

Untying a Gordian knot: Exploring the nomological network of resilience

Cinzia Modafferi¹ | Marcello Passarelli²  | Carlo Chiorri³

¹V.I.E. (Valorizzazione Innovazione Empowerment) Spin-off dell'Università degli Studi di Genova, Genova, Italy

²Institute for Educational Technology, National Research Council of Italy, Genova, Italy

³Dipartimento di Scienze della Formazione (DISFor), Università degli Studi di Genova, Genova, Italy

Correspondence

Marcello Passarelli, Institute for Educational Technology, National Research Council of Italy, Via de Marini 6, 16149 Genova, Italy.
Email: passarelli@itd.cnr.it

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Abstract

Objective: This study investigates the relations of resilience with coping, personality traits, emotional intelligence, sense of coherence and maladaptive personality traits.

Method: The study employs network analysis techniques to the study of resilience, showcasing how these methods can estimate a model that is simple to interpret while still retaining the most important relations and that can even suggest the direction of causality despite using a cross-sectional design ($N = 305$).

Results: The results highlight several important variables that should be considered for fostering resilience, foremost among them the use of positive reappraisal coping, sense of coherence, and the social management aspect of emotional intelligence.

Conclusions: The results successfully replicated known associations between resilience and other psychological constructs (emotional intelligence, personality, sense of coherence, coping) and shed light on relations between resilience and maladaptive personality traits. Network analysis considered all these constructs together, so as to take into account the complex pattern of relations between them and offer a bird's eye view of the whole network of associations centred on resilience. The resulting model is parsimonious and easy to interpret while still striving to preserve the complexity of the variables' interrelations.

KEYWORDS

coping, dark triad, emotional intelligence, nomological network, resilience, sense of coherence

1 | INTRODUCTION

Psychology is a science of complexity. By its very nature, its aim is often to study variables that cannot be directly observed. Psychological constructs may have multiple, contrasting definitions and are interrelated in a wide

network of causes and effects. Yet, despite the inherent complexity of the subject matter, the psychological sciences often aim to simplify their models and findings in order to better guide practitioners. One of the reasons it is far more common for researchers in psychology to employ linear models rather than neural networks is not that the

This study was not preregistered.

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former describe reality better than the latter. Indeed, the simple linear model often proves to be a gross oversimplification of relations between variables. However, the ease of interpretability of a regression equation, compared to the sheer unintelligibility of more predictive approaches, makes it so that the humble linear model continues to be the founding stone of our discipline.

Most of the history of psychological research is a careful balancing act between (over)simplification and depth of understanding. Since academic findings will help inform practitioners in planning and enacting interventions, keeping theoretical models simple is a priority. On the other hand, since those same interventions will deal with the complexity of the human mind, theoretical models cannot be so simple as to ignore reality. In other words, they should be as simple as possible and as complex as necessary.

One reason for this complexity is that psychological phenomena do not manifest in a vacuum: when we design an intervention, for example, to treat Major Depressive Disorder in a patient, we must keep in mind that the intervention will involve a specific individual, and their symptoms will be influenced not only by their stable characteristics (e.g., personality traits), but also by sociocultural context, social and biographical features, and transient characteristics (e.g., trait anxiety) (see Borsboom, 2017; Olthof et al., 2020). Additionally, symptoms could build on each other (e.g., heightened anxiety could lead to sleep disturbances, which could lead to difficulty concentrating). Knowing precisely how multiple variables influence a psychological construct and how the features of the construct interact with each other will help design more effective interventions.

Often, psychological studies consider relatively few variables, and certainly less variables than there are at play (often due to legitimate concerns over statistical power). This is especially true when we consider psychological processes that, due to their definition, are bound to interact with multiple other constructs. For example, coping strategies have both affective and cognitive features; as such, they will inevitably be related with several other processes.

Adding to this, some constructs have multiple definitions. Keeping the example of coping strategies, they can be classified in multiple ways, some of which are usable as taxonomy without considering the context (Luthar et al., 2015), while others are not (e.g., the concept of “adaptive” and “maladaptive” coping, while intuitive, cannot be employed without considering the interplay of context and coping strategy). Because of both the contrasting definitions of constructs and the driving need for simplification, psychological literature is often fragmented and lacks a coherent, unified view of many phenomena.

In this paper, we aim to illustrate the use of an approach—network analysis—that can be employed for

studying the nomological network of psychological constructs, i.e., investigating the construct's relations with several other variables at once without ignoring that those variables are related to each other as well.

Network analysis has historically been used for studying social networks, including citation networks. Recently, it has been gaining traction as a method for studying networks of variables, and it is even being considered as an alternative way of understanding mental illness, in which disorders are conceptualized as a system of reciprocally interacting symptoms rather than a set of symptoms stemming from a common cause (Borsboom & Cramer, 2013; Fonseca-Pedrero et al., 2018; Fried et al., 2016). However, its application is still not widespread. We believe that network analysis can be used to help academics and practitioners better understand the intricacies of psychological constructs. We claim that network analysis provides results that can be both easy to interpret and relatively faithful to the complexity of the world, with the main caveat that its users need to be aware of model assumptions.

In this paper, we will present a network analysis application on the nomological network of a multifaceted psychological construct: resilience. This construct, like coping, is rooted in both the affective and cognitive domains, is related to personality and contextual features, and presents alternate, incompatible definitions (Skinner et al., 2003). As we will argue in the following sections, the literature on resilience is especially fragmented and in need of a unified view. As such, it presents an ideal case for the application of network analysis techniques. While this study will not consider all variables directly at play, it will strive to be more comprehensive than most of the studies we surveyed. The end result will be a graphical representation of the core nomological network of resilience. We will employ two algorithms that will provide directions for most of the relations in the graph, identifying which is the cause and which is the effect in most pairs of variables, despite our study being correlational in nature. The drawbacks of using these methods will be discussed, but their practical usefulness can not be understated.

In the end, we hope that these techniques will be applied to other domains in psychology, helping academics and clinicians traverse the web of causes and effects with the intimate knowledge and deftness of the spider and avoid being entangled and confused like the fly.

