.

The incongruence between the difficulties ingrained in living with PTSD symptoms, and the individual's ability to accept and adapt to these demands, might be accelerated by the demands of aging. This incongruence may deplete one's coping reserves, which, in turn, may be reflected in older perceptions of age identity (Palgi, 2016).

Some studies have pointed to the reverse possibility, that subjective age may also influence and exacerbate the level of PTSD symptoms (Hoffman et al., 2016; Hoffman, Shrira, & Grossman, 2015). These findings indicate that an older subjective age identity is a psychological marker of vulnerability, which signifies a lack of resources that take their toll when the individual develops PTSD symptoms following a new traumatic experience.

Although the causal sequencing of subjective age and PTSD symptoms is unclear, previous studies have not, thus far, examined the reciprocal relations between subjective age and PTSD symptoms in a longitudinal manner. Exploring the mutual connections between PTSD symptoms and subjective age over time would better ascertain the nature of accelerated psychological aging following trauma. Is it the case that PTSD symptoms strain midlife or older adults' coping resources with the challenges of aging, thereby predicting an older subjective age? Or, perhaps, the causal sequencing follows the opposite direction, such that an older subjective age makes one more vulnerable to the effects of a future traumatic exposure and its aftermath?

Thus, the aim of the present study is to explore these reciprocal relationships between subjective age and PTSD symptoms. We assume that amongst individuals in the second half of life who are exposed to a prolonged threat, such as missile attacks on a civilian population, we will find mutual, bi-directional relationships between subjective age and PTSD. Amongst such individuals, PTSD symptoms may increase age identity, leading them to feel older than their chronological age on the one hand, while the vulnerability related to an older age identity may also exacerbate PTSD symptoms on the other hand.

1.2. Subjective age, PTSD symptoms, and successful aging

Following this hypothesis, it can also be asked how these factors affect domains included in the more generic term successful aging (Pruchno, Wilson-Genderson, Rose, & Cartwright, 2010), which refers to physical health, functioning, and the perceptions of the aging process? In its current definition, this concept aims to encompass the maintenance of good functioning, along with physical and psychological health, as indicated by objective as well as subjective measures (Pruchno et al., 2010). It is understood as a

process of maintaining reasonable functional abilities, in the face of chronic illness and disability, and involves positive development in late life (Aldwin & Igarashi, 2015; Rowe & Kahn, 2015). These definitions delineate successful aging as a concept that comprises diverse aspects of positive functioning in several domains such as physical, mental, and subjective aspects of aging well (Pruchno et al., 2010).

Successful aging has recently drawn criticism, suggesting it is biased by cultural and ethnocentric factors, and entails use of judgment (Katz & Calasanti, 2014; Liang & Luo, 2012; Stowe & Cooney, 2014). Therefore, although this concept is of central importance in the gerontological literature, it may be beneficial to assess and interpret successful aging with some caution.

Drawing from the literature, we assume that a younger age identity and lower PTSD symptoms will prospectively predict higher levels of successful aging. While the association between subjective age and successful aging has already been assumed in several studies, only few studies have examined this assumption directly by showing that a younger subjective age was related to higher levels of successful aging (Uotinen, Suutama, & Ruoppila, 2003). Although both variables are related to subjective evaluations (as successful aging also reflects subjective evaluations of aging), these variables are only moderately correlated (Bodner et al., 2017), perhaps as subjective age refers to the discrepancy between objective and subjective evaluations of age that are not necessarily related to the aging process. Similarly, only a few studies have found that PTSD symptoms are negatively related to successful aging, by showing that participants who were exposed to traumatic events suffered from higher levels of psychological distress and had lower successful aging scores (Bodner et al., 2018; Pietrzak, Tsai, Kirwin, & Southwick, 2014). A recent study showed that older adults suffering from clinical levels of PTSD symptoms had lower successful aging, unless they preserved a youthful age identity. Those with a younger subjective age did not show a significant decrease in successful aging compared to their counterparts without clinical levels of PTSD symptoms (Shrira et al., 2016). It should be noted, however, that this study was based on a cross-sectional design.

The present study therefore had two aims. First, as mentioned earlier, it aimed to examine the reciprocal relationships over time between PTSD symptoms and subjective age. Second, it examined in a longitudinal manner the relationships between PTSD symptoms and subjective age with successful aging.

