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The indirect effect of experience between personality hardiness and situational awareness

Bjørn Helge Johnsen ¹
Evelyn-Rose Saus ²
Roar Espevik ³
Sverre Sanden ⁴
Olav Kjellevoid Olsen ³

Abstract

Studies on the relation between personality and Situation Awareness (SA) have been inconclusive. The present study investigates the relation between personality hardiness and SA during a simulated police scenario using a mediation approach. One hundred and sixty-seven police officers completed the test in a scenario with the arrest of a suspected perpetrator. The results showed a direct relationship neither between hardiness and SA, nor a total effect of the model tested. However, an indirect relationship between hardiness and SA, through the amount of annual operational training, beyond mandatory training, occurred. This indirect effect of training occurred for the total hardiness score, and for the control dimension on the facet level of the Dispositional Resilience Scale (15 items). The findings were interpreted as police officers high on hardiness being more motivated and engaged in voluntary operational training. By being more involved in training, they were gaining more experience in perceiving and interpreting critical stimuli in operational scenarios. Thus, the findings of an indirect effect was seen as a result of the relationship between experience and SA.

Keywords

Police training, Situation awareness, personality hardiness, indirect effect.

Corresponding author: Bjørn Helge Johnsen. Dept. Psychosocial Science, University of Bergen, Christies gt. 12. 5015 Bergen, Norway. E-mail: bjorn.johnsen@uib.no

¹ University of Bergen, Norway and Royal Norwegian Navy, Medical Branch

² University of Bergen, Norway, and Norwegian Armed Forces Joint Medical Services

³ University of Bergen, Norway and Royal Norwegian Naval Academy

⁴ Royal Norwegian Navy, Medical Branch

Introduction

Situation awareness

Situation awareness (SA) is crucial for operational personnel in their performance of critical activities. This is of outmost importance in the decision-making process of police personnel involved in handling scenarios where the officers or other members of the public is at risk (Johnsen et al., 2016). SA as a cognitive concept has received broad support in human factor communities (Lo, Sehic, Brookhuis & Meijer, 2016). Endsley's hierarchical model of SA consists of perception of information (level 1), understanding the meaning of the information (level 2) which is the basis for predicting the status in the near future (Level 3; Endsley, 1995).

According to this - SA is important for the performance in critical situations and a lack of an ability to generate or maintain SA can result in potentially dangerous failures. Accident analyses from the offshore oil-drilling industry showed that 67% of human errors could be attributed to a lack of perception of critical signals (Level 1). Twenty percent could be attributed to comprehension (Level 2) and 13% to the inability to project the status of the situation in the near future (Level 3; Sneddon, Mearns & Flin, 2006).

SA can be influenced by both environmental and individual factors, resulting in operators exhibiting different accuracy of SA in the same situation. When controlling for experience Carretta, Perry and Ree (1996) identified cognitive factors such as working memory, spatial reasoning and divided attention predicting SA. In addition, Durso and coworkers (2007) stated that SA relies heavily on cognitive mechanisms as knowledge, long-term memory and mental models. In the oil and gas industry Roberts, Flin and Cleland (2015) studied drillers, and identified six factors with the potential to aid and hinder SA. These were distraction, experience, and expectation, coping with stressful or demanding situations, work environment and workload.

Personality factors as predictors of Situation awareness

Although most of the literature on individual differences as predictors of SA have focused on the cognitive domain, also personality factors are worth investigating. One reason is the growing interest in using personality assessment in selection of police personnel (Sanders, 2003). Increased knowledge of a potential relationship between personality factors and SA, including mechanisms of how this potential relationship works, could result in selection and training of law enforcement personnel with an increased ability to succeed in operational scenarios. However, surprisingly few studies have examined this link. An example of an indirect evidence for this link could be found in studies using a Big- Five approach (Costa & McCrae, 1992). Flin (2001) reported that high scores on Extraversion and Conscientiousness and low scores on Neuroticism are characteristics in predicting success in the training of emergency service recruits. The selection of emergency service recruits is not specifically related to SA. However, these services rely heavily on SA in order to successfully perform their role (Saus, et al., 2012). High scores on Extraversion and Conscientiousness and low scores on Neuroticism are referred to as a Resilient Personality Type (Asendorpf, Borkenau, Ostendorf & Van Aken, 2001; Berry, Elliott, & Rivera, 2007; Rammstedt, Riemann, Angleitner & Borkenau, 2004; Saus et al., 2012; Schnabel, Asendorpf & Ostendorf, 2002). Subjects with a

resilient personality type are known to be adept in their responses to environmental demands and when confronted with stressful situations. Thus, resilience may indicate a well-adjusted personality profile with better coping abilities in demanding situations. Saus et al., (2012) confirmed the proposed link between resilient personality type and SA. In her study, naval cadets profiled as a resilient personality type based on their scores on Neuroticism, Extraversion and Conscientiousness, showed higher SA during performance in a navigation simulator compared to a non-resilient type.

