

Openness Research: A Narrative Review

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ABSTRACT

Openness, as one of the four positive Big Five personality traits, is characterized by being open to new experiences, curious, adventuresome and creative. Some papers have appeared in this recent literature on positive effects of openness on emotions including emotional intelligence, social anxiety, empathy and affect. Openness has also contributed to several cognitive effects including episodic memory, cognitive functioning, knowledge-sharing, creativity, academic success, and liberalism. Several behaviors have also been influenced by openness including greater tolerance, having different race friends, less aggression, less caution of robots, greater humor production, and greater non-suicidal injury. Potential underlying biological mechanisms have been addressed for openness including brain status variables, brain network features, the default mode network, the memory network, the prefrontal cortex, the locus coeruleus, functional connectivity and gray matter volume.

Openness or openness to experience, as one of the four positive Big Five personality traits, is characterized by being open to new experiences, curious, adventuresome and creative. Individuals who are high on openness show receptiveness to new ideas and imagination, often resulting in greater achievement and better health. These qualities and effects highlight the importance of research and reviews of research on openness.

This narrative review includes current research not only on positive effects of openness on emotions, cognition and behaviors but also on potential underlying biological mechanisms for openness. The papers were found on PubMed and PsycINFO by entering the term openness and the years 2022-2026. Exclusion criteria were protocols, case studies and non-English language papers.

The 31 papers in this current literature review can be categorized as positive effects of openness on emotions (4 papers), cognition (7 papers), and behaviors (6 papers), as well as potential underlying biological mechanisms (12 papers) and interventions (2 papers). These sections are followed by a discussion on methodological limitations of this current literature.

Emotions

Only a few papers appeared in this literature on the effects of openness on emotions (see table 1). They include research on emotional intelligence, empathy and affect.

In a study on **emotional intelligence**, the relationship between teacher – student relationships and adolescent emotional intelligence was mediated by openness (N= 352 students 11 to 15 years old) [1]. Positive teacher – student relationships led to openness and empathy which led to adolescent emotional intelligence. These relationships might be expected given that emotional intelligence is defined as having empathy and emotional awareness.

A special form of openness called cultural openness has also contributed to **empathy** in a sample of Spanish university students (N= 530) [2]. In that study, cultural openness as well as

the desire to learn from others (which is a component of cultural openness) were, not surprisingly, correlated with empathy.

Openness has also led to **lower social anxiety** which may relate to the better teacher-student relationships already mentioned. For example, in research entitled “The relationship between openness and social anxiety”, openness and social anxiety were assessed in college students from China (N= 522) [3]. In this sample, openness led to a decrease in social anxiety which may have been related to better teacher-student relationships.

Openness has also been correlated with **positive affect** [4]. In this study openness was correlated with positive affect over the course of 14 days of repeated observations (N=191 individuals for 14,095 repeated observations). Openness was also correlated with less exhaustion in this sample. The increase in positive affect could have resulted from decreased exhaustion as well as

a decrease in social anxiety noted in the previously described study.

Cognitive Effects

Openness has contributed to several cognitive effects (see table 1). They include episodic memory, cognitive functioning in general, knowledge-sharing, creativity, academic success, “craftsmanship spirit”, and liberalism.

In research on **episodic memory** (defined as recollection of specific personal experiences), openness to experience led to better episodic memory in both younger and older adults (N= 29 younger and 27 older individuals) [5]. In this sample, strategy use (employing a structured plan) mediated the relationship between openness to experience and episodic memory. It’s not clear why strategy use was selected as a mediator, but the researchers likely had a theoretical basis for this selection which is, of course, essential for including mediators in data analyses.

Openness has led to better **cognitive functioning** in general in at least two studies in this literature. In one study on healthy older people (N=87), openness was related to better cognitive functioning four years later [6]. In this sample, cognitive reserve (the brain’s ability to improvise or select alternative pathways to solutions) was a mediator, which seems to be a theoretically sound mediator.

However, a different mediator was noted in another study on the same relationship between openness and cognitive function also in older adults [7]. In this sample (N=476, mean age =73), openness led to cognitive ability with **activity diversity** as a mediator. Although both cognitive reserve and activity diversity seem like plausible mediators for the relationship between openness and cognitive ability, the different mediators for the same relationships across these two studies highlights the potential selection bias of the different researchers.

In a study entitled "Are adolescents with higher openness more creative under stress? The mediating role of stress perception and cognitive flexibility", the results are in the title [8]. In this sample (N=1489 junior high school students), openness led to greater stress perception and greater cognitive flexibility which led to greater **creativity**. The inclusion of a negative mediator (stress perception) along with a positive mediator (cognitive flexibility) highlights a more complex relationship between openness and creativity than the simple relationship between openness and creativity itself.