Our first hypothesis is that reciprocal relationships will be found between PTSD symptoms and subjective age. In this way, it is assumed that higher PTSD symptoms predict an older subjective age, and an

older subjective age predicts higher PTSD symptoms. Our second hypothesis is that higher levels of PTSD symptoms an older subjective age at T1 will predict lower successful aging more than two years later (at T3), and PTSD symptoms and subjective age at T2 will mediate these relationships.

2. Methods

2.1. Participants and procedure

Using a polling company which applied an in-region random digit dialing methodology (from the national telephone directory), we sampled Jewish participants aged 50 or above, residing in the region surrounding the Gaza Strip, an area under ongoing missile attacks. The sample was stratified by age group (50–64, 65–90), gender, and place of residence (see Palgi, 2016, for further information).

Phone calls were conducted to 2374 households where someone was present to respond to the calls; 930 of these households included eligible interviewees (over age 49); 254 potential interviewees refused to participate in the survey; 232 additional potential interviewees could not be interviewed because of hearing problems or cognitive incapacity; 105 participants filled only the initial part of the survey and refused to complete the rest of the interview, either because the interview was too long or because they did not want to respond to some of the questions.

The first interviews (T1) were conducted between January–February 2014, 14 months after a military operation in which more than 800 rockets were fired on the area (a.k.a. Operation Pillar of Defense). The sample included 339 participants who completed the interview.

T2 interviews began on December 2014, four months after the relatively prolonged 2014 Israel–Gaza conflict, (a.k.a. Operation Protective Edge, June–August, 2014), and lasted until July 2015. During this latter conflict, more than 4500 rockets were fired on civilian regions in Israel, especially in its southern region. The sample included 170 participants who completed the interview (71% of those who participated in T1 and who agreed to be interviewed again). Ninety-eight of T1 respondents requested not to participate in subsequent interviews. Of the 241 participants who agreed to participate in a follow-up survey, 46 participants did not respond after five consecutive calls or could not be reached because of wrong or disconnected numbers. An additional 22 participants refused to participate, mostly due to their physical condition, and three participants were reported as deceased.

T3 interviews were conducted between December 2015 and April 2016. During the period spanning between the end of T2 and the end of T3, 22 rockets were fired, a period that is considered to be relatively quiet since the political conflict that was reignited in 2006. The final number of participants who took part in all three waves was 132 (84.6% of those who participated in T2 and who agreed to be interviewed again). Fourteen of T2 respondents requested not to participate in subsequent interviews. Out of the remaining 156 respondents, 15 declined to be interviewed when approached during T3 and nine more were not located.

Attrition analyses compared T1 measurements among those who participated in T1 only ($n = 169$) and those who participated in both T1 and T2 ($n = 170$). There were no significant differences in age ($t[336] = -0.95$), gender ($\chi^2[1] = 0.24$), education ($t[333] = 0.85$), exposure ($t[337] = -1.74$), PTSD symptoms ($t[321] = -1.55$), and subjective age ($t[286] = -0.66$). Similarly when comparing those who participated in T1 only ($n = 169$) and those who participated in all three waves ($n = 131$), there were no significant differences in age ($t[297] = -0.86$), gender ($\chi^2[1] = 0.17$), education ($t[294] = 0.69$), exposure ($t[298] = -1.15$), PTSD symptoms ($t[284] = -0.78$), and subjective age ($t[252] = -0.95$).

Demographic characteristics of the final sample ($N = 132$) are presented in Table 1. The mean age was 66.90 ($SD = 9.14$, range = 51–88), more than half were women (54.5%), and the mean years of education was 13.52 ($SD = 3.18$).

The telephone interviews were carried out by experienced interviewers in either Hebrew or Russian, lasting on average of 15–30 minutes in each wave of research. Informed consent was obtained at the beginning of each interview. Recruitment and administration for all waves were approved by the Ethics Committee of the University of Haifa.

3. Measures

Exposure to rocket attacks was assessed by asking participants to report on eight personal experiences they went through during the first wave: for example, 'a rocket fell close to me' or 'my house was hit' as in Gelkopf, Berger, Bleich, and Silver (2012). A summary score was used.

Posttraumatic-stress-symptoms were assessed in both T1 and T2 using the PTSD Checklist (PCL, Weathers et al., 2013), adapted to the DSM-5 (PCL-5; American Psychiatric Association, 2013; Blevins, Weathers, Davis, Witte, & Domino, 2015). This questionnaire is a 20-item measure of posttraumatic stress symptoms. For each symptom, participants are asked to choose their response on a 5-point Likert scale from 1 ('not at all bothered') to 5 ('extremely

Table 1. Descriptive statistics and correlations between the study variables.