Personality hardiness and Situation Awareness

Within the field of resilience research, the concept of Personality hardiness has gained increasing attention. Although hardiness is found to correlate with several of the Big Five factors (Bartone, Eid, Johnsen, Laberg & Snook, 2009), it is considered to be a separate resilience construct. Several studies have shown the explanatory power of hardiness when the broad personality domains of the Big Five approach have been controlled for (Bartone, et al., 2009). Furthermore, a meta-analysis including 180 studies, conducted by Eschleman, Bowling and Alarcon (2010), confirmed hardiness as a unique resiliency resource across a wide range of research areas, even when controlling for the domains of the Big Five.

Personality hardiness is defined as to as a personality or cognitive style marked by increased levels of commitment, control, and challenge (Kobasa, 1979; Maddi & Kobasa, 1984). Individuals with high hardiness scores believe they can control or influence events and are strongly committed to activities, the environment they operate in and to interpersonal relationships. They are also committed to their own self, in that they recognize their own distinctive values, goals and priorities in life (Johnsen, Bartone, Sandvik et al., 2013). This influences the individual to cope with challenges in a constructive and proactive manner (Kobasa et al., 1982). People high on the challenge dimension of hardiness consider change as more common than stability, and a difficult situation is a potential for learning and growth, which should not be avoided. Hardiness could be related to SA in complex and high-intensity situations because high hardy people would show higher *commitment* to the task at hand. High commitment results in greater involvement in the scenario, which could lead to an increased ability to generate and maintain SA. High commitment and involvement create a greater chance of detecting critical stimuli (Level 1), integrating these stimuli in order to understand a situation (Level 2), and making a plan to solve the situation (Level 3). Subjects high on hardy *control* view difficult situations as possible to master through increased effort. High hardy control subjects exercise control over own activity and understand that effort increases the probability of success. This approach strategy of increased effort and mastery beliefs could result in a broaden experience base and thus increase SA in high-intensity situations. High hardy *challenge* subjects would interpret difficult situations as having learning potential, and by that show an approach towards the situations. By learning from experience, novices would transform into experts, and the higher ability to generate and maintain SA in experts compared to novices is a stable finding in the literature (Caretta et al, 1996; Kas, Cole & Stanny, 2007; Roberts, Flin & Cleland, 2015; Saus, Johnsen & Eid, 2010). Thus, one may argue for a positive relation between hardiness and SA in the present study.

Hardiness and motivation

It has been argued that personnel motivated for operational duty could have been more engaged in previous operational activities, proactively searched for opportunities to engage in such activities, and by doing so, showing an increased ability to generate SA (Johnsen et al., 2017).

Theoretical and empirical bases. One could argue that operators in demanding occupations who are high on personality hardiness have an increased motivational ability to expose themselves for stressful training. For instance, several studies have concluded that in high-risk occupations, hardiness represents one promising pathway to train and select resilient individuals who can remain healthy under stress (Bartone, Eid, & Hystad, 2016; Westphal, Bonanno, & Bartone, 2008). On a theoretical level, Maddi (2007) stated in a presentation of the initial hardiness project: “*The conclusion reached was that, under stress, the courage contained in the hardy attitudes provided the strength and motivation to do the hard work of transformational coping, supportive social interactions, and facilitative self-care*”. Furthermore, Maddi (2004) claimed that based on hardiness theory, the combined influence of the dimensions of commitment, control and challenge constitutes the existential courage and motivation.

There is also empirical support for an association between hardiness and motivation in operational settings. In studies of stressful military training exercises, cadets high in hardiness were viewing themselves as more capable of coping with the training and considered the training exercises as less threatening (Johnsen et al., 2013). Furthermore, several reports have presented a positive relationship between hardiness and achievement motivation in a variety of environments. Hedayati and Khaeez (2015) reported a positive and meaningful relationship in an industrial organization and Cole, Field and Harris (2015) found the relationship in academic performance. The same relationship was also found in Greek schoolchildren (Kamtsios & Karagiannopoulou, 2016).