In still another study on the relationship between openness and cognitive function, openness was linked to convergent and divergent thinking as predictors of **academic success** [9]. These results were perhaps not surprising given that the sample was comprised of high-achieving students. In addition, the link between openness and convergent and divergent thinking would appear to have a strong theoretical basis as would the links between convergent and divergent thinking and academic success. The use of mediation analysis, however, does not determine the relative significance of these multiple variables contributing to academic success.

Openness has also influenced “**craftsmanship spirit**” [10]. Both conscientiousness and openness had positive effects on “craftsmanship spirit”, which was defined as an individual’s state of feeling competent, transcendent and valuable during work (N=746). Conscientiousness and openness have often been associated in studies on the Big Five personality traits, although they have rarely been compared for their effects in studies in this current literature.

In a paper entitled "Beyond openness to experience and conscientiousness: Testing links between personality traits and American political orientation", four studies included the use of the Big Five Aspect Scales and the Big Five Inventory-2 [11]. In these four studies (Ns ranging from 1123 to 116,406) reviewed in the same paper, openness, intellect, compassion and withdrawal were positively associated with **liberalism**. Orderliness, politeness, and assertiveness were negatively associated with liberalism. The positive relationship of withdrawal to liberalism is difficult to interpret as are the negative relationships reported. For example, it’s not clear why the positive behaviors of orderliness, politeness and assertiveness would be negatively correlated with liberalism. The large number of variables associated with openness in these studies may relate to their large sample sizes and the relationships that were difficult to interpret may derive from the typically political definition rather than the broader definition of liberalism.

Openness has also been a mediator instead of a predictor variable in a study on cognitive diversity (inclusion of individuals with different ways of thinking) (N= 238) [12]. In this sample, cognitive diversity led to openness to experience which in turn led to **knowledge-sharing**. Although the relationships between these variables seem to be theoretically based, the selection of openness as a mediator rather than a predictor variable would be considered arbitrary as all three variables were assessed at the same time in this cross-sectional study.

Behavior Effects

Openness to experience has also affected several behaviors (see table 1). They include the positive behaviors of greater tolerance, having different race friends, less aggression, less caution of robots, greater humor production as well as the negative behavior of greater non-suicidal injury.

Table 1: Openness effects on emotions, cognition and behaviors (and first authors)

Effects	Emotions	First Authors
Emotional intelligence		Wan
Empathy		Pena-Acuna
Lower social anxiety		Gong
Positive affect		Kuipers
	Cognition	
Episodic memory		Talpain
Cognitive functioning		Montoliu, Jackson
Creativity		Wang

Academic success		Alabbasi
Craftsmanship spirit		LI
Liberalism		Xu
Knowledge-sharing		Cui
	Behavior	
Greater tolerance		Ng
Different race network members		Antonopolis
<Aggressive behavior		Su
>Cautious and suspicious of robot		Li
>Humor		Sun, Leeman
>Sleep quality		Block
Non-suicidal self-injury		Bresin

In a paper on tolerance entitled "Associations between openness, prejudice and tolerance: A scoping review with meta-analysis" the "facets" of openness included in the analysis were aesthetics, curiosity, imagination, and desire for new experiences [13]. In this meta-analysis of 17 studies, **greater tolerance** was related to the aesthetics facet of openness. This finding was surprising as aesthetics (appreciation of art and beauty) is a much narrower facet than the more facets of openness including curiosity, imagination and desire for new experiences.

Individuals with high openness to others have also had a one-to-one ratio of **same to different race network members** [14]. In contrast, low openness individuals had a four-to-one ratio of same race to different race network members. In this sample (N=1820 in four studies), the results were similar for both college students and adults. That similarity is surprising as the college students might be expected to have more openness to different-race friends than older adults because of their greater exposure to different race network members on campus.

In a longitudinal study on the relationship between the interpersonal openness trait and aggressive behavior (N=942 undergrads), interpersonal openness was correlated with **less aggressive behavior** [15]. This finding was not surprising given that interpersonal openness likely led to greater closeness which would result in less aggressive behavior.

In an unusual study on reliable robots and their users, the users with low openness exhibited less subjective trust, more fixations on the robot and greater neural activation [10]. The lower openness individuals were both more **cautious and suspicious** about the highly reliable robot and the arousal related to those feelings would lead to greater neural activation.

At least two research groups have explored the relationship between openness and **humor production**. In one study entitled "The relationship between openness to experience and humor production: Exploring the mediating roles of cognitive flexibility and ambiguity tolerance", the results are in the title

[16]. Openness to experience was related to humor production with cognitive flexibility and ambiguity tolerance as mediators. Ambiguity tolerance and cognitive flexibility are highly correlated and not surprisingly related to openness, but their relationship to humor production is unique. And the relationship between openness and humor is also unique.