Variable	M (%)	SD	1	2	3	4	5	6	7
(1) PTSD T1	40.50	19.01	-						
(2) PTSD T2	32.64	16.93	.68***	-					
(3) Proportional subjective age T1	0.23	0.19	−.11	−.17	-				
(4) Proportional subjective age T2	0.16	0.19	−.23*	−.30**	.57***	-			
(5) Physical functioning T3	64.61	33.91	−.41***	−.49***	.25**	.30**	-		
(6) Mental functioning T3	68.30	27.43	−.47***	−.57***	.26**	.40***	.82***	-	
(7) Subjective successful aging T3	4.18	0.94	−.30**	−.36***	.19*	.28**	.52***	.57***	-
(8) Age T1	65.84	9.12	−.12	−.08	.10	.03	−.26**	−.06	.10
(9) Gender (women)	55.0	-	.02	.11	.01	−.07	−.10	−.16	−.02
(10) Education	13.52	3.18	−.40***	−.23**	.03	.13	.23**	.18*	.08
(11) Exposure to rockets T1	3.90	1.30	.30**	.27**	.04	.02	−.08	−.07	−.14

N = 132, *p < .05, **p < .01, ***p < .001.

bothered'). Participants were asked to rate each symptom while thinking of the most stressful event related to rocket fire that they reported having been exposed to. Due to the chronic nature of the stressor, the questions referred specifically to symptoms experienced during the previous month. Reliability was excellent (Cronbach's α = .93 and .95 in T1 and T2, respectively).

Subjective age was assessed at both T1 and T2 by asking participants to state how old they felt most of the time. Proportional subjective age score was computed by subtracting one's felt age from chronological age and this sum (i.e., chronological age - subjective age) was then divided by ones' chronological age (Stephan et al., 2013). Higher scores reflect a younger age identity.

Successful aging was assessed in T3 with the physical and mental functioning subscales from the 12-item Short-Form Health Survey (SF-12; Ware, Kosinski, & Keller, 1996) and the 3-item subjective successful aging scale (Pruchno et al., 2010) as described below.

Physical and mental health functioning were assessed using the SF-12, a quality of life and functioning measure in domains of mental and physical health. Hence, in the present study, it was regarded as an indicator of physical and mental successful aging (as done in previous studies, see for example, Geard, Rebar, Reaburn, & Dionigi, 2018; Hodge, English, Giles, & Flicker, 2013). It is a measure of six items assessing each component (e.g. for physical functioning: having trouble in climbing flights of stairs, experiencing pain that interferes with both housework and work outside home. For mental health: feeling downhearted and blue, having difficulties in social activities). Due to differences in Likert scales, scores were transformed according to a formula converting raw scores to values in percentages (ranging from 0–100), as suggested by Ware, Kosinski, Turner-Bowker, and Gandek (2002). Higher scores

indicate better physical and mental functioning (Cronbach's α = .90 and .80 for physical and mental functioning, respectively).

Subjective successful aging was assessed by three items from Pruchno et al. (2010). Each item (e.g. 'I am aging well') was rated on a 5-point scale ranging from 1 (completely disagree) to 5 (completely agree). The score was the respondent's mean rating. Cronbach's alpha was .89.

4. Data analysis

We used structural equation modelling (AMOS 23) to construct a cross-lagged autoregressive design. This model (see Figure 1) simultaneously tested a regression path from T1 PTSD symptoms to T2 subjective age, and from T1 subjective age to T2 PTSD symptoms, allowing the error terms of the same wave variables to covary. T2 paths subsequently predicted a latent variable T3 of successful aging comprised of physical condition, physical functioning, mental functioning, and subjective successful aging as outlined above. The T1 variables were regressed on years of education and exposure to rocket attacks – the two background variables that were significantly related to T1 variables.