One behavioural output of motivation could be increased level of training in order to cope with operational scenarios. Based on hardiness theory a link between hardiness and training could be caused by high hardy police officers perceive stressful operational training as something to be committed to (commitment), it has to be approached in order to learn (challenge) and these situations could be controlled depending on own effort (control). On the other hand, the effect of low hardiness would result in alienation (low in commitment), powerlessness (low on control), and threat (low on challenge; Maddi, 2005). This in turn would result in an avoidance of stressful training, with the consequence of less experience and less SA in operational settings.

One way to record the behavioural output of motivation, is through training hours that extends mandatory training. Thus, the present study predicts a positive relation between Hardiness and hours of operational training beyond mandatory training.

Experience and Situation Awareness

One of the most influential predictors of SA is experience. This has been reported in studies of aviation (Caretta et al., 1996), drilling operators (Roberts, Flin & Cleland, 2015), driving simulators (Kas, Cole & Stanny, 2007) as well as in ship-handling simulators (Saus, Johnsen & Eid, 2010). For instance, Carretta, Perry and

Ree (1996) found that number of flying hours was the best predictor of SA in simulation using F-15 fighter pilots. It has been suggested that the ability to achieve and maintain SA seem to develop over time, resulting from an increased level of experience (Prince & Salas, 1998). This has been shown in visual attention and the transition from novices to advanced drivers (Underwood, 2007), as well as in the context of decision-making in a real-time, complex cognitive tasks (Randel, Pugh & Reed, 1996). The results revealed that experts emphasize decisions of the nature of the situation and concentrate on assessing the situation correctly. Novices, on the other hand, were more focused on strictly following procedures. Expertise also promotes a larger array of mental models which again can give rise to better and faster acquisition of SA. Hence, in our study a positive relation between annual training hours and SA was hypothesized.

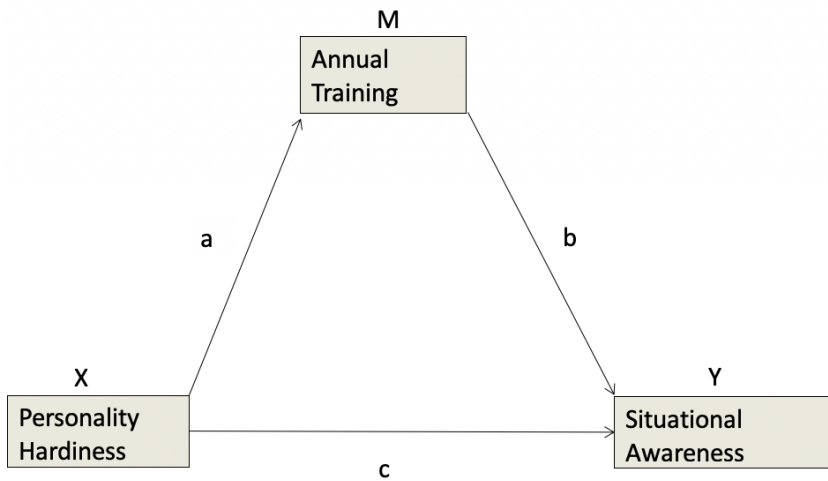


Figure 1 presents a proposed model with Annual training hours as a mediator between Personality Hardiness and Situational Awareness

Study aims

The first aim of the present study was to investigate the relationship between personality hardiness and SA in a simulated police scenario. It was hypothesized a direct effect of personality hardiness on SA (c). The relatively limited findings in the literature of an association between personality and SA may be caused by previous research models lack of an integration of potential mediators in their design. Thus, the second aim was to investigate a possible mediating role of training hours between personality hardiness and SA. Operational training, and particularly simulations, are the most common way to gain experience in critical situations that occur infrequently in natural settings. A pre-condition for a possible indirect effect between hardiness and SA stipulate a positive relationship between personality hardiness and annual training hours (a) as well as a positive association between annual training hours and SA (b). Based on the proposed association between the variables, a mediated indirect effect of annual training hours between personality hardiness and SA (ab) was predicted (see Figure 1 for hypothesized model).

