Conceptualisation

May 3, 2024

1 Conceptualisation

The summarised RDF statements derived in Table **??** are used to define the concepts in the ontology. Definitions are first described by concise NL statements, which are then expressed as logical statements using DL. In DL notation, '⊑' indicates a subclass, '≡' equates concepts, '⊔' unites conditions, and '⊓' intersects them. The symbol '∃' is used to show that a property exists, and a dot in a term like 'hasAssociatedAppraisal.ThoughtAppraisal' specifies the property 'hasAssociatedAppraisal' relates to the 'ThoughtAppraisal' concept. Prior to their representation in the ontology, these NL definitions undergo an evaluation process by domain experts, as detailed in Chapter **??**. This evaluative step ensures that the definitions are appropriately reflect the domain-specific knowledge.

Note that 'indexes' refer to the indexes of statements represented in the knowledge acquisition file.

The conceptualisation of OCD concept within our ontology is informed by key statements, indexed as 1 and 3 in Table **??**. These statements guide the conceptual framework as depicted in Figure 1. Additionally, Table 1 provides both the Description Logic (DL) representation and the Natural Language (NL) definition of OCD.
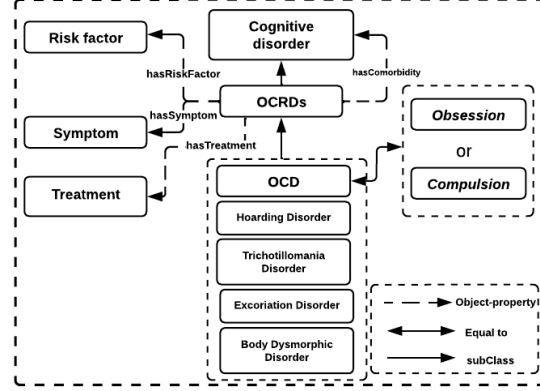
Figure 1: The conceptualisation of OCD

OCD $\sqsubseteq$ OCRDs.
OCD $\equiv$ Obsession $\sqcup$ Compulsion.
OCRDs $\sqsubseteq$ $\exists$hasRiskFactor.RiskFactor.
OCRDs $\sqsubseteq$ $\exists$hasSymptom.Symptoms.
OCRDs $\sqsubseteq$ $\exists$hasTreatment.Treatment.
OCRDs $\sqsubseteq$ $\exists$hasComorbidity.CognitiveDisorder .

NL: OCD is classified within Obsessive-Compulsive and Related Disorders (OCRDs) and is defined as either an obsession, a compulsion, or both. Obsessive-Compulsive and Related Disorders (OCRDs) are associated with specific risk factors. Obsessive-Compulsive and Related Disorders are associated with specific symtoms. OCRDs has corresponding treatments. OCRDs may coexist with cognitive disorders.

Table 1: DL and NL Definitions of OCD

The classification of OCD within OCRDs in natural language leads to the DL representation that OCD is a subclass of OCRDs. This implies that all instances of OCD are also considered instances of OCRDs. The definition of OCD, stating it can manifest as an obsession, a compulsion, or both, translates to the DL equivalence of OCD to the union of obsession and compulsion. This DL representation specifies that OCD encompasses all instances that are either obsessions, compulsions, or both, without excluding any potential overlap between these two categories. However, this union equivalence does not imply symmetry; while any obsession or compulsion can qualify as OCD, not all OCD instances are strictly one or the other.

Object properties in ontologies are used to describe relationships between two entities or classes. In the OCD framework, object properties define relationships. 'hasRiskFactor' associates 'OCD' with its 'Risk factors,' (elicited from statement 1 in Table **??**) while 'hasSymptom' relates 'OCD' to its specific 'Symptoms' (elicited from statement 3 in Table **??**). Additionally, 'hasComorbidity' delineates the connection between 'OCRDs' and 'Cognitive disorders', highlighting the possibility of concurrent mental disorders with OCD (elicited from statement 10 in Table **??**). 'hasTreatment' is another object property that connects 'OCRDs' to various 'Treatments,' representing the therapeutic interventions applicable to the disorders (elicited from statement 3 in Table **??**).