Following the recommendations by Hu and Bentler (1999) for relatively small samples, model fit was assessed by the Chi-square value divided by degrees of freedom (χ^2/df), and by the Comparative Fit Index (CFI), root mean square error of approximation (RMSEA), and the standardized root mean squared residual (SRMR). Although there is no consensus regarding an acceptable ratio for χ^2/df, common recommendations range from as high as 3.0 to as low as 2.0 (Hooper, Coughlan, & Mullen, 2008). Scores above .95 indicate good fit for CFI, and values below .08 indicate good fit for RMSEA and SRMR (Hu & Bentler, 1999).
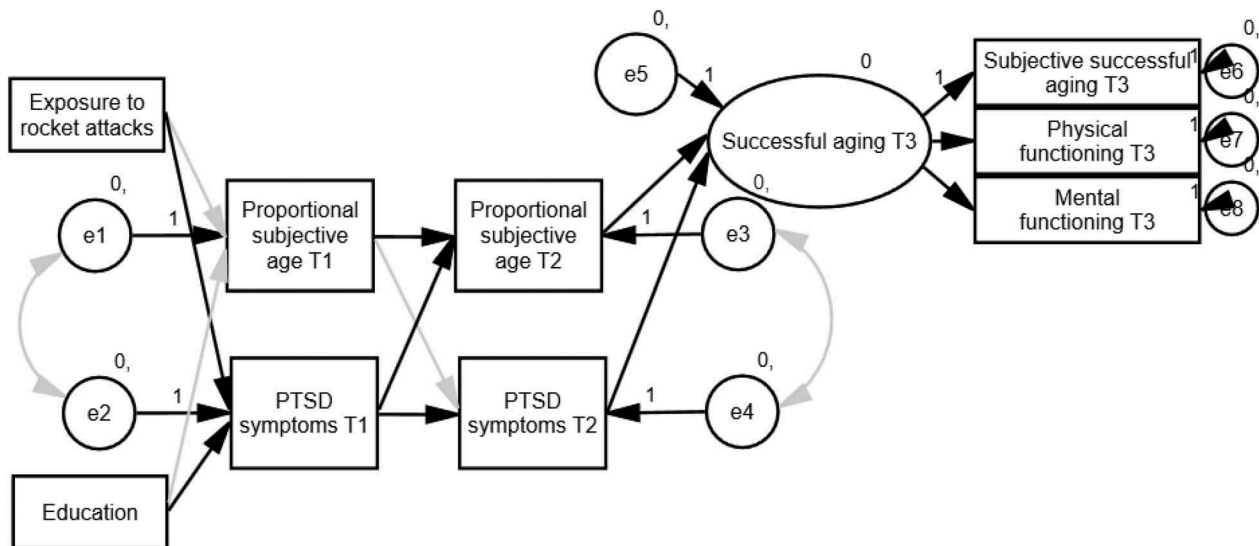
Figure 1. The study model (non-significant paths are in light grey while significant paths are in black).

5. Results

Table 1 presents the descriptive statistics for the study variables. As can be seen, PTSD correlated strongly across times, $r = .68$, $p < .001$, as did proportional subjective age, $r = .57$, $p < .001$. PTSD symptoms and proportional subjective age were negatively correlated at both times, although the relationship was significant only at T2 (for T1: $r = −.11$, $p > .05$; for T2: $r = −.30$, $p < .01$). Critically, only the correlation of PTSD symptoms at T1 and proportional subjective age at T2 was significant (proportional subjective age: $r = −.23$, $p < .05$; T1 proportional subjective age-T2 PTSD symptoms: $r = −.17$, $p > .05$). PTSD at both T1 and T2 significantly correlated with T3 successful aging indices ($rs = −.30$ to $−.57$, $p < .01$). Proportional subjective age at both T1 and T2 also correlated with T3 successful aging ($rs = .19$ to $.40$, $p < .05$). The three successful aging indices were strongly correlated with each other ($rs = .52$ to $.82$, $p < .001$). Finally, background variables and exposure to rocket attacks showed few correlations with the main variables (e.g. education and exposure correlated with PTSD at both times).

We next tested the study model. The model exhibited excellent fit, $\chi^2/df = 0.61$ ($\chi^2 = 12.95$, $df = 21$), CFI = 1.00, RMSEA = 0.000, SRMR = 0.000. Table 2 presents the selected parameters for that model. T1 PTSD predicted T2 older proportional subjective age, but not vice versa. Moreover, there was a significant effect of T2 PTSD and T2 proportional subjective age on T3 successful aging. Higher PTSD symptoms and an older age identity at T2 separately predicted lower scores of successful aging at T3.