Method

Subjects

The subjects in the present study consisted of Norwegian operational police officers. All officers had completed a three-year bachelor program in the Norwegian Police Academy. 167 officers participated in the study out the 183 (34 females and 149 males) subjects involved in the training. Exclusion was caused by missing data. The sample consisted of personnel from a police district on the west coast of Norway, from both urban and rural areas.

Questionnaires and Procedures.

Personality hardiness. The Dispositional Resilience revised 15-item scale was used to measure personality hardiness. This is a revised scale that improves over earlier instruments of hardiness, includes both positively and negatively keyed items, and covers the three important hardiness dimensions of commitment, control and challenge (DRS-15-R; Hystad, Eid, Johnsen, Laberg & Bartone, 2010). The items are scored on a four-point Likert scale (from 0 = *Not true* to 3 = *Completely true*). Example items are: “By working hard you can nearly always succeed in reaching your goals,” and “Change in routines are interesting.” The standard measure for internal reliability is Cronbach’s alpha and previous studies on military samples have revealed alpha values ranging from .62 to .79 (Bartone et al., 2008; Hystad et al., 2010;). The DRS-15 scale consists of three dimensions of five items each. It has been suggested (Taber, 2017) that Cronbach’s alpha underestimate internal consistency of scales with 10 items or less. The suggested alternative measure of internal consistency was mean inter-item correlation values (Herman, 2015). Since the present study report the reliability measures for the three dimensions separately, the mean inter-item correlations were used as a reliability measure on this scale. For commitment a mean $r(183) = .223, p < .05$; for the control dimension a mean $r(183) = .259, p < .01$ and for the challenge dimension a mean $r(183) = .278, p < .01$ were found. The total scale showed a mean inter-item correlation of $r(183) = .253, p < .05$. In a psychometric study of the DRS-15, Hystad and coworkers (2010) reported hardiness as a hierarchical model comprised of the three intercorrelated dimensions under a general hardiness factor. This call for separate analyses of the dimensions and the total hardiness score.

Situational Awareness. SA was measured by the *Situational Awareness Rating Scale* (SARS; Waag & Houck, 1994 adapted to use in a shooting simulator, see Saus et al., 2006). Originally the SARS consisted of 25 items including a dimension of general ability. In the Norwegian version this dimension was excluded, and the version consisted of 17 SA related items (scored 1 – “to a minor extent” to 6 – “to a great extent”). The scale included the SA-dimensions of tactical planning, equipment operations, communication, information interpretation, tactical decisions and general tactics (see also Saus, et al., 2010; 2012). Example of item was “To what extent could you create a plan of the situation?” Cronbach’s alpha for the SARS was .73.

Annual training hours. Annual mandatory police training for Norwegian Police Officers is 48 hours. Thus, professional experience was measured by one item: “How many hours of operational training, the last year, did you perform, with the

exception of the mandatory hours?” The responses to this variable were square root transformed.

Test situation. The subjects were tested as part of their annual training program. The test scenario was designed in order to tap into Endsly’s model of SA, and focus was put on critical details in the situation. The test scenario consisted of two person patrols, which is the standard set-up for Norwegian police patrols. Allocation to teams were random, excepting officers who normally patrol together, which would not be teamed up for the exercise. The subjects received exercise instructions orally while seated in a patrol car. The subjects were instructed regarding a robbery of a shop in which an employee was stabbed by the perpetrator. The perpetrator was later observed entering a hostel known for hosting several previously convicted persons. The main task of the patrol was to guard the back door while another unit entered from the front in order to arrest the criminal. After the patrol had positioned themselves at the back door, one person would exit the door. This person was similar to the description of the perpetrator except for two details. These small, but significant details (SA-level one) were important in order to generate and maintain SA during the simulation. The second person exiting 30 seconds later was identical to the perpetrator.

