

Frame-based analysis of mental disorders: towards a novel systematic approach to represent mental disorders

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Abstract

Introduction: Current advances concerning the classification of mental disorders require the development of new approaches to bridge the gap between the neurosciences and psychopathological findings. One innovative approach to define and classify mental disorders is a *frame-based representation of mental disorders* based on Barsalou's Frame Theory. Frame Theory is a general format of the representation of concepts in human cognition using frame structures, consisting of attributes of mental representations and the values they may take.

Methods: In our study, we applied Barsalou's Frame Theory for the representation of mental disorders using specific phobias as an example.

Results: We show that pathophysiological and classificatory aspects of specific phobias can be integrated into a comprehensive frame structure, so that a complete picture of the complex interrelationships between different pathogenic processes and classification issues emerges.

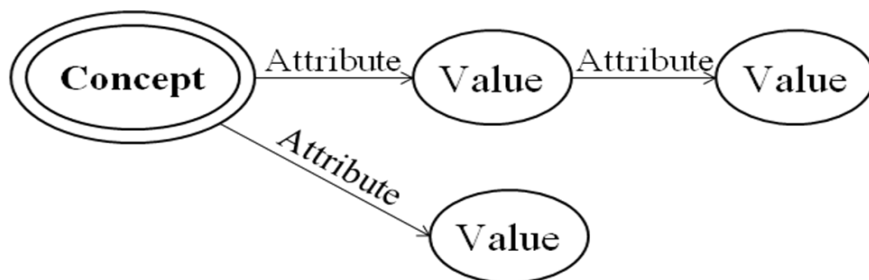
Conclusion: A frame-based analysis of mental disorders according to Barsalou's Frame Theory provides a novel systematic approach to represent mental disorders. Furthermore, frame-based representation of mental disorders offers a stringent basis for analyzing complex interrelationships of pathophysiological and classificatory aspects of mental disorders, which may be helpful to develop novel approaches towards a classification of mental disorders based on pathophysiological principles.

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Keywords: phobia, frame theory, mental disorders, classificatory systems, mechanisms

1 **1. Introduction**

2 There is increasing evidence that cognitive dysfunctions play an important role in the patho-
3 physiology of mental disorders like, e.g., schizophrenia (Green et al., 2004) or specific phobi-
4 as (Armfield, 2006). New proposals for including cognitive impairment and other neuropsy-
5 chological findings in the classification of mental disorders are being put forward (Cuthbert,
6 2013). Acknowledging the importance of cognitive dysfunctions for the classification of men-
7 tal disorders, the newly revised Diagnostic and Statistical Manual contains cognitive specifi-
8 ers (APA, 2013). As another example, in schizophrenia, where cognitive dysfunctions play a
9 major role in determining functional impairments, there are recommendations in the current
10 revision process of ICD 11 to replace the existing clinical subtypes by symptom qualifiers,
11 one of which represents cognitive symptoms (Gaebel, 2012). New concepts to incorporate the
12 neuroscientific advances on the pathophysiology of mental disorders in future classifications
13 of mental disorders are underway (Cuthbert, 2013). We investigated whether using a frame-
14 based representation of mental disorders according to Barsalou’s Frame Theory (Barsalou,
15 1992) would be applicable for such concepts. Frame Theory is a general format for the repre-
16 sentation of cognitive and other aspects of human brain function using frame-structures. Ac-
17 cording to Barsalou (Barsalou, 1992), frames are recursive structures, by which mental repre-
18 sentations of abstract ideas or concrete experiences and observations can be described in
19 terms of attributes and the values they take. Following the conventions developed by Petersen
20 (Petersen, 2007), Barsalou frames can be represented by directed graphs. In such a graphic
21 representation, arrows represent the attributes and oval fields indicate the values that these
22 attributes may have. The main concept is represented by a central node with a double line.
23 Figure 1 illustrates a general attribute-value structure proposed by Barsalou (Barsalou, 1992).



24

25 **Figure 1. The general attribute-value structure of frames.**

26 Representation of the general attribute–value structure of frames proposed by Barsalou [6]. The
27 main concept is represented by a central node with a double line. Arrows represent attributes and
28 oval fields indicate values.