We further tested the indirect effect of T1 PTSD symptoms on T3 successful aging. The indirect effect was $−0.25$, bootstrapped 95% CIs $[−0.14, −0.38]$, indicating the effect was significant (below the .05 level). The results revealed that T1 PTSD symptoms predicted T2 PTSD symptoms and T2 proportional subjective age, both of which subsequently predicted T3 successful aging. Moreover, we tested the indirect effect of T1 proportional subjective age on T3

Table 2. Selected parameters for the study model.

Covariance			B	β	SE	LLCI	ULCI
PTSD T1	↔	Proportional subjective age T1	−0.46	−0.15	0.19	−1.09	0.05
PTSD T2	↔	Proportional subjective age T2	−0.30	−0.15	0.30	−0.76	0.05
Regression Weights							
Exposure to rockets T1	→	PTSD T1	5.65***	0.40	1.18	3.39	8.17
Exposure to rockets T1	→	Proportional subjective age T1	0.004	0.02	0.01	−0.03	0.03
Education	→	PTSD T1	−2.39***	−0.35	0.57	−3.55	−1.21
Education	→	Proportional subjective age T1	0.004	0.05	0.007	−0.009	0.01
PTSD T1	→	PTSD T2	0.60***	0.65	0.07	0.40	0.79
Proportional subjective age T1	→	Proportional subjective age T2	0.53***	0.53	0.08	0.37	0.71
PTSD T1	→	Proportional subjective age T2	−0.002**	−0.22	0.001	−0.004	−0.001
Proportional subjective age T1	→	PTSD T2	−5.80	−0.06	6.66	−18.02	7.45
Physical functioning T3	→	Successful aging T3	55.96***	0.85	8.54	40.00	87.97
Mental functioning T3	→	Successful aging T3	51.39***	0.96	7.65	36.02	84.38
Subjective successful aging T3	→	Successful aging T3	1.00	0.60	-	1.00	1.00
PTSD T2	→	Successful aging T3	−0.01***	−0.58	0.003	−0.02	−0.01
Proportional subjective age T2	→	Successful aging T3	0.54*	0.20	0.22	0.21	0.98

*$p < .05$, **$p < .01$, ***$p < .001$

successful aging. This indirect effect was 0.39, bootstrapped 95% CIs [0.10, 0.79], indicating the effect was significant, T1 proportional subjective age predicted T2 proportional subjective age which subsequently predicted T3 successful aging.[1]

6. Discussion

The present study set out to examine the reciprocal relationships between PTSD symptoms and proportional subjective age over time along with their implications for successful aging. This examination took place in a cohort of midlife and older adults living in the south of Israel, who were exposed to ongoing rocket fire. Results reveal in line with previous studies, that PTSD symptoms (i.e. Cook & Simiola, 2017) as well as proportional subjective age (i.e. Westerhof et al., 2014) are each highly correlated over time. These findings point to the persistent nature of trauma sequelae and to the consistent nature of perceptions regarding one's own aging over time. It should be noted, however, that the average level of PTSD symptoms across the waves was relatively low, as the sample was comprised of community-dwelling individuals.

Regarding the first hypothesis, the results show that PTSD symptoms at T1 predicted proportional subjective age a year later, at T2, however, proportional subjective age at T1 did not predict PTSD symptoms at T2. These findings partially support our hypothesis, as PTSD symptoms at first assessment predict an older proportional subjective age identity, but an older proportional subjective age identity does not predict an exacerbation of one's PTSD symptomatology. These relationships between PTSD symptoms and proportional subjective age are in line with the suggested directionality implied in previous, cross-sectional studies (i.e. Avidor et al., 2014; Solomon et al., 2009). Theoretically, it means that following the modification to the weathering hypothesis (Palgi et al., 2015), PTSD symptoms may deplete the ability to preserve a younger age identity. The depletion in this ability makes it harder for those suffering from PTSD symptoms to use their age identity as a buffer against stressors in old age (Hoffman et al., 2016), and may lower the chances for successful aging. However, our findings do not support the existence of a negative spiral wherein proportional subjective age identity exacerbates PTSD symptoms. Our findings suggest, instead, that PTSD symptoms are the precursor to an older proportional subjective age, and that the latter may result from trauma, but does not necessarily play a role in further increasing one's vulnerability to PTSD symptoms following trauma. These results are not in line with previous findings which demonstrated, based on a sample of community-dwelling older adults, that

subjective age predicted physical, mental, and self-rated health, but the reverse effect was only limited to self-rated health (Spuling, Miche, Wurm, & Wahl, 2013). Therefore, it is also possible that while proportional subjective age seems to be an important predictor for several facets of health for healthy midlife and older adults, it does not predict mental health following exposure to ongoing trauma. It is also possible that the lack of reciprocal relationship between proportional subjective age and PTSD symptoms is due to a more complicated mechanism underlying the development of PTSD symptoms among traumatized midlife and older adults. These findings need to be further explored in future studies.