A different mediator was noted for the relationship between openness and humor in a different study [17]. In this sample (N=457, 16 to 87 years-old), **wisdom** mediated the relationship between openness and humor. Once again, different researchers have arbitrarily selected different mediators for the same relationship, likely depending on their "pet variables". The research group of this latter study likely selected wisdom because they included older adults in their sample and wisdom has been frequently attributed to older adults.

Sleep quality has also been positively affected by openness [18]. Other predictors of sleep quality in this study were engagement and anticipatory stress with the latter variable being considered a negative influence on sleep quality [18]. Sleep quality improved across the course of one week regardless of insomnia severity. This result was observed in a very diverse sample (N=3,976 assessments) of individuals with major depression (N=118), social phobia (N=47) and healthy controls (N=119). That sleep quality improved independent of insomnia severity was surprising since insomnia typically negatively affects sleep quality. It's also not clear why this research team sampled individuals with major depression along with those with social phobia which are very different conditions. In addition, the sample sizes for the groups were significantly different, lowering the power of the results.

The only negative effect and a very negative effect of openness noted in this current literature was reported in a paper entitled "The downside of being open minded: The positive relation between openness to experience and non-suicidal self – injury" [19]. The results are in the title, suggesting that openness contributed to **non-suicidal self – injury** in a sample of undergraduate students (N= 340). Although this is a surprising effect, openness might be expected to have both positive and negative effects.

Potential underlying biological mechanisms

Several potential underlying biological mechanisms have been addressed in this current literature on openness (see table 2). These include brain status variables, brain network features, default mode network, memory network, prefrontal cortex, locus coeruleus, functional connectivity and gray matter volume.

Table 2: Potential underlying biological mechanisms for openness (and first authors)

Mechanisms	First Authors
Brain status variables	Coors
Personality network features	Shengwen
Default mode network	Blain, Wang, Marstrand-Joergensen
Memory network	Stolz
Prefrontal cortex activation	Azhari
Locus coeruleus	Plini

>Gray matter volume in the inferior frontal gyrus	Wan
>Gray matter volume in the anterior prefrontal cortex	Skov

Greater openness has been associated with fluid reasoning and greater vocabulary in a cross-sectional and five-year longitudinal study reported in the same paper (N=399, 19 to 80 years old) [20]. In this sample, **brain status variables** explained 43% of the variance in the openness, fluid reasoning and vocabulary tasks. Fewer brain status variables were associated with less openness. Typically, even in cross-sectional studies when measures are taken at the same time, brain variables are thought to contribute to behavioral variables rather than the reverse.

Specific **personality network features** corresponding to openness have been reported as being stable across different adult-age periods in a study on healthy adults (N= 343) [22]. In this fMRI study, the openness trait of the Big Five Personality Questionnaire was related to specific personality network features in the brain. The other personality traits that were not measured were also likely related to specific network features, although it is surprising that specific network features have been reported given that the specific brain networks significantly overlap.

The **default mode network** has been reportedly involved in openness behavior in at least three studies in this current literature. This network is primarily comprised of the medial prefrontal cortex, posterior cingulate cortex, precuneus and angular gyrus. The network is best known for being active when a person is not focused on the outside world and the brain is at wakeful rest such as during daydreaming and mind wandering. Other times that the network is active include when individuals are thinking about others, about themselves, remembering the past and planning the future. In one of these studies, functional connectivity in the default mode network was related to openness based on a sample from the Human Connections Project (N=1003) [23].

In another study, **functional connectivity in the default mode network** was associated with openness to experience as well as divergent thinking and creative achievement [23]. In this research, openness to experience was also correlated with activity in other brain networks including the attention network, the primary sensory motor network and the frontoparietal network. These overlapping networks comprise a large area of the brain that apparently is activated during openness.

In contrast to the positive relationship between openness to experience and functional connectivity in the default mode network, another research group reported a **negative relationship between default mode network functional connectivity** and openness to experience [24]. In this sample (N = 470) functional connectivity of the default mode network was negatively associated with openness to experience.

That two of the three studies on the relationship between openness and the default mode network reported a positive relationship between openness and functional connectivity of the default mode network suggests a robust relationship.

However, the negative relationship reported in the latter study highlights the importance of further replication studies. The default mode network is a large-scale network that is not focused on the external world but is in a restful state such as tasks, during daydreaming and mind-wandering. The negative relationship reported in the latter study may have related to the fMRIs being conducted during a non-restful state.