Statistics

The PROCESS procedure for SPSS (Hayes, 2013) was applied in our analyses to estimate possible direct and indirect effects. The PROCESS procedure uses an OLS regression-based path-analytic framework for estimating indirect effects, and provides inferential procedures such as the normal theory Sobel Test (Sobel, 1987) to test for indirect effects. Training hours (M) was proposed as a mediator in four separate analyses in the relation between Personality Hardiness (X) and Situational Awareness (Y). The first analysis used the sum score of Hardiness as independent variable (X) and the rest of the analyses used the dimension of challenge, commitment and control as independent variable (X). In our analyses, 1000 bootstrap resamples were used to estimate the 95% bootstrap confidence intervals for the indirect effects. If the confidence interval does not contain zero, this supports the conclusion that an indirect effect exists (Hayes, 2013). The analyses of possible indirect effects were performed even when the total effects did not differ from zero. This was done because there is a possibility that X could exert an effect on Y indirectly through M even if a total effect could not be shown (Hayes, 2018). Hayes (2018, p. 117) states that: “There is now a general consensus among methodologists that a total effect of X on Y should not be a prerequisite to searching for evidence of indirect effects”. He even strengthens this argument (p. 118) by claiming that it is a mistake to condition the investigation of possible indirect effects on evidence of a total effect of X on Y. In the analyses, all regression weights are presented as unstandardized Betas.

Results

Inter-correlations and descriptive statistics are presented in Table one. As can be seen in Table one, the total score of DRS-15 correlated with annual training hours ($r(183) = .20, p < .01$). When separating the DRS-15 into its dimension, only the

control dimension correlated with annual training hours ($r(183) = .17, p < .05$). A correlation between annual training hours and SA was also found, $r(167) = .30, p < .011$. When testing the total effect of the model, no correlations between hardiness measures and SA reach the significance level (see Table 1).

	Mean	SD	1	2	3	4	5
Sum Hardiness (1)	28.76	3.18					
Commitment (2)	9.3	1.49	.71**				
Control (3)	11.89	1.80	.76**	.38**			
Challenge (4)	7.57	1.49	.51**	.06	.03		
Training hours (5)	4.77	4.25	.19**	.10	.17*	.08	
Situational Awareness (6)	78.34	10.64	-.06	-.15	.07	-.08	.30**

* = $p < .05$ (two-tailed) ** = $p < .01$ (two-tailed)

Table 1 presents descriptive statistics and inter-correlations of the variables

In order to look for mediating or indirect effects of training hours between hardiness and SA, associations between the three variables have to be established. A positive association between hardiness and annual training hours occurred ($B = .246, p < .018$). Furthermore, a positive relation between number of annual training hours and SA also appeared ($B = .788, p < .000$). No direct effect of hardiness on SA occurred ($B = -.214, p < .4$). However, the indirect effect of annual training hours on the relationship of personality hardiness on SA was significant ($B = .194$, Bootstrap Lower Level Confidence Interval = .042 and Bootstrap Upper Level Confidence Interval = .466).

When separating personality hardiness into its three dimensions of challenge, commitment and control, the only significant model that occurred was for the control dimension. A positive association was found between hardiness- control and training hours ($B = .378, p < .04$) as well as between training hours and SA ($B = .751, p < .000$). No direct effect was found between hardiness - control and SA. However, an indirect effect of annual training hours was found for the relation ($B = .284$, Bootstrap Lower Level Confidence Interval = .025 and Bootstrap Upper Level Confidence Interval = .727).

Discussion

The present study revealed an indirect effect of annual training hours on the relationship between personality hardiness and SA. The only dimension of hardiness showing this effect was control. Neither the direct effect between hardiness and SA was revealed, nor did we find a total effect of the model.

Pre-conditions for indirect modeling

The inter-correlation revealed significant positive relations between the total hardiness score and annual operational training hours, indicating that as levels of

hardiness increase, so do training hours. This positive association was only evident for the total score on hardiness and the dimension of control. The positive relations are in line with our predictions. As expected, a positive correlation was found between number of training hours and SA, showing that increased training was associated with increased SA. Since the purpose of operational training is to enhance experience through development of knowledge and mental models (Durso et al., 2006), the finding is in line with numerous studies showing a positive relation between expertise and SA (Carretta et al., 1996; Prince & Salas, 1998; Roberts, Flin & Cleland, 2014). However, the size of these significant correlations were small to medium (range = .17 to .30). When further examining the intercorrelations, all hardiness dimensions showed a strong association to the DRS-15 total score (range .51 to .56). Surprisingly, the intercorrelations of subdimensions did not reach significance. The exception was a medium size correlation between commitment and control. The lack of intercorrelations between the subscales did not match the theoretical assumption (Maddi, 2007) or previous research (Hystad et al., 2010).