Following our second hypothesis we showed that, in line with previous findings, lower levels of PTSD symptoms, and younger proportional subjective age, as measured both at T1 in separate analyses, are related to better successful aging (Pietrzak et al., 2014; Shrira et al., 2016; Uotinen et al., 2003). These relationships were mediated by PTSD symptoms and proportional subjective age at T2, respectively. Taking these results together may enhance our understanding of the way midlife and older adults are challenged by traumatic exposures that occur in the second half of life. Drawing from models which conceptualize mental systems that promote coping with adversity (i.e. Shmotkin, 2005), individuals who maintain a younger proportional subjective age in spite of PTSD symptoms can be said to have successfully negotiated a positive psychological environment. Such a positive psychological environment may facilitate their coping with the aging process, thus predicting higher levels of successful aging. Following the results, it can be suggested that a younger proportional subjective age over several time measurements may robustly embody such a positive psychological environment in the face of continuous traumatic exposure, which may, in turn, promote successful aging. It should be noted, however, that it appears that a younger proportional subjective age does not hinder the development of additional PTSD symptoms (as it did not predict T2 PTSD symptoms).

The research presents several novel findings regarding successful aging and PTSD symptoms, but also suffers from some caveats that should be considered when interpreting its results. First, although the participants in T1 were selected using an in-region random digit dialling methodology, the randomization of the study was biased due to the stratification methodology, refusal to participate, across-wave attrition rate, and strict inclusion demands. For example, high scores on physical and mental functioning indices indicated that our sample was mainly composed of healthy respondents. Yet, this sample has one of the strongest

methodological designs among the longitudinal studies that have been conducted in the south of Israel, where civilians have been exposed to rocket fire for more than a decade. To the best of our knowledge, it is the only longitudinal study that focuses on individuals in the second half of life exposed to ongoing missile attacks. Second, as previously mentioned, there are diverse ways to evaluate successful aging (Rowe & Kahn, 2015), and it is possible that using different measures for successful aging could have affected the results, which may limit their generalizability at present. Further research replicating the present model, relying on more diverse measurements of our outcome measure of successful aging, is needed. Third, due to the continuous nature of the exposure to traumatic events, with missile attacks in the southern region of Israel lasting for more than a decade, it is possible that some of our respondents could have suffered from PTSD symptoms before T1.

In sum, the present study shows that individuals in the second half of life with higher levels of PTSD symptoms may have higher level of successful aging if they possess a relatively youthful age identity. This finding can be added to the growing list of advantages associated with younger proportional subjective age in the second half of life (Westerhof & Wurm, 2015). Future endeavours should involve the developing of interventions that would focus on skewed or even negatively distorted evaluations of age identity on the one hand hand, and on the means by which these may be reconstructed on the other hand, in order to improve one's self-image related to aging. One such recent study, for example, evaluated an intervention programe focused on perceptions of aging, in order to promote physical activity (Brothers & Diehl, 2017). Studies such as these may enhance the adoption of a younger age identity among individuals who suffer from PTSD symptoms, which, in turn, may contribute to one's successful aging.

Notes

1. Although not all successful aging indices were available across the study waves, in an additional analysis we added subjective successful aging in T1 and T2 to the model. The main findings were very similar. The model exhibited good fit, χ^2/df = 1.08, CFI = 0.99, RMSEA = 0.02, SRMR = 0.04. T1 PTSD predicted T2 older proportional subjective age (β = −0.26, p = .003), but not vice versa (β = −0.06, p = .41). Moreover, there was a significant effect of T2 PTSD on T3 successful aging (β = −0.51, p < .0001), but T2 proportional subjective age was no longer a significant predictor of T3 successful aging (β = 0.10, p = .24). Finally, T1 proportional subjective age predicted T2 subjective successful aging (β = 0.23, p = .007), but not vice versa (β = −0.07, p = .43).

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