Indexes 2, 6, and 8 in Table **??** guide the conceptualisation of "Obsession" and "Compulsion" as outlined. Figures 2 and 3 visually depict the conceptualisation process of obsession and compulsion, respectively. Furthermore, Table 2 provides the DL and NL definitions for these two critical aspects of OCD.
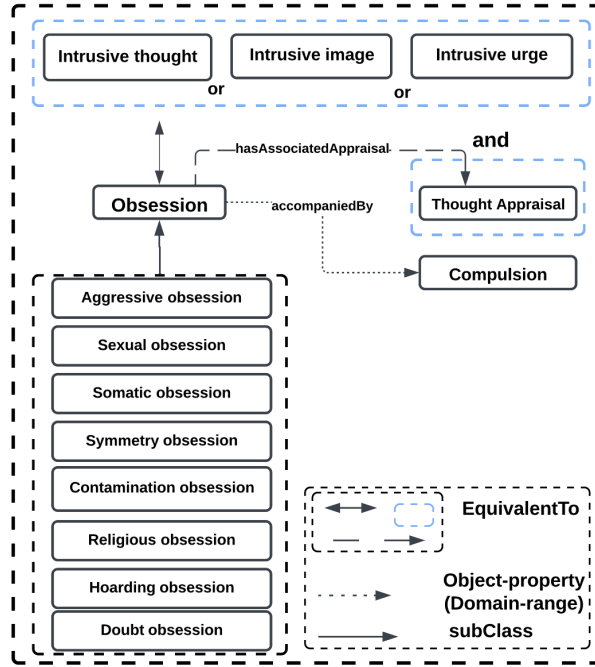

Figure 2: The conceptualisation of Obsession

The NL description states that an obsession is characterised by the presence of "intrusive thoughts, images, or urges". This part of the description directly justifies the use of the union operator ($\sqcup$) in DL. The mention of "thoughts, images, or urges" indicates that obsessions can manifest in any one of these forms or even in multiple forms simultaneously. The use of "or" in this context is inclusive, suggesting that an obsession can be any one of these types or a combination thereof. The use of equivalence in DL stems directly from how the NL description articulates the essence of what constitutes an obsession. By detailing that an obsession is composed of intrusive elements—such as thoughts, images, or urges—that significantly distress the individual, the NL description effectively establishes the definitive characteristics of an obsession. This precise delineation of criteria in the NL description is mirrored in DL through the equivalence operator ($\equiv$), indicating that the concept of obsession is exactly and solely defined by these established criteria.

Specifically, aggressive obsessions are a subtype of obsession characterised by the content of aggression in the intrusive thoughts, images, or urges. In DL, aggressive obsessions are defined as a subclass of the broader obsession category, specifically focusing on the aggressive nature of the intrusion. This is represented by the union of aggressive intrusive thoughts, aggressive intrusive images, or aggressive obsessive urges, underlining the specific thematic content of these obsessions.

The object property 'hasAssociatedAppraisal' highlights the cognitive evaluation process related to obsessions, linking them to the concept of 'Thought Appraisal'. Furthermore, the 'accompanied' property highlights the association between obsessions and compulsions, suggesting that obsessions often lead to compulsive actions (elicited from knowledge acquisition. Different types of obsessions, like 'Aggressive,' 'Sexual,' or 'Contamination,' are defined as subclasses under the general 'Obsession' category, denoting that while they have distinct features, they all share the foundational elements of obsession.

Compulsions are described as behaviors or mental acts that an individual feels driven to perform in response to an obsession or according to rules that must be applied rigidly. These acts are aimed at preventing or reducing distress or preventing some dreaded event or situation; however, these behaviors or mental acts are not connected in a realistic way with what they are designed to neutralise or prevent, or are clearly excessive. Compulsions are characterised by the distress they aim to mitigate, the functional impairment they cause, and