29

30 Attributes are general properties or functions by which a mental representation is de-
31 scribed. For instance, the frame for a *person* may have attributes like *eye color*, *gender* etc.
32 The values are concrete specifications of such attributes. Thus, the attributes mentioned above
33 may have values such as *blue* for eye color, and *male* for gender.

34 We apply Barsalou’s Frame Theory for the representation of the pathophysiology psycho-
35 pathology and clinical classification of mental disorders. The central idea is that cognitive
36 processes are crucial targets of pathophysiological processes in mental disorders. For exam-
37 ple, cognitive processes represent core pathophysiological features of anxiety disorders
38 (Armfield, 2006 and Mathews et al., 1985). Using frame theory, such cognitive processes may
39 be described using appropriate attributes and values.

40 We chose specific phobia as an example of mental disorders because of its fixed stimulus-
41 reaction relation and comparably well-known pathomechanisms. Specific phobias are defined
42 as a marked fear of a specific object or situation during the actual contact with or during im-
43 agining the threat-related stimulus. As a result, emotional distress is experienced, which caus-
44 es significant impairment in daily life (WHO, 1992). Specific phobias are among the most
45 common anxiety disorders with a lifetime prevalence of approximately 12.5% (Kessler,
46 2005).

47 To our knowledge, this is the first attempt to represent mental disorders systematically us-
48 ing attribute-value structures according to Barsalou's Frame Theory. We aim to investigate
49 the feasibility of a putative new approach towards a comprehensive, systematic and stringent
50 representation of the psychopathology and the pathomechanisms of a mental disorder in a
51 descriptive way by means of Frame Theory. Furthermore, we aim to show that by providing a
52 clearer picture of the partial overlap of mental dysfunctions in different attribute-value pairs,
53 complex interrelationships may become discernible and complex systemic effects of single
54 localizable disturbances can be identified.

55 2. Methods

56 We applied Barsalou's Frame Theory for representing specific phobias. The frame for specific
57 phobia is a representation of the stimulus-reaction-relation, its possible etiological causes, and
58 its pathological consequences. For the development of this frame representation, we used the
59 general format of attribute-value sets as proposed by Barsalou (Barsalou, 1992). Our frame
60 analysis is based on a systematic review of cognitive pathomechanisms in specific phobia
61 conducted in 2013 (not yet published). We also considered classification information for rep-
62 resenting it in frames, since mental disorders are currently conceptualized as normative repre-
63 sentations of sets of clinical criteria, which reflect common denominators of the clinical pic-
64 tures of a multitude of individual cases.

65 Studies which have investigated cognitive dysfunctions (attentional, memory and other bias-
66 es) as well as characteristic brain activity in adults fulfilling criteria for phobic disorder an-
67 swered the first inclusion criteria set in our review. The second inclusion criterion for studies
68 was the appliance of quasi-experimental between-group design comparing phobic and non-
69 phobic persons. After this steps of selection articles which have encased phobic patients hav-
70 ing another mental disorder as fact of co-morbidity were excluded. Another reason for exclu-
71 sion was any participation on therapeutic or psychotropic treatment. The core features of
72 study samples (size, diagnosis, treatments, etc.) and relevant results were extracted in a stand-
73 ardized matter. Finally, 34 papers have been reviewed using method of narrative synthesis of
74 reported results.

75 We have chosen the following way to build sortal frames representing all found results
76 summed up in this systematic review:

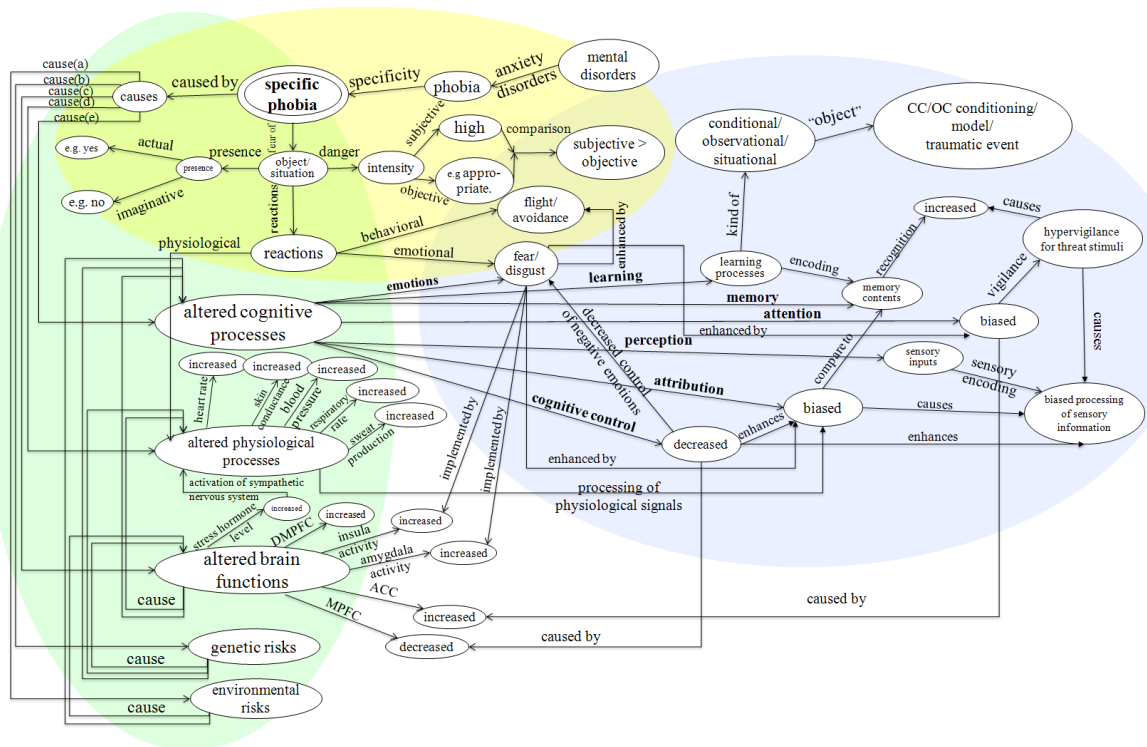
77 a) Evidently shown altered cognitive and brain functions were understood as attributes or ar-
78 rows. Considering the frame notion of classificatory definition - behavioral, emotional and
79 enviromental conditions relevant for the phobic disorder were applied to the arrows.

80 b) Values in the nodes were assigned to the empirically observed distinctions between phobic
81 and non-phobic populations as well as classificatory defined symptoms and states of condi-
82 tions.

83 c) We also included other factors which may lead to the development and/or the maintenance
 84 of specific phobia, including genetic and environmental factors, and alterations of brain func-
 85 tions or brain structure.

86 **3. Results**

87 The result of the frame-based analysis of specific phobia is shown in Figure 2, which illus-
 88 trates the complete frame-based analysis of specific phobia. Different colors mark the differ-
 89 ent levels of analysis. The analysis of the classificatory definition of specific phobia according
 90 to ICD-10 (WHO, 1992) is distinguished by yellow color. Cognitive processes are marked in
 91 blue. The analysis of the pathogenesis of specific phobia is marked in green.