2 | THEORETICAL BACKGROUND

2.1 | Defining resilience

Resilience is a multifaceted construct that has been conceptualized and measured in different ways. Some

authors consider resilience as an individual's psychological outcome after exposure to traumatic events or significant risk and focus on the individual's capability to respond to these events (Bonanno et al., 2011). For others, resilience is an emergent property resulting from a complex interaction of individual characteristics, contextual features, personal and social resources, and risk factors. In this study, we will define resilience as the latter. In the conceptualization we used, resilience comprises six facets: Perception of self and Perception of future (i.e., how much an individual feels they have the internal resources to face present and future problems, respectively), Structured style (how much they feel able to plan their daily routine and strategies for problem solving), Social competence, Family cohesion, and Social resources (Friborg et al., 2003).

Researchers identified several psychological variables (Masten et al., 2021; Rutter, 2012) that can facilitate or obstruct resilient processes: individual characteristics (such as personality traits, including “dark triad” personality traits), individual abilities (e.g., emotional intelligence), environmental resources (such as social cohesion), and capabilities to manage stress. However, the relation of each psychological construct with these features have been investigated in separate studies, sometimes with subtle differences in the definition and operationalization of resilience itself. To the best of our knowledge, no single study that simultaneously takes into consideration all these variables has ever been carried out, although network analyses that consider a subset of those have been recently published (Baggio et al., 2015; Hoorelbeke et al., 2016). The lack of unifying studies leads to a fragmented literature, and, as a result, the role of resilience in the theoretical landscape appears unclear. Additionally, the lack of a unified model makes it difficult to plan interventions for strengthening resilience. Were we to improve resilience, would we be better off focusing on emotional intelligence or on coping strategies? What if the apparent direct relation between emotional intelligence and resilience were mediated by coping strategies (i.e., emotionally intelligent people choose more adequate coping strategies, but it is the coping strategies themselves that improve resilience)? Is resilience predicted more by the Big Five personality traits, or are the potentially maladaptive “dark” personality traits more important? Having a single study that considers all these variables at once would help answer these questions and, from a clinically-oriented perspective, would help in designing, planning, and carrying out practical interventions.

For these reasons, we aimed at investigating the nomological network of resilience in order to offer a coherent bird's eye view of the relations between a specific definition of resilience (as a capability to respond positively to

traumatic events that stems from both individual characteristics and social/contextual features and resources) and several psychological constructs, especially focusing on the role of coping strategies and interpersonal skills. In this study, we have taken into account the following factors: coping, sense of coherence, emotional intelligence, personality traits, and dark personality traits. Based on our literature review, in the following sections we will briefly outline our reasoning for including each of the variables in the network.

2.2 | Coping

Coping strategies comprise the behaviors enacted by individuals to respond to stressful events. These can range from behaviors directed towards resolving the stressful situation (task-oriented) to behaviors directed at attenuating distress (emotion-oriented), or behaviors that aim at emotionally distancing oneself from the stressor (avoidance-oriented) (Lazarus & Folkman, 1984).

Task-oriented coping strategies are usually associated with higher well-being, whereas emotion- or avoidance-oriented coping strategies are usually associated with psychological distress (Konaszewski et al., 2021; Littleton et al., 2007; Tull et al., 2004). Nevertheless, in some specific situations—e.g., when it is impossible to remove the source of distress, such as bereavement—task-oriented strategies may be less adaptive than some emotion-oriented strategies (Lazarus, 1999). For these reasons, we decided to consider two separate classifications of coping strategies. We used both Lazarus and Folkman's (1984) classification, as well as a separate, more nuanced and fine-grained classification for emotion-oriented strategies that distinguishes those that can safely be considered maladaptive (e.g., rumination, self-blame) from those that can result in adaptive behavior (e.g., acceptance, positive reappraisal; Antoine et al., 2018; Garnefski et al., 2001).

Previous studies suggested that the use of generally adaptive coping strategies (such as task-oriented coping and social support) is positively associated with individual resilience (Dvorsky et al., 2021; Zautra et al., 2010). Among emotion-oriented coping strategies, rumination seems to be negatively associated with resilience, while others, such as refocus on planning and positive reappraisal, seem to have a positive correlation (Lee et al., 2019; Min et al., 2013).

2.3 | Sense of coherence

Sense of coherence includes the ability to comprehend, manage, and find meaning in life's challenging events

(Antonovsky, 2012). As such, it is strongly associated with resilience (Armstrong et al., 2011; Fossion et al., 2014; Friberg et al., 2003; Grevenstein et al., 2016; Stewart & Yuen, 2011). Sense of coherence was therefore included in the network, expecting it to be highly related to all facets of resilience.

2.4 | Emotional intelligence

There are different conceptualizations of emotional intelligence: in the present study, we refer to Mayer and Salovey's definition (Mayer & Salovey, 1993), which considers emotional intelligence as a set of competences that allow an individual to perceive, understand, use, and manage emotions in an efficient and flexible way.

Some authors have hypothesized a relation between resilience and emotional intelligence (Matthews et al., 2003; Schneider et al., 2013; Slaski & Cartwright, 2002), and there is some evidence for them to be connected (Magnano et al., 2016; Tugade & Fredrickson, 2004). We decided to include emotional intelligence in the network in order to test whether or not it is related to resilience. Since emotional intelligence is strongly related to other variables in the network, such as coping strategies (Saklofske et al., 2007; Zeidner & Matthews, 2018), it is entirely possible that any apparent (bivariate) relation between emotional intelligence and resilience is fully explained by mediating variables. Were this to be the case, in the network it would be apparent that emotional intelligence is connected to resilience only through other nodes.

2.5 | Personality traits

The Five Factor Model (FFM) for the study of personality organizes personality characteristics into five broad traits: Agreeableness, Conscientiousness, Extraversion, Neuroticism/Emotional Stability, and Openness to experience (John et al., 1991).

A specific pattern of personality traits is associated with resilience: Emotional Stability, Conscientiousness, Agreeableness, Extraversion, and Openness to experience are related to the Social Competence facet of resilience, and Openness to experience is related to the capacity to respond adaptively to stressful events (Ercan, 2017; Friberg et al., 2005; Lü et al., 2016; Oshio et al., 2018; Skodol, 2010). Additionally, due to the conceptualization of personality traits as stable individual features, we expect paths connecting personality to other variables to be directed outwards, i.e., we expect personality traits to be causes and not effects.

2.6 | Dark Triad and covert narcissism

The Dark Triad is a set of three personality traits: Machiavellianism (i.e., the tendency to manipulate and exploit others for personal interest; to show a callous affect; to have a cynical and wary attitude towards other people; and to maintain a strategic-calculating orientation in interpersonal relationships and activities involving interaction with others in general), subclinical narcissism (i.e., the tendency to grandiosity, authority, and self-sufficiency; to have a sense of entitlement and superiority; and to show an inflated self-esteem and vanity), and subclinical psychopathy (i.e., the tendency towards antisocial and amoral behavior; impulsiveness; and as absence of remorse, guilt, and empathy for others). These maladaptive features characterize individuals that, while socially competent, do not exhibit empathy and prosocial behavior (Paulhus & Williams, 2002).