the significant time they consume, which can manifest in various forms such as physical actions (e.g., checking doors) or mental acts (e.g., praying). The DL formulation for compulsion mirrors its complexity by defining compulsion as equivalent to the union of behaviors or activities, each associated with an emotion (hasAssociateEmotion), functional impairment (hasAssociateImpairment), and a particular severity or duration of the behavior (hasAssociatedDuration). This formalisation encapsulates the essence of compulsive actions or mental acts, their emotional underpinnings, the resultant impairment in functioning, and their duration or severity, thereby providing a comprehensive ontological representation.
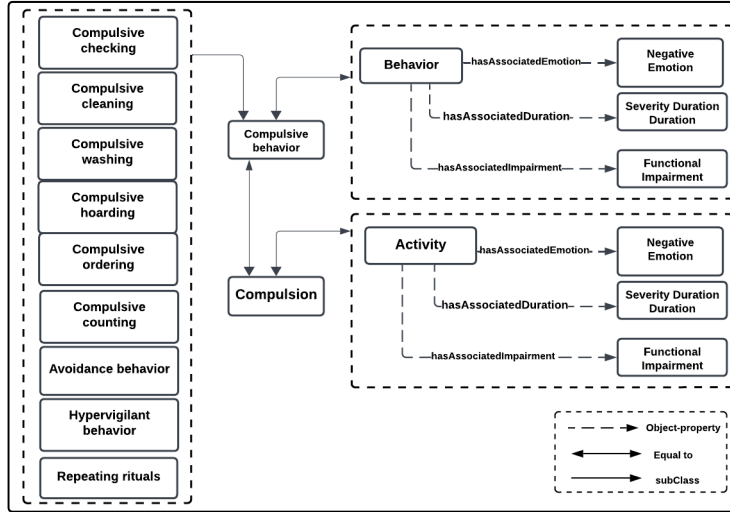

Figure 3: The conceptualisation of Compulsion

The object property 'hasAssociatedEmotion' establishes a relationship between 'Behavior' and 'Activity' with 'Negative Emotion', indicating that such actions can be associated with adverse emotional states. 'hasDuration' property associates 'Behavior' and 'Activity' with 'Severity Duration', marking the extent and severity of the activity/behavior over time. Moreover, 'hasAssociatedImpairment' denotes the link between 'Behavior' and 'Activity' with 'Functional Impairment', reflecting the impact of these actions on functional capabilities and daily life. These properties are essential in illustrating the progression from 'Behavior' and 'Activity' to 'Compulsion'. For 'Obsession', they delineate the

transformation of thoughts, mental images, and urges into a state of intrusiveness, leading to intrusive thought, intrusive image or intrusive urge as illustrated in Figure 4. Furthermore, the OCD ontology utilises a set of object properties to capture the assessment criteria for obsessions and compulsions. These properties include 'hasControlLevel', 'hasDistressLevel', 'hasDurationLevel', and 'hasInterferenceLevel'. Each property links the behaviors, activities, and intrusive thoughts or urges to their respective assessment criterion. For instance, 'hasControlLevel' connects these elements to the 'Severity Control Level', which assesses an individual's ability to control OCD symptoms. 'hasDistressLevel' relates to the 'Severity Distress Level', gauging the emotional distress caused by the symptoms. 'hasDurationLevel' ties to the 'Severity Duration Level', indicating the persistence of symptoms over time. Lastly, 'hasInterferenceLevel' associates with the 'Severity Interference Level', reflecting the extent to which OCD symptoms interfere with the individual's daily functioning. These properties are essential for a nuanced understanding of how OCD symptoms manifest and impact a person's life.

Obsession ≡ Intrusive thought ⊔ Intrusive image ⊔ Intrusive urge) ⊓ (∃ hasAssociatedAppraisal.ThoughtAppraisal).
Obsession ⊑ ∃ accompaniedBy.Compulsion.

NL: An obsession is characterised by an intrusive thought, image, or urge causing distress, often emphasized by the individual's significant appraisal. Obsession is accompanied by compulsion.

Aggressive obsession ⊑ Obsession.
≡ Aggressive intrusive thought ⊔ Aggressive intrusive image ⊔ Aggressive obsessive urge.

NL: An aggressive obsession in OCD can manifest as an aggressive intrusive thought, image, or urge characterised by the nature of aggression.