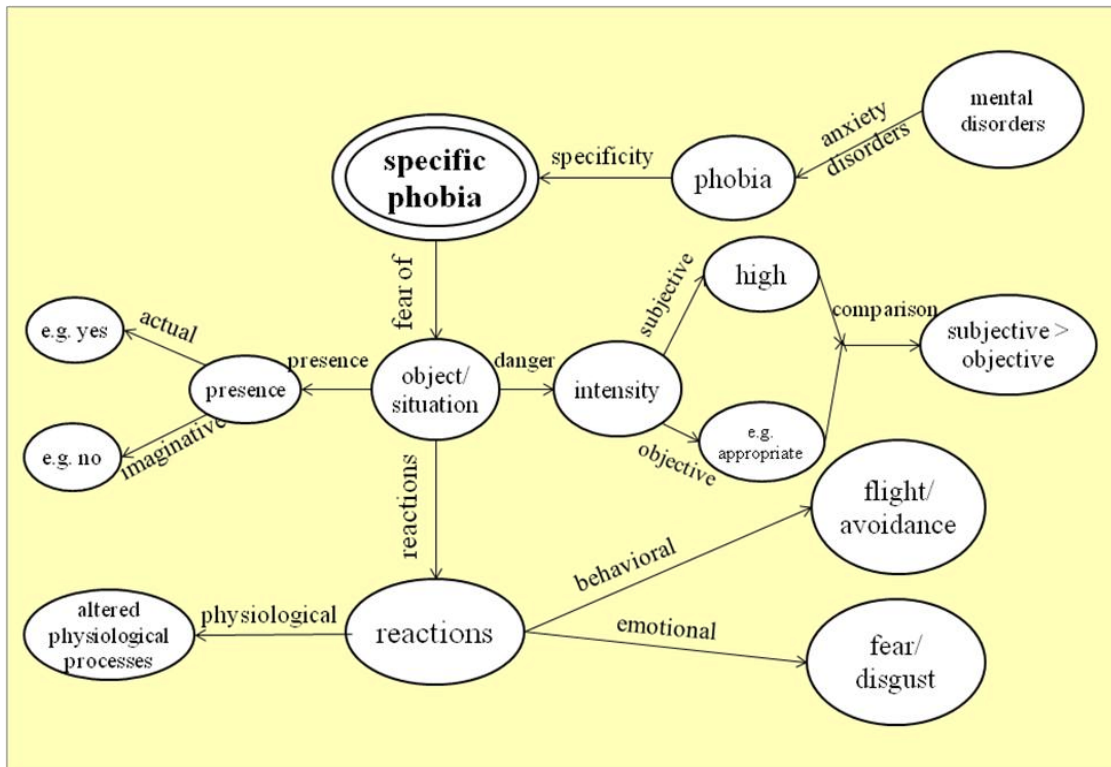
92
 93 **Figure 2. Frame-based representation of specific phobia.**

94 This figure shows a Barsalou-type frame-based analysis of the classificatory definition and
 95 pathomechanisms of specific phobia. The definition of the disorder is highlighted by yellow color,
 96 pathomechanisms by green color. The involved cognitive processes are shown in the blue field.
 97 Arrows indicate attributes. Oval fields represent values.

98 **3.1. Frame-based analysis of the classificatory definition of specific phobia**

99 Figure 3 depicts the frame-based analysis of the classificatory definition of specific phobia
 100 according to ICD-10 criteria (WHO, 1992). Figure 3 demonstrates that specific phobia is part
 101 of the group of anxiety disorders. The concept *specific phobia*, represented by a double line,
 102 implies a fear of a specific object or situations, which is represented by the attributes *specificity*
 103 and *fear of*. This specific fear-related stimulus is represented by the value *object/situation*.
 104 This node has several further attributes such as *danger*, *presence*, and *reactions*. The attribute
 105 *danger* and its value *intensity* imply that the intensity of danger is considered to be higher by
 106 persons with specific phobias compared to non-phobic persons.

107 This frame-based representation of the definition of specific phobia contents among others
 108 the representation of an exclusion/inclusion criterion for the diagnosis of specific phobia rep-
 109 resented by an attribute *comparison*. The corresponding value *subjective > objective* means
 110 that for the diagnosis of specific phobia, the subjective danger intensity for a specific object or
 111 situation of a person should be higher than the objective danger intensity of the most of peo-
 112 ple. The attribute *presence* with a same-named value *presence* shows that encounter with a
 113 feared stimulus, independent of the actual presence, or imagining of such a stimulus, evokes
 114 behavioral, emotional and physiological reactions depicted by the corresponding attributes.