The indirect effect of training hours

The main finding of the present study was the indirect effect of training hours on the relation between Hardiness and SA. In order to explain the indirect effect revealed in the present study, the hardiness concept could be viewed as an individual factor that motivates for operational training. The construct of Hardiness is thought of as the foundational basis for a person's interactions with his/her surroundings, and provides a source of motivation to endure hardship (Maddi, 2002) as well as to provide courage and motivation to approach and engage in difficult tasks (Maddi, 2007). This motivational factor could be the source for involvement in operational training, which in turn act as a precursor for the development and maintenance of SA, through the use of cognitive mechanisms like working memory, long-term memory (acquired knowledge) and mental models. An interpretation of hardiness as an individual motivational factor is strengthened by the fact that annual training hours, as measured in the present study, excluded mandatory training for the police officers. When further analyses of the dimensions of Hardiness were conducted, the indirect effect of operational training hours on SA was only found for Hardiness - control. Hardiness is often viewed as involving positive coping strategies (Bartone, 1999; Bartone, Johnsen, Eid, Brun, & Laberg, 2002; Tohamssen et al., 2015; 2018). The coping style most commonly associated with hardiness is transformational coping, an optimistic style of coping that transforms stressful events into less stressful ones (Kobasa, 1982). Individuals high in hardiness control are believed to react to challenging situations by increased interaction to strive to gain control. This personality style could be an underlying factor and act as the motivating force for training, and as a result higher SA is experienced during complex and intense training scenarios. Personnel high on hardiness control also have the notion that they can influence their surroundings by their own actions. This again would result in a focus on and a will to be involved in training and thereby better performance in training and real-life scenarios. People low on hardiness control would view their experiences as something they could not influence, and in extreme cases as something they do not have the resources to control. Therefore, these operators

would avoid operational training and at best only be involved in mandatory training. Thus, both motivation for and effects of operational training could be viewed as dependent on personality hardiness.

The present study did not reveal a total effect of the model. The total effect tested, included both the direct and the indirect effect. According to Hayes (2018) the lack of a total effect, in spite of a significant indirect effect, is common and could be caused by several factors. One reason for this finding could be that the analyses of indirect effects have more power compared to the analyses of the direct effects due to larger number of sampling errors in the analyses of direct effects. Furthermore, the sample or subsamples could show an opposite direction on the total effect versus the indirect effect (Hayes 2018, p.117 and 118). Thus, subsamples of high hardy police officers could show no or negative association between hardiness and SA. Further research has to explore this hypothesis.

In one of the few studies on the relation between personality and SA, Saus et al. (2012) found that a resilient personality type predicted SA in a navigational simulator. The scarce body of positive findings reported in the literature could be caused by studies investigating direct effects, ignoring the possibilities of indirect effects indicating that the relationship is working through a “chain of events”.

Limitations of the study

Some limitations of the study should be noted. The study only used number of operational training hours exceeding standard annual training. Thus, no control for type and quality of training were recorded. It could be argued that specific types of training enhances SA to a greater degree compared to others (Graafland et al., 2014). Despite this, the scope of the present study was to investigate how the relation between individual differences of hardiness and SA works (mediation), rather than when (moderation) it works (Hayes, 2013).

Another limitation of the present study is the use of self-report measures. It has been argued that the use of the hardiness scale on professionals in operational environments could be influenced by social desirability (Thomassen et al., 2015). However, the mean score on the hardiness questionnaire ($M = 28,76$) was considerable lower than in for instance the military sample reported by Thomassen et al. (2015; $M = 32,29$). If social desirability was influencing the self-report of hardiness, the data indicate that the influence of social desirability plays a lesser role in the present compared to other studies (Thomassen, 2015).

A third limitation is the relatively low scores on internal consistency. Although the correlations were in the low range (range .223 to .278) they were all significant and could be used as a reliability measure in the study.

Conclusions

To sum up, this study expands previous knowledge showing an indirect effect of annual operational training hours on the link between personality hardiness and SA. Personality hardiness could be viewed as a motivational factor for gaining experience through training, which in turn increases SA in operational scenarios. Since only the total hardiness and the control dimension showed an indirect effect, the study confirms previous theoretical assumptions of hardiness as comprised of a general factor (G-factor) and three separate dimensions. Thus, hardiness could be

viewed as being more than its dimensions. The study increases the knowledge of hardiness, by relating it to SA and describing how this relation occur. It also helps to fill the gap in the literature in the study of personality factors related to SA, by indicating the need to use indirect models. The study also has practical implications by giving an argument for using hardiness in selection or focusing on programs aimed at developing hardy attitudes.

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