Compulsion ≡ Activity ⊓ (∃ hasAssociateEmotion.Emotion) ⊓ (∃ hasAssociateImpairment.FunctionalImpairment) ⊓ (∃ hasAssociatedDuration.SeverityDurationLevel).

Compulsive behavior ≡ Behavior ⊓ (∃ hasAssociateEmotion.Emotion) ⊓ (∃ hasAssociateImpairment.FunctionalImpairment) ⊓ (∃ hasAssociatedDuration.SeverityDurationLevel).

Compulsion ≡ Compulsive behavior

NL: Compulsions in OCD are behaviors or mental acts performed in response to obsessions, characterised by distress, functional impairment, and significant time consumption, including both physical actions like checking doors and mental acts like praying.

Table 2: DL and NL Definitions of Obsession and Compulsion

Indexes 4, 5, 7, 9 and 11 guide the modeling of 'Intrusive thought', 'Intrusive image', and 'Intrusive urge'. Figure 4 visualizes the conceptualisation of these concepts, while Table 3 details their DL and NL definitions.

Intrusive thoughts ≡ (Thoughts ⊓ (∃ hasAssociateEmotion.Emotion) ⊓ (∃ hasAssociateImpairment.FunctionalImpairment) ⊓ (∃ hasAssociatedDuration.SeverityDurationLevel)) NL: Intrusive thoughts in OCD are obsessions accompanied by negative emotions such as distress, leading to functional impairment and defined by their duration and severity.
Intrusive Images ≡ Mental Image ⊓ Intrusive Thought NL: An intrusive mental image, as a form of obsession in OCD, is an intrusive thought that manifests as a vivid visual image, causing distress.
Intrusive urge ⊑ Urge Intrusive urge ≡ (urge ⊓ (∃ hasAssociateEmotion.Emotion) ⊓ (∃ hasAssociateImpairment.FunctionalImpairment) ⊓ (∃ hasAssociatedDuration.SeverityDurationLevel)) NL: An intrusive urge in OCD is a compelling desire to perform distressing behaviors, significantly impacting daily life and characterised by its emotional association, functional impairment, and duration.

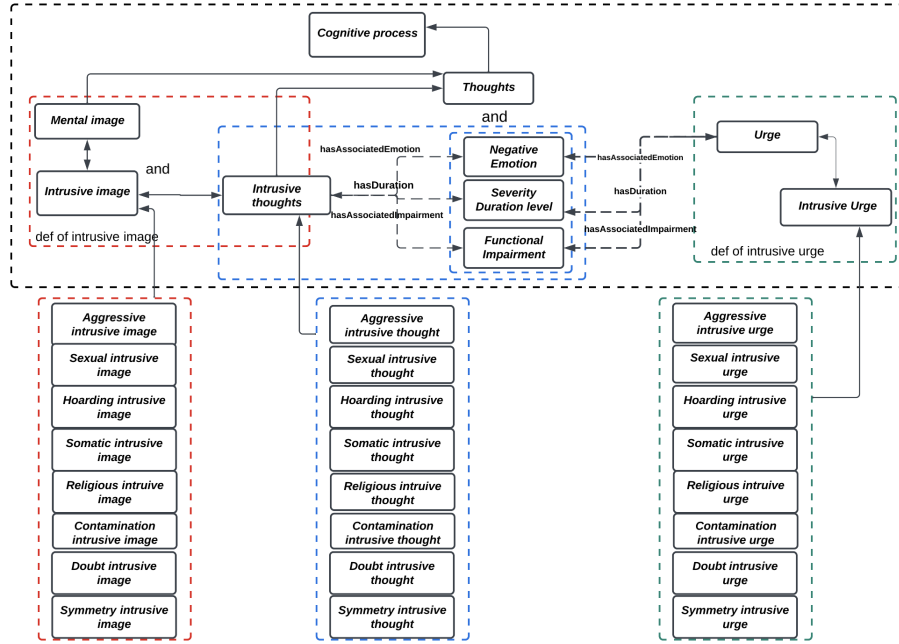Table 3: DL and NL Definitions of Intrusive thought, Intrusive image and Intrusive urge