These traits—and especially narcissism—seem to be related to mental toughness and resilience (Brand et al., 2016; Papageorgiou et al., 2019; Szabó et al., 2022). We therefore included a measure of the Dark Triad traits in order to take this relation into account. As the measure of narcissism we employed covered only the grandiose (overt) side of narcissism, we also included a measure of vulnerable (covert) narcissism in order to perform a more comprehensive evaluation of the relation between this construct with resilience.

3 | METHOD

3.1 | Participants

The sample included 305 Italian participants (61% female), aged 18 to 74 ($M = 37.32$, $SD = 13.32$). Participants' education level ranged from 5 years (elementary school) to 21 years (PhD) ($M = 14.47$; $SD = 3.65$). As for employment status, 14.1% of participants were students, 9.8% unemployed, 15.4% fixed-term employed, 41% permanently employed, 13.8% freelancers, and 5.9% retired. Participants were recruited among the general population using convenience sampling, and they received no financial compensation or incentive in exchange for participation in the study. As for the sample size, there is currently no rule-of-thumb or power analysis that can suggest a priori the appropriate sample size for a network analysis (Epskamp et al., 2018). Therefore, we bootstrapped parameters to ensure the reliability of our estimates (see Supplementary Materials). The study was conducted in accordance with the American Psychological Association ethical principles for psychologists (APA, 2002).

3.2 | Measures

Resilience Scale for Adults (RSA) (Friborg et al., 2003; Italian version by Laudadio et al., 2011). The Italian RSA is a 29-item self-report scale for measuring protective resilience factors among adults. Participants answer on a five-point semantic differential scale in which each item has a positive and a negative attribute at each end of the scale continuum. The scale provides scores in six different subscales measuring protective factors (both inter- and intrapersonal): Perception of self (6 items; e.g., “When something unforeseen happens: I always find a solution/I often feel bewildered”), Perception of future (4 items; e.g., “My plans for the future are: difficult to accomplish/possible to accomplish”), Structured style (5 items; e.g., “I am at my best when I: have a clear goal to strive for/can take one day at a time”), Social competence (6 items; e.g., “I enjoy being: together with other people/by myself”), Family cohesion (5 items; e.g., “I feel: very happy with my family/very unhappy with my family”), and Social resources (3 items; e.g., “I get support from: friends-family members/No one”). In the Italian version Cronbach's α ranged from .78 to .82.

Coping Inventory for Stressful Situations—Short Version (CISS-SV) (Endler & Parker, 1990; Italian short version by Pisanti et al., 2015). The CISS-SV is a measure of coping strategies. Participants are asked to rate on a 5-point frequency scale (from 1 = *never* to 5 = *always*) how often in difficult, stressful, or upsetting situations they use task-oriented coping (7 items; e.g., “Focus on the problem”), emotion-oriented coping (7 items; e.g., “Blame myself for the situations”), treat oneself-oriented coping (3 items; e.g., “Treat myself to a snack”), or contact a friend-oriented coping (3 items; e.g., “Visit a friend”). In the Italian version Cronbach's α ranged from .72 to .82.

Cognitive Emotion Regulation Questionnaire (CERQ) (Garnefski et al., 2001; Italian version by Ubbiali et al., 2012) was used to evaluate cognitive emotion regulation. Participants are asked to rate their frequency of engagement in 36 cognitive strategies when they experience negative or unpleasant events on a 5-point frequency scale (from 1 = *almost never* to 5 = *almost always*). The CERQ provides a measure of adaptive strategies such as Acceptance (4 items; e.g., “I think that I have to accept the situation”), Refocus on planning (4 items; e.g., “I think of what I can do best”), Positive refocusing (4 items; e.g., “I think about pleasant experiences”), Positive reappraisal (4 items; e.g., “I think I can learn something from the situation”) and Putting into perspective (4 items; e.g., “I think that it all could have been much worse”). The scale also provides a measure of maladaptive strategies such as Self blame (4 items; e.g., “I feel that I am the one to blame for it”), Blaming others (4 items; e.g., “I feel that others are

to blame for it”), Rumination (Focus on thought, 4 items; e.g., “I often think about how I feel about what I have experienced”), and Catastrophizing (4 items; e.g., “I continually think how horrible the situation has been”). In the Italian version Cronbach's α ranged from .73 to .86.

Sense of Coherence Scale (SOCs) (Antonovsky, 1993; Italian version by Barni & Tagliabue, 2005). The SOCS includes 11 items in a seven-point semantically differentiated scale with positive and negative sentences at each endpoint. The scale provides a total score of sense of coherence and a measure of two different dimensions of sense of coherence: Cognitive (7 items; e.g., “Do you have the feeling that you are being treated unfairly?”, responses range from 1 = *very often* to 5 = *very seldom or never*) and Motivational (4 items; “Until now your life has had”, responses range from 1 = *no clear goals or purpose at all* to 5 = *very clear goals and purpose*). In the Italian version, Cronbach's α ranged from .69 to .84.

Self-Rated Emotional Intelligence Scale (SREIS) (Brackett et al., 2006; Italian version by Modafferi et al., 2012). The scale comprises 19 items to be rated on a 5-point Likert-type scale (from 1 = *very inaccurate* to 5 = *very accurate*). The measure provides five “branch” scores: Perceiving emotion (4 items; e.g., “By looking at people's facial expressions, I recognize the emotions they are experiencing”), Use of emotion (3 items; e.g., “When making decisions, I listen to my feelings to see if the decision feels right”), Understanding emotion (4 items; e.g., “I have a rich vocabulary to describe my emotions”), Managing emotion (4 items; e.g., “I can handle stressful situations without getting too nervous”), and Social management of emotion (4 items; e.g., “I know the strategies to make or improve other people's mood”). In the Italian version Cronbach's α ranged from .75 to .87.

Single-Item Measure of Personality (SIMP) (Woods & Hampson, 2005; Italian version by Chiorri et al., 2014). The SIMP is a five-item short measure of the Big Five. Each item has a 9-point graded line placed between two different opposing descriptions representing the poles of each of the Big Five (e.g., Extraversion includes the following descriptions: “someone who is sensitive and excitable, and can be tense” and “someone who is relaxed, unemotional rarely gets irritated and seldom feels blue”).