115
 116 **Figure 3. Frame-based analysis of the classificatory definition of specific phobia.**

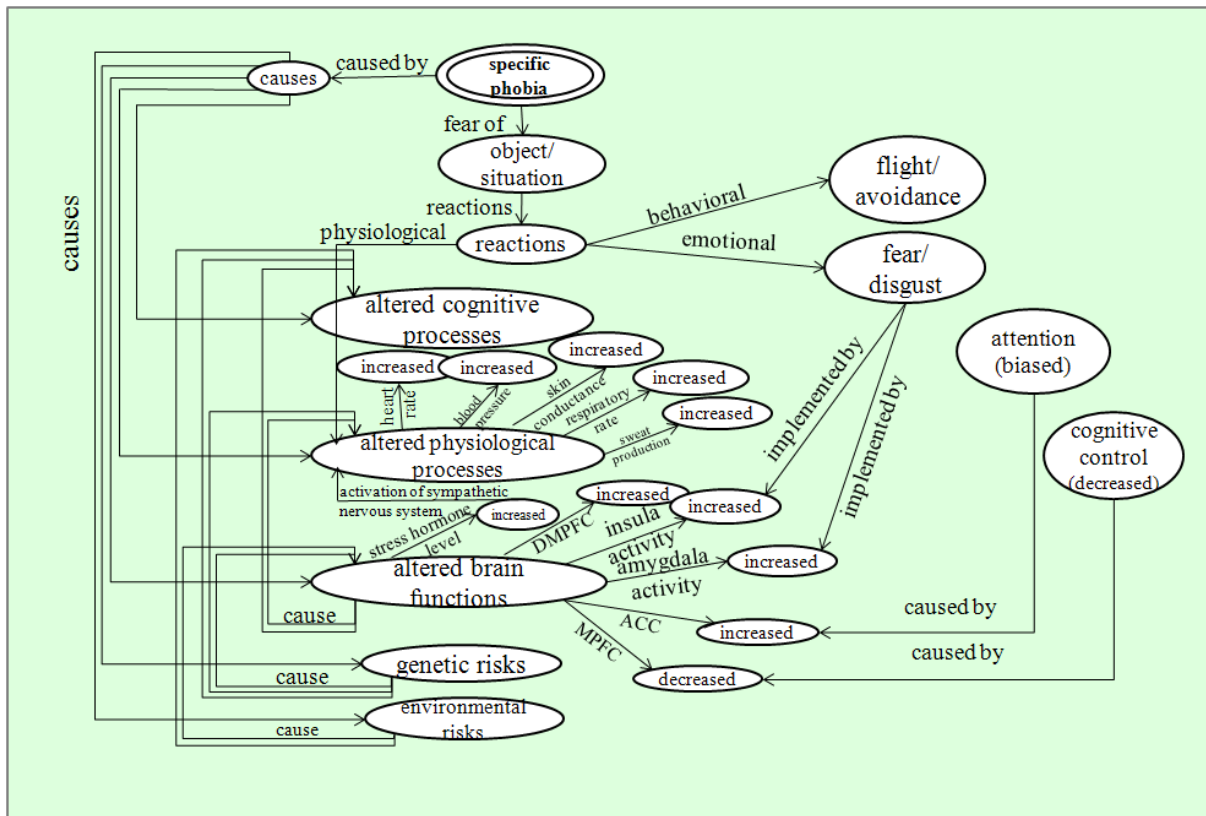
117 This figure shows the frame-based analysis of a classificatory definition of specific phobia. The
 118 concept of specific phobia is represented by a central node with a double line. Arrows indicate at-
 119 tributes. Oval fields represent values.

120 3.2. Frame-based analysis of the pathophysiology of specific phobia

121 Figure 4 shows the frame-based analysis of the pathophysiology of specific phobia. The etio-
 122 logical causes of specific phobia are complex and yet unknown, but various factors, repre-
 123 sented by values of the attributes *causes*, contribute to the development of specific phobia.
 124 We found evidence for alterations in the domains such as *cognitive processes*, somatic *physio-*
 125 *logical functions*, and *brain functions* in persons with specific phobia. Due to inconsistent
 126 research results in the *environmental risks* and *genetic risks* factors, the frame analysis of the-
 127 se two factors was considered as not efficient.

128 Our frame analysis demonstrates that different etiological factors may lead to the develop-
 129 ment of specific phobia. Furthermore, Figure 4 shows that these factors may interplay and
 130 therefore evoke some alterations in other factors and by this way contribute to the develop-
 131 ment of specific phobia.