Figure 4: The conceptualisation of Intrusive thought/Image and Urge

Intrusive thoughts in OCD are described as thoughts that are accompanied by

negative emotions, such as distress, and lead to functional impairment. They are also defined by their duration and severity. This description leads to a DL formulation where intrusive thoughts are equivalent to thoughts that meet three conditions: they must be associated with a negative emotion (hasAssociateEmotion.Emotion), cause functional impairment (hasAssociateImpairment.FunctionalImpairment), and be characterised by a specific duration and severity (hasAssociatedDuration.SeverityDurationLevel). The equivalence ($\equiv$) operator indicates that for a thought to be classified as intrusive, it must satisfy all these conditions, reflecting the complex nature of such thoughts as defined in the NL description. An intrusive mental image is characterised as an intrusive thought that specifically manifests as a vivid visual image, causing distress. This leads to the DL representation where intrusive images are defined as mental images that are also intrusive thoughts. This is denoted by the intersection ($\sqcap$) of being a mental image with the properties of an intrusive thought. The DL formulation captures the specific manifestation of intrusive thoughts as visual images.

In DL, intrusive urges are depicted as a subclass of urges ($\sqsubseteq$ urge) that are specifically defined ($\equiv$) by the intersection of several criteria: they are urges associated with a negative emotion (hasAssociateEmotion.Emotion), lead to functional impairment (hasAssociateImpairment.FunctionalImpairment), and have a particular duration and severity (hasAssociatedDuration.SeverityDurationLevel). This captures the essence of intrusive urges as not merely any urge but those with distressing consequences and significant impact, reflecting the detailed description provided in the NL.

In an ontology, a data property defines attributes or characteristics of classes or instances, allowing them to have values that are specific data types or literals. In our ontology, we define particular data properties to capture the varying levels of OCD criteria. Each property is associated with an rdfs:Literal range, enabling these data properties to express a wide range of descriptive values, such as textual descriptions ("mild", "moderate", "severe", "extreme").For instance, 'hasControlValue' denotes the individual's ability to control obsessions or compulsions, with levels ranging from "mild", where the individual is rarely successful in stopping the behavior, to "extreme", indicating a complete lack of control. Similarly, 'hasDistressValue' reflects the degree of discomfort caused by the OCD symptoms, 'hasResistanceValue' assesses the individual's effort to resist these symptoms, and 'hasInterferenceValue' measures the extent to which

these symptoms disrupt daily activities. Each level is described using qualitative measures such as "mild ", " moderate", "severe" and "extreme".

Table 4: Data Properties for OCD Criteria Levels

Data Property	Domain	Range
hasControlValue	Severity Control Level	rdfs:Literal
hasDistressValue	Severity Distress Level	rdfs:Literal
hasResistanceValue	Severity Resistance Level	rdfs:Literal
hasInterferenceValue	Severity Interference Level	rdfs:Literal

A complete representation of the DL of OCD concepts are presented in table 5.

Table 5: Description Logic Representation of OCD-related Concepts

Concept	Description Logic
OCD	$\sqsubseteq$ OCRDs.
OCD	$\equiv$ Obsession $\sqcup$ Compulsion.
OCRDs	$\sqsubseteq$ Cognitive disorder.
Body Dysmorphic Disorder	$\sqsubseteq$ OCRDs.
Hoarding Disorder	$\sqsubseteq$ OCRDs.
Trichotillomania	$\sqsubseteq$ OCRDs.
Skin Picking Disorder	$\sqsubseteq$ OCRDs.
Obsession	$\equiv$ (Intrusive thought $\sqcup$ Intrusive image $\sqcup$ Intrusive urge) $\sqcap$ ($\exists$ hasAssociatedAppraisal.ThoughtAppraisal).
Aggressive Obsession	$\sqsubseteq$ Obsession. $\equiv$ Aggressive intrusive thought $\sqcup$ Aggressive intrusive image $\sqcup$ Aggressive obsessive urge.
Hoarding Obsession	$\sqsubseteq$ Obsession. $\equiv$ Hoarding obsessive thought $\sqcup$ Hoarding obsessive image $\sqcup$ Hoarding obsessive urge.
Contamination Obsession	$\sqsubseteq$ Obsession. $\equiv$ Contamination obsessive thought $