Dirty Dozen (DD) (Jonason & Webster, 2010; Italian version by Chiorri et al., 2019). The DD includes 12 items to be rated on a 7-point Likert-type response scale (from 1 = *strongly disagree* to 7 = *strongly agree*). The measure includes three subscales: Machiavellianism (4 items; e.g., “I tend to manipulate others to get my way”), Psychopathy (4 items; e.g., “I tend to lack remorse”), and Narcissism (4 items; e.g., “I tend to want others to admire me”). In the Italian version Cronbach's α ranged from .73 to .88.

Narcissistic Vulnerability Questionnaire (NVQ) (Rosso et al., 2009). The NVQ is an Italian-developed measure of vulnerable narcissism. It comprises 15 items (e.g., “I suffer criticism a lot”) to be rated on a 6-point Likert-type response scale (from 1 = *not at all* to 6 = *completely*), providing an overall total score of vulnerable narcissism. Cronbach’s α was .90.

3.3 | Procedure

After providing informed consent, participants were asked for socio-biographical information. Subsequently they completed the questionnaires in a quiet room at the premises of a psychology department in northwestern Italy. The completion time was about 30 minutes. The order of the questionnaires varied according to a balanced latin square design in order to control for sequence and order effects. The data were collected confidentially. The research was conducted according to APA guidelines for ethical research in psychology (American Psychological Association, 2016). Analyses have been run using R 4.1.1 and packages bootnet 1.4.3 (Epskamp et al., 2018), car 3.0-11 (Fox & Weisberg, 2019), graph 1.70.0, pcalg 2.7-3 (Kalisch et al., 2012), psych 2.1.9, qgraph 1.6.9 (Epskamp et al., 2012), and Rgraphviz 2.36.0. R codes and data are publicly available at <https://github.com/M-Pass/NomologicalNetworkResilience>.

4 | RESULTS AND DISCUSSION

4.1 | Association graph

The analysis of variables’ inter-relations starts with their zero-order and partial correlations. By zero-order correlations, we mean bivariate associations—the same that would be typically reported in a correlation matrix. These

correlations are measures of simple association between two variables and do not control for the possible influence of other variables. The resulting network of associations can be represented graphically, as in Figure 1. This network should be expected to include several spurious correlations, but it is a first step towards understanding the interrelations of investigated variables.

Partial correlation, instead, should be understood as the residual correlation between two variables after taking into account all other variable associations in the network. As such, they are a useful measure of direct association that helps rule out correlations that would (incorrectly) appear to be meaningful while examining zero-order correlation matrices. All associations computed this way can be plotted on a graph, sometimes called Gaussian graphical model (Højsgaard et al., 2012) or concentration graph (Roverato, 2021), which for our case is reported in Figure 2.

Overall, variable associations are weaker in this second graph due to the removal of spurious contributions to bivariate associations. For example, the dense cluster of associations between cognitive sense of coherence, emotion-oriented coping, covert narcissism, and perception of self is noticeably weaker. However, it is also possible that some variables that appear not to be associated in the partial correlation network may appear not to be associated when computing zero-order correlations, as other variables in the network “mask” their relation (see the Tables in the Supplementary Materials).

These two graphs start painting the picture, but they are both dense and difficult to interpret; due to background statistical noise, all variables appear to be related to each other, and discerning the most important associations can prove to be arduous. An often used solution to this problem is computing and plotting a LASSO-regularized (“least absolute shrinkage and selection operator”; Epskamp et al., 2018) partial correlation network. This kind of network can aid interpretability, as it will

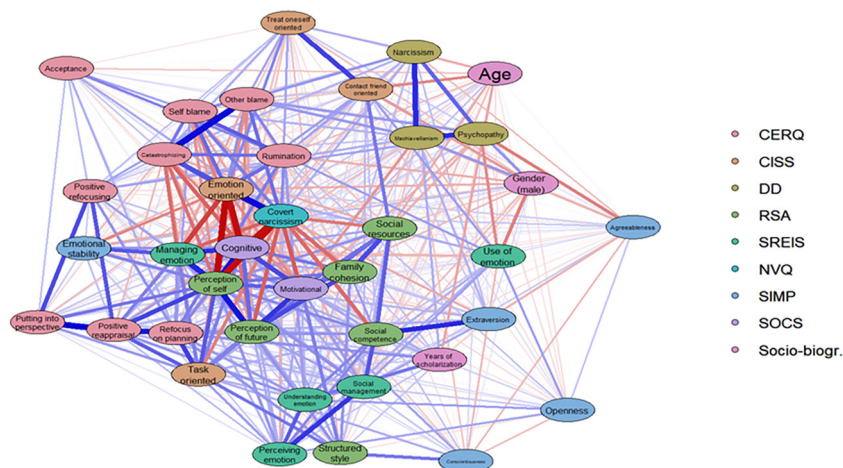
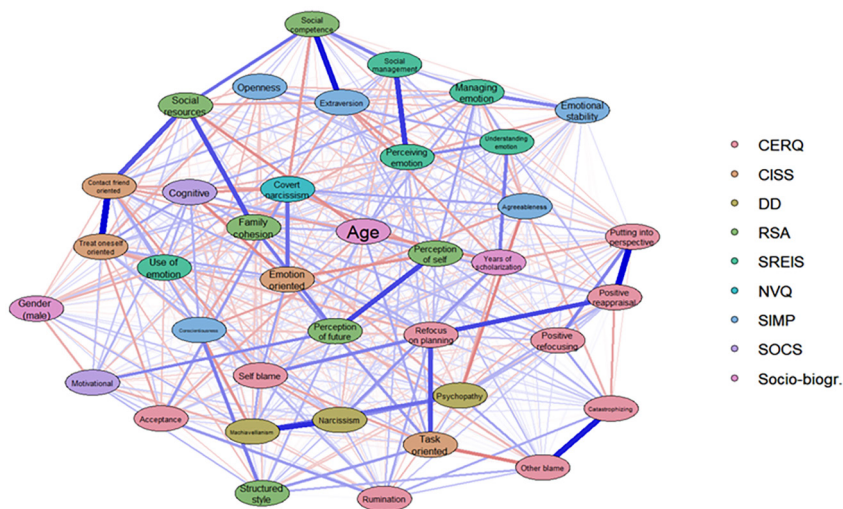


FIGURE 1 Network of zero-order correlations. Blue connections = positive correlations, red connections = negative correlations. Connection width and color saturation are proportional to the size of the correlation.