The **memory network** has also been related to openness in young adults (N= 209, 18 to 35 years old) as well as older adults (N=143 50 to 80 years old) [25]. In this sample, openness was said to be a protective factor against cognitive aging by preservation of the brain's memory network. Once again, openness was said to be activating a network rather than the reverse, although they were measured simultaneously.

In another fMRI study, **prefrontal cortex activation** was noted in adults with a high openness personality trait [26]. In this research, three videotapes were shown to participants including one on a romantic relationship, one on a friendship and one on a sibling. Prefrontal cortex activation occurred in high openness individuals to romantic relationship and friendship videos but not to those on siblings. This may have related to the romantic and friendship videos being more arousing than the sibling videos, thus resulting in greater prefrontal cortex activation.

The **locus coeruleus** has also been activated in individuals with the openness trait in a study entitled "Locus coeruleus is associated with higher openness to experience and IQ: implications for the noradrenergic system for novelty seeking in daily life" [27]. In this fMRI study on healthy young adults (N= 135), greater locus coeruleus signal intensity was correlated with greater openness to experience as well as IQ. The relative difference in signal intensity for openness and for IQ was not determined. That the locus coeruleus was involved with both openness and IQ would be expected as its primary functions are attention, learning and memory. That the locus coeruleus had implications for the noradrenergic system is also not surprising given that the locus coeruleus is the primary source of norepinephrine in the brain and is said to be essentially synonymous with the brain's noradrenergic system.

The **gray matter volume of the inferior frontal gyrus** has also been suggested as the neural basis underlying the association between openness, intellect and "scientific creativity" [28]. This large area of the prefrontal gyrus has been involved in higher order cognitive tasks and they, in turn, would be expected to be associated with openness, intellect and "scientific creativity".

Openness has also been involved in ratings of beauty and pleasantness in a study entitled "Differences in regional gray matter volume predict the extent to which openness influences judgments of beauty and pleasantness of interior architectural spaces" [29]. Openness and pleasantness ratings were correlated with regional **gray matter volume in the anterior prefrontal cortex** which plays a critical role in high-level cognitive functions. Openness and beauty ratings were correlated with regional gray matter volume in the temporal pole including the posterior cingulate cortex and the paracentral lobule which are also involved in high level-cognitive functions.

Interventions

Only two interventions for increasing openness have appeared in this current literature (see table 3). They include inducing openness and the presentation of intranasal oxytocin.

Table 3: Interventions for increasing openness (and first authors)

Interventions	First Authors
Openness induction	Hotchin
Intranasal oxytocin	Wong

In the **openness induction** study called “Open to contact? Increased state openness can lead to greater interest in contact with diverse groups,” openness was induced in adults (N=687) [30]. The openness induction led to greater openness which led to greater contact with diverse groups and less prejudice. That greater contact with diverse groups led to less prejudice was not surprising as stereotypes are typically reduced by exposure to different people and their perspectives.

In a paper entitled “Intranasal oxytocin increases state anhedonia following imagery training of positive social outcomes in individuals lower in extroversion, trust-altruism and openness to experience”, the results are in the title [31]. In this sample (N=111 university students), **intranasal oxytocin** increased openness to experience. Oxytocin, the “love hormone”, has been noted to decrease anxiety and increase trust, empathy and positive social interactions. These, in turn, have been related to openness.

Methodological Limitations of this Literature

Several methodological limitations can be noted for this current literature on openness. They include study design, sampling, measures and data analyses.

The focus on openness has varied across studies with some addressing openness in general and others defining openness specifically as **openness to experience, cultural openness and interpersonal openness**. These various definitions limit comparisons across studies. Most of the studies were cross-sectional rather than longitudinal, limiting any conclusions about directionality or causality. Most of the samples were **university students**, limiting the generalizability to other age groups.

Openness was rarely compared to or studied with **other positive Big Five personality traits** including conscientiousness, extroversion and agreeableness. However, those traits may have been confounding variables for the effects of openness but were not entered as covariates in several data analyses.

Most of the researchers used **mediation/moderation data analyses** which involve potentially biased selections of mediators/moderators. That problem was highlighted by the two studies that addressed the same relationship between openness and cognitive functioning with one study featuring cognitive reserve as a mediator and the other entering activity diversity as a mediator. That was a similar problem for two other studies on the relationship between openness and humor. One research group entered wisdom as a mediator and the other group used

two mediators including ambiguity tolerance and cognitive flexibility. Although all these mediators may be theoretically sound, they may also reflect author bias.

As important as openness is for so many functions including cognitive functioning and academic success, it was surprising that there were only two intervention studies for increasing openness. Despite these methodological limitations, this research will help inform future research on openness.

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