132 We found evidence for *altered brain functions*, represented in Figure 4 by attributes such
 133 as *insula, amygdala, anterior cingulate cortex, medial prefrontal cortex, dorsomedial prefr-*
 134 *rontal cortex activities*, and *hormone stress level* with their corresponding values. Some of these
 135 factors may be a cause for alterations of cognitive processes like *attention, cognitive control*
 136 and *emotion*. The *increased hormone stress level* results in *activation of the sympathetic nerv-*
 137 *ous system* and evokes alterations in *physiological processes* represented by the following
 138 attributes: *heart rate, skin conductance, blood pressure, respiratory rate, and sweat produc-*
 139 *tion*. The corresponding values imply alterations in these functions in persons with specific
 140 phobia.



141

142 **Figure 4. Frame-based analysis of the pathomechanisms of specific phobia.**

143

144 This figure shows the frame-based analysis of various pathophysiological and psychopathological
 145 domains of specific phobia. Arrows indicate attributes. Oval fields represent values.

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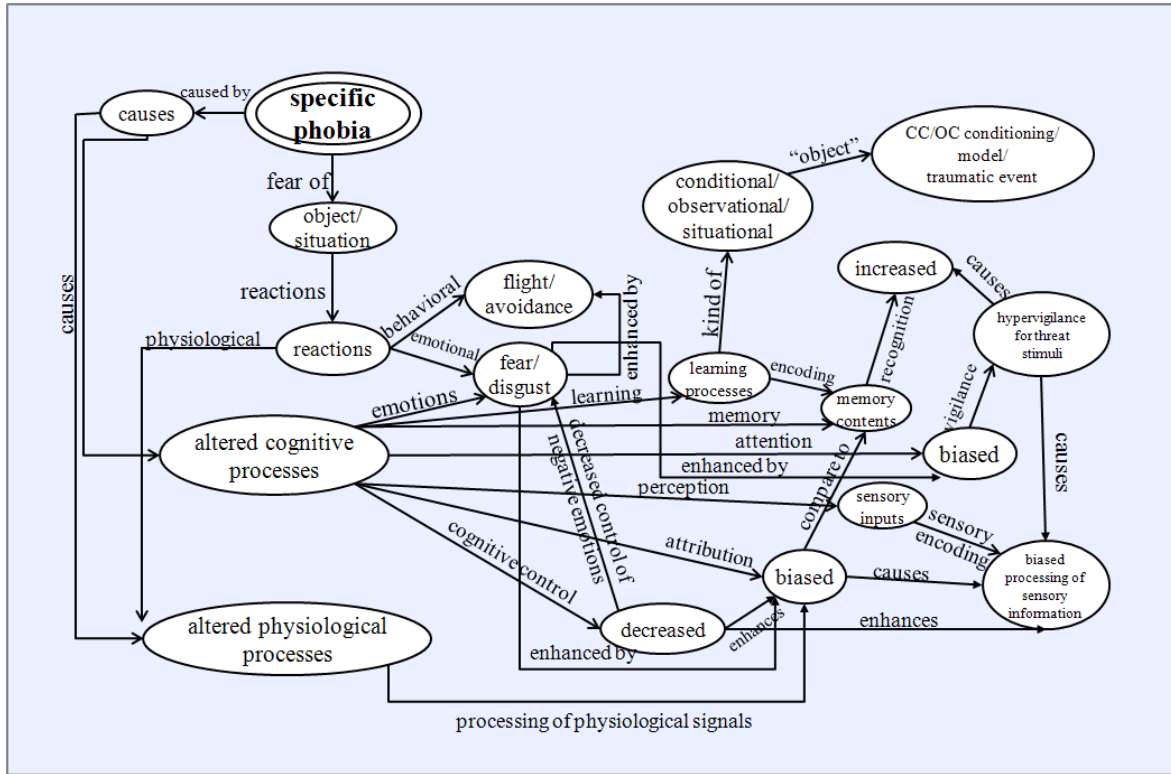
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3.3. Frame-based analysis of the cognitive pathomechanisms of specific phobia