FIGURE 2 Network of partial correlations. Blue connections = positive correlations, red connections = negative correlations. Connection width and color saturation are proportional to the size of the correlation.



only visualize relatively strong associations and set all weaker associations to exactly zero. LASSO regularization applies a penalty to the likelihood function used for estimating variable associations by limiting the total sum of (absolute) partial correlations. This results in the shrinkage of all estimated correlations and, most importantly, the lowest correlations shrink to exactly zero.

The extent of regularization is controlled by the tuning parameter λ . A lower λ results in less shrinkage, while a higher λ will set more edges to zero and result in a sparser network. The optimal value for λ can be identified by minimizing the EBIC (extended Bayesian information criterion; Chen & Chen, 2009), a strategy that will tend to select the model that best reproduces the underlying true network structure (Barber & Drton, 2015). Additionally, in the reported graph, we removed all edges with a non-significant partial correlation. The resulting graph is far easier to interpret and we can see, for example, strong relations between specific resilience facets and several other investigated variables, most notably covert narcissism ($r_{\text{partial}} = -.28$ with perception of self, $-.15$ with social competence; Sękowski et al., 2021) and sense of coherence ($r_{\text{partial}} = 0.24$ between cognitive sense of coherence and perception of self, 0.27 between motivational sense of coherence and perception of future; Lee et al., 2019), as expected, while dark traits form a separate component that is not much related to resilience (contrast with Brand et al., 2016; Szabó et al., 2022).

Regarding personality traits, we can see that extraversion is associated with social competence ($r_{\text{partial}} = 0.39$; Oshio et al., 2018) and conscientiousness to having a structured style ($r_{\text{partial}} = 0.15$; Friberg et al., 2005), while—surprisingly—agreeableness and openness are not related to resilience (contrast with Oshio et al., 2018). Emotional stability is not directly connected to resilience, but it does have an indirect path to it through the ability to manage one's own emotions ($r_{\text{partial}} = 0.21$ between

emotional stability and managing emotions, $r_{\text{partial}} = 0.25$ between managing emotions and perception of self; Iliopoulos, 2020). This is an example of spurious correlation: notice how, in the graph of zero-order correlations, there appears to be a direct positive association between emotional stability and perception of self; this association is weaker when considering partial correlations, and is omitted from the regularized graph, suggesting that the relation between these two variables is not as direct as it could appear at first glance. One possibility, for example, could be that the ability to manage one's own emotions actually mediates between perception of self and emotional stability. [Correction added on 28 October 2022, after first online publication: The citation Panagiotis, 2020 has been changed to Iliopoulos, 2020].

Lastly, the graph also highlights some relations between variables other than resilience, such as a negative association between capacity for using emotion and being male ($r_{\text{partial}} = -0.19$; Cabello et al., 2016), or a negative association between agreeableness and psychopathy ($r_{\text{partial}} = -0.13$; Muris et al., 2017). While not the focus of this study, these relations are generally in accord with the literature and construct definitions, and provide a wider perspective on the considered variables.

4.2 | Centrality measures

Network analysis offers multiple statistics that can be interpreted as measures of the centrality of a given node. In Figure 3 we report three such statistics, all computed using the LASSO-regularized network of partial correlations (see Table S4 in the supplemental materials for the numerical values).

Strength centrality indicates which nodes have the overall stronger *direct* associations. These nodes are likely to interact with other nodes in the network, as

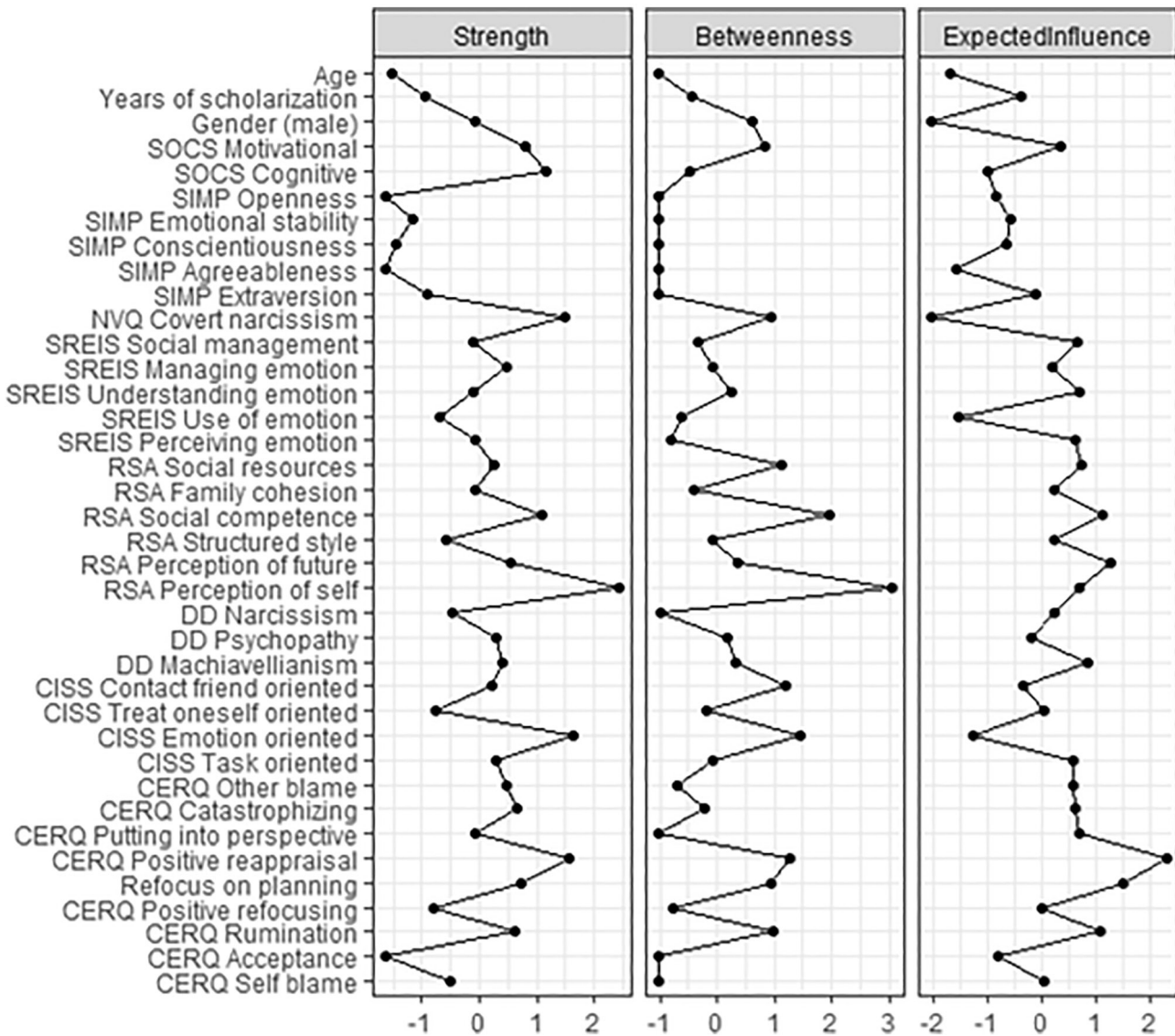


FIGURE 3 Strength centrality, betweenness centrality and expected influence for all LASSO-regularized network nodes

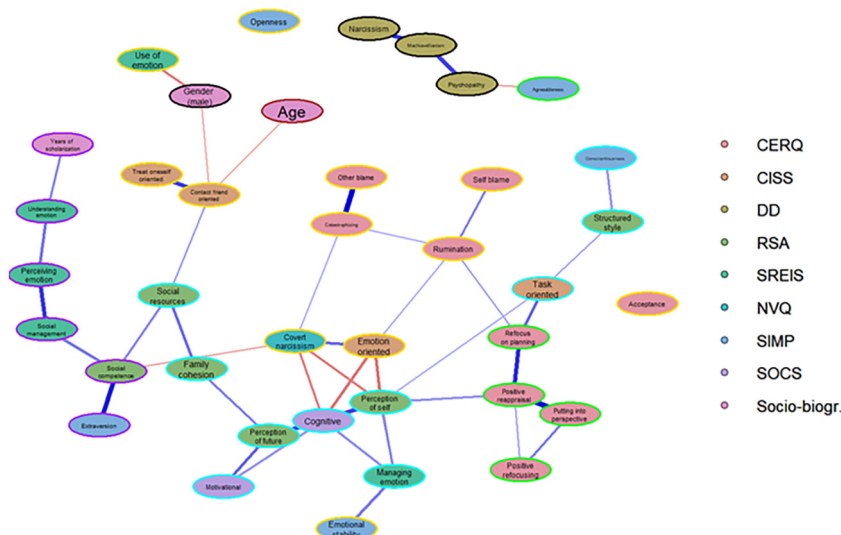
they predict and/or are predicted by them (Bringmann et al., 2019). The figure suggests that perception of self is the most central node (strength centrality = 2.44), as it has seven direct associations, most of which are relatively strong. Betweenness centrality, instead, is higher for nodes that frequently appear on the shortest path between other pairs of nodes. As a result, nodes with high betweenness centrality could play the role of “bridges” between separate parts of the network (the community structure can be estimated by an algorithm, such as the spin-glass, that separates nodes into different clusters; see node border colors in Figure 4 for such an estimate; Reichardt & Bornholdt, 2006).

In our case, there are three nodes that may play this role: perception of self, social competence, and emotion-oriented coping (betweenness centrality = 3.06, 1.95, and 1.45, respectively). Perception of self, in particular,

appears to bridge between adaptive and maladaptive coping strategies, with relatively strong connections with cognitive reappraisal ($r_{\text{partial}} = 0.15$), on the one hand, and with emotion-oriented coping ($r_{\text{partial}} = -0.20$) and covert narcissism ($r_{\text{partial}} = -0.18$), on the other. Social competence bridges between resilience facets via social resources ($r_{\text{partial}} = 0.16$), the social aspects of emotional intelligence via social management ($r_{\text{partial}} = 0.19$) and maladaptive aspects of coping via covert narcissism ($r_{\text{partial}} = -0.11$). Lastly, emotion-oriented coping is connected with resilience facets via cognitive sense of coherence ($r_{\text{partial}} = -0.19$) and perception of self ($r_{\text{partial}} = -0.20$) and maladaptive coping strategies through several connections (e.g., covert narcissism, $r_{\text{partial}} = 0.20$).

Lastly, expected influence is a measure of how much change in the value of a node (in our case, change in a

FIGURE 4 LASSO-regularized network of partial correlations. Blue connections = positive correlations, red connections = negative correlations. Connection width and color saturation are proportional to the size of the correlation. Node border color refers to the community structure as identified by the spin-glass algorithm with $\gamma = 1$, see “Centrality measures” section.



subscale score) is expected to influence other nodes in the network (Robinaugh et al., 2016). While this measure does not take into account the direction of causality—as the network of correlations is undirected—it does take into account the sign of the association, unlike the previous measures. According to this measure, the most influential nodes are positive reappraisal coping, refocus on planning, and perception of the future (expected influence = 2.28, 1.47, and 1.25, respectively).

Taken together, the three centrality measures offer different perspectives on which variables could be the most important in a network. In our case, two out of three measures suggest that perception of self is a key variable to consider (and it still has relatively high expected influence, 0.69), while positive reappraisal seems to be the most influential coping strategy, with high strength (1.65) and expected influence (2.28). However, interpretation of the relative importance of nodes should not be based only on centrality measures. For example, a peripheral node may well be a priority target for an intervention if it has few causes or antecedents. On the other hand, a central node may not be a good intervention candidate if most of its connections are directed towards the node rather than outwards. For this reason, it is important to supplement centrality measures with analyses that could provide an idea of the direction of causality between the nodes, so as to understand which variables are likely to be antecedents of the others (Dablander & Hinne, 2019).

4.3 | Causal discovery

Fortunately, network analysis provides causal discovery algorithms that can suggest the direction of associations from purely observational (cross-sectional) data. This

allows us to transform the association graph—which is undirected—into a directed causal graph, in which some variables are identified as causes and others as effects. However, given the observational nature of the data, there are some important caveats, which we will note when interpreting the results.