147

148 This last section of our frame analysis illustrates the cognitive processes which are involved
 149 in the pathophysiology of specific phobia as a result of a systematic review of the relevant
 150 literature (manuscript in preparation). Figure 5 shows these cognitive processes, which are
 151 represented by the attributes *emotions, learning, memory, attention, perception, attribution,*
 152 *and cognitive control*. The frame in Figure 5 demonstrates that fear of a specific object can be
 153 learned in different ways, for instance through linkage of stimuli with each other (*conditional*
 154 *learning*), through observation of another person (*observational learning*), or through a trau-
 155 matic event (*situational learning*). This learned information will be saved in *memory* storage.
 The biased attentional process *hypervigilance for threat stimuli* is associated with increased

156 memory performance for threat-related stimuli in persons with specific phobia. Furthermore,
 157 there is an association of *hypervigilance* with *biased processing of encoded sensory infor-*
 158 *mation*. This biased perception process is further enhanced by *biased attribution processes*
 159 and by insufficient *cognitive control*. This decreased *cognitive control* leads to insufficient
 160 control of negative emotions, which are associated with avoidant behavior, biased attentional
 161 and biased attributional processes in persons with specific pho-
 162 bia.



163
 164 **Figure 5. Frame-based analysis of the cognitive pathomechanisms of specific phobia.**

165 This figure represents the frame-based analysis of the cognitive pathomechanisms of specific phobia. Arrows
 166 indicate attributes. Oval fields represent values.

167 **4. Discussion**

168 We show by the example of specific phobia how information from multiple domains such as
 169 classificatory definition criteria and pathomechanisms can be integrated into a comprehensive
 170 Barsalou-type frame structure, so that a complete picture of the complex interrelations be-
 171 tween different pathogenic processes and their ensuing classificatory importance emerges.
 172 The frame shows the interplay of different factors including alterations in cognitive processes,
 173 which appears to be crucial for anxiety disorders (Grupe et al., 2013). Therefore, Barsalou’s
 174 Frame Theory appears appropriate to systematically represent the complex structure of the
 175 pathomechanisms in mental disorders, their possible neural correlates and ensuing classifica-
 176 tory elements.

177 Some limitations of representing mental disorders in Barsalou’s type frames need to be
 178 taken into consideration. First, Frame Theory has not yet defined a way to represent the time-
 179 course-variable clinical picture of mental disorders. Another aspect which needs to be ad-
 180 dressed is the question of a continuum between symptoms of mental disorders and less intense

181 similar symptoms in persons without mental disorders. Finally, the etiological causes of spe-
182 cific phobia are unknown, but several pathophysiologic mechanisms can be demonstrated.
183 The strength of frame-based analysis is that it bridges such important borders as those be-
184 tween “causes” and ensuing pathophysiologic processes by representing them in a single
185 frame.

186 The frame-based representation of mental disorders provides a useful basis for the system-
187 atic representation of the complex pathomechanisms of mental disorders. Furthermore, this
188 novel kind of representation has benefits compared to traditional flow charts and diagrams.
189 Due to systematic rules for the representation of the concepts according to Barsalou’s Frame
190 Theory, it becomes possible to compare different mental disorders and to identify possible
191 overlaps in their pathomechanisms. “Bridge symptoms” common to “comorbid” mental dis-
192 orders may provide a starting point for comorbidity analyses (Cramer et al., 2010). Also,
193 frame-theory may be used as a tool to depict and unify different levels of analysis in a single
194 representation, like shown here for informations from the neurosciences, cognitive psycholo-
195 gy or clinical observations as reflected by clinical classification criteria.

196 In conclusion, frame-based analysis of mental disorders according to Barsalou’s Frame
197 Theory provides a novel tool for a systematic and comprehensive representation of the com-
198 plex structure of the pathomechanisms and classification of mental disorders, with a view to
199 analyze comorbidity patterns in mental disorders, which may be helpful for the future devel-
200 opment of classification systems of mental disorders based on pathomechanistic information
201 (Borsboom et al., 2011).

202 **Conflict of interest**

203 All authors state no conflict of interest

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