The basis for causal discovery is rooted in the concepts of conditional independence and d-separation (Hayduk et al., 2003). By d-separation we mean a set of criteria that can determine whether two (sets of) variables are independent, given a set of other variables, which forms the basis of the PC-stable algorithm (Colombo & Maathuis, 2012). The algorithm starts by identifying the skeleton of a graph, i.e., the correlation graph. Then, it identifies triplets of variables X , Y , and Z such that: (1) Y is associated with X ; (2) Y is associated with Z ; (3) X and Z are not associated; and (4) X and Z are associated when partializing for Y . For example, in our data, we have such a situation between the variables Contact-friend-oriented coping (CISS), social resources (RSA), and family cohesion (RSA): contacting a friend and family cohesion are both associated with social resources ($r = 0.32$ and $r = 0.44$, respectively), but not with each other ($r = -0.04$). However, if we control for social resources, the relation between family cohesion and contact-friend-oriented coping becomes substantial ($r = -0.22$). In cases such as this, both edges X - Y and Z - Y can be oriented towards Y , i.e., family cohesion and contact-friend-oriented coping could be considered causes, rather than effects, of perceived social resources.

This happens because such a triplet of variables has only 4 possible configurations: $X \rightarrow Y \rightarrow Z$, $X \leftarrow Y \leftarrow Z$, $X \leftarrow Y \rightarrow Z$, and $X \rightarrow Y \leftarrow Z$. However, only the latter would result in conditional dependence between X and Z when conditioning for Y . By directing those edges, the graph implements new constraints that can be used to further direct other edges in the graph. The algorithm thus

proceeds iteratively until it directs all edges for which it is possible to infer directionality. The parameters used for the PC-stable algorithm are $\alpha = .01$, partial correlations as independence tests, majority rule for checking ambiguous edges, and resolution of conflicts via bidirected edges. This particular setting configuration ensures the algorithm is order-invariant. The resulting graph for our data is reported in Figure 5.

The graph suggests the possible direction of causality for most of the relations (but not all: for example, the relation between perception of the future and family cohesion is still bidirectional, as the PC algorithm was not able to direct it unambiguously). However, the interpretation of the graph should be cautious. While this procedure allows us to obtain a directed graph for observational data, it relies on strict assumptions that are likely to be violated in real-world scenarios. One of the most important ones is that no relevant variables, and especially no common causes, should be omitted from the network. This assumption is unlikely to be met: as argued in the introduction, psychological constructs are embedded in a complex network of relations, and it would be impossible to devise a test battery that investigates all relevant variables. Therefore, results from the PC-stable algorithm should be interpreted very tentatively, as “educated guesses”. However, the directed graph still offers some suggestions, and can be used to inform future research studies.

Starting from the topmost section of the graph, we can see that perception of the future seems to influence both

perception of self and motivational sense of coherence, two aspects deeply connected to wellbeing ($r_{\text{partial}} = 0.27$ and 0.15 , respectively; Mc Gee et al., 2018). From centrality measures, we know that perception of self and future play a central role in the graph: the former, in particular, influences the use of emotion-oriented coping strategies ($r_{\text{partial}} = -0.20$). An intervention focusing on perception of future—which seems to be the cause, rather than the effect, of perception of self—is likely to have positive cascading effects on the considered constructs.

Additionally, one coping strategy that seems especially important is positive reappraisal, i.e., creating a positive meaning for the event in terms of personal growth. This strategy has a positive effect on both refocus on planning (a generally-adaptive coping strategy, $r_{\text{partial}} = 0.30$) and perception of self ($r_{\text{partial}} = 0.15$; Baghjari et al., 2017). This result is consistent with centrality measures, as both positive reappraisal and perception of the future were among the highest nodes in terms of expected influence.

Another section of the graph with important directed relations pertains to social aspects: both extraversion and social management seem to influence social competence ($r_{\text{partial}} = 0.32$ and 0.19 , respectively; Guerin et al., 2011; Yip & Martin, 2006). Social resources, another important facet of resilience, is positively affected by family cohesion ($r_{\text{partial}} = 0.20$) and has a bidirectional connection ($r_{\text{partial}} = 0.16$) with social competence (which could mean that they influence each other, but it could also mean that there is a clear direction of the

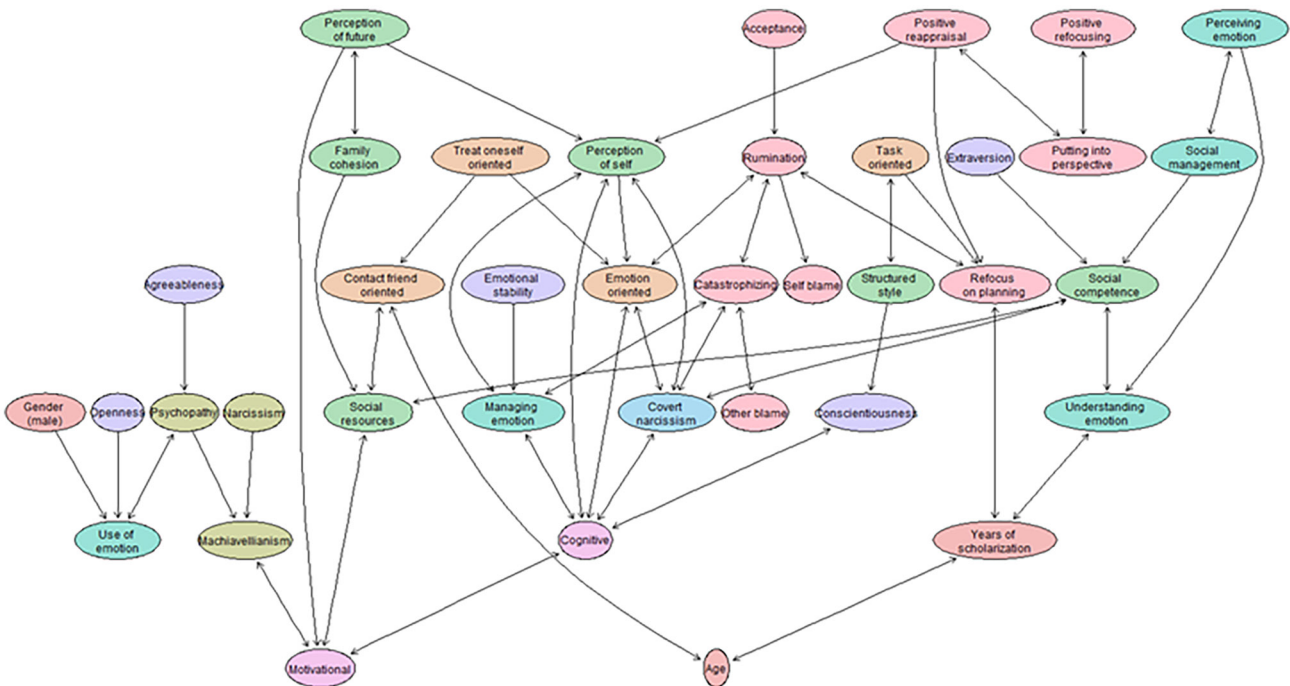


FIGURE 5 Causal network as obtained using the PC-stable algorithm

causality that the PC-stable algorithm could not infer). Importantly, family cohesion seems to play the role of bridging individual aspects of resilience (perception of self and future) and socially-focused aspects of resilience (social resources and competence). Lastly, the correlations between resilience facets we found largely overlap with a previous network analysis on the RSA measure (Briganti & Linkowski, 2020).

Regarding coping strategies, apart from the already mentioned role of positive reappraisal, we can see an interesting causal chain involving acceptance, rumination, and self-blame. While it may seem surprising that acceptance is positively associated with rumination, in the CERQ acceptance conflates active acceptance and resignation (Wilson, 1996). This confusion may explain why the CERQ Acceptance subscale shows both a positive relation with well-being and higher scores in the clinical population (Garnefski et al., 2002; McKinnon et al., 2020).

Sense of coherence seems to be positively associated with resilience, as the motivational subscale is associated with perception of the future ($r_{\text{partial}} = 0.21$). This is consistent with previous studies (Grevenstein et al., 2016; Lee et al., 2019). However, sense of coherence seems to play the role of an effect rather than a cause, which is in contrast with previous interpretations (Fossion et al., 2014).

As could be expected, emotional intelligence seems to be mostly related with the social competence facet of resilience ($r_{\text{partial}} = 0.19$ for the association between social management and social competence; Bochkova & Meshkova, 2018), but the capacity to manage one's own emotions is also related to the perception of self ($r_{\text{partial}} = 0.17$), although the direction of causality is unclear.

Regarding associations between resilience and personality traits, extraversion seems to have a positive impact on social competence ($r_{\text{partial}} = 0.32$), while conscientiousness seems to be an *effect* of having a structured style ($r_{\text{partial}} = 0.15$). The associations are in line with the theoretical definitions of the constructs since Extraversion is a tendency towards sociality and Conscientiousness implies a preference for order and rules. However, the direction of causality in the structured style-Conscientiousness relation is unexpected: for theoretical reasons, we would expect personality traits to be causes rather than effects; indeed, this holds true for all of the Big Five traits except Conscientiousness. It is possible that structured style partially overlaps with Conscientiousness, effectively measuring the same construct (Friborg et al., 2005).

Lastly, dark traits are involved in an interesting, and theoretically consistent, causal chain (agreeableness influences psychopathy, $r_{\text{partial}} = -0.12$, which influences Machiavellianism, $r_{\text{partial}} = 0.27$). However, dark traits seem to be effectively unconnected with resilience, except

through very indirect paths involving blaming other people. On the other hand, covert narcissism—which is not strictly part of the dark triad but theoretically related—seems to play a more central role in the network, with direct but bidirectional associations with social competence and perception of self ($r_{\text{partial}} = -0.11$ and -0.18 , respectively). This may be due to covert narcissism being characterized by a self-absorbed relationship style (Kernberg, 1985) and high vulnerability (Gabbard, 1989).

Summarizing, these results suggest that, for bolstering resilience, an intervention should probably focus on perception of future, positive reappraisal, and social management. Strengthening family cohesion, when possible, could have a positive impact on both social resources and more individual aspects of resilience. Lastly, dark traits seem not to have an influence on resilience, but covert narcissism could merit further investigation.

5 | CONCLUSIONS

This paper presented an application of network analysis to the study of the nomological network of a complex psychological construct, namely, resilience. The results successfully replicated several findings on the association between resilience and other psychological constructs (emotional intelligence, personality, sense of coherence, coping) and shed light on new ones (Dark Triad personality traits, covert narcissism). The main strength of the method is that it considers all these constructs together, so that analyses take into account the complex pattern of relations between them and offer a bird's-eye view of the whole network of associations centred on resilience. The resulting model is parsimonious and easy to interpret while still striving to preserve the complexity of the variables' inter-relations. This method is especially suitable for exploratory studies with multiple variables, especially when—as it was in our case with resilience—the key variable of interest is not defined as a latent construct, but as an emergent property of the variables' inter-relations.

Additionally, while the study design is cross-sectional, the method used suggests the direction of causality for several relations between variables; these have potential practical implications that are worth exploring. The relation between positive reappraisal and resilience, for example, is relatively strong, and interventions focused on fostering a sense of coherence may be especially effective in promoting resilient processes in the general population. Similarly, interventions focused on emotional intelligence, and specifically social management, may be particularly helpful in strengthening the aspects of resilience more strongly connected to one's social resources and support.

Specific limitations of the study include the use of a convenience community sample and the use of self-report instruments only. A convenience sample is limited with respect to generalizability. Consequently, we do not claim that this sample is representative of a specific population. The use of self-report instruments is especially critical for coping strategies since examining the situation-dependent aspects of coping is more difficult. As our study did not use a performance test, results on emotional intelligence relate more to self-perceived emotional intelligence than actual ability.

Lastly, as mentioned, network analysis is especially suitable for exploratory studies, and results should therefore be interpreted with caution. Future research should focus on supporting this model and generalizing these results using more representative samples and—when possible—moving to methods more suited to testing model fit. Additionally, studies using performance tasks could offer further insight into the relations between resilience, self-perception, and actual social skills. A last, critical improvement would be to explore the constructs considered using a longitudinal design.

Despite its limitations, this study serves as a step forward in exploring the complex inter-relations of psychological constructs related to resilience, integrating fragmented evidence and offering a first coherent view of its nomological network. Additionally, we argue that network analysis techniques are especially suited for this kind of analysis, offering a comprehensive view that, while to be interpreted with caution, offers powerful insights that can guide future research.

AUTHOR CONTRIBUTIONS

All authors contributed to study conceptualization, preparation, and final drafting; Cinzia Modafferi contributed to data collection; Marcello Passarelli and Cinzia Modafferi jointly contributed to data preparation, data analysis, and initial drafting.

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ETHICS STATEMENT

The study was conducted in accordance with the American Psychological Association ethical principles for psychologists and the principles of the Declaration of Helsinki.

ORCID

Marcello Passarelli  <https://orcid.org/0000-0002-7991-8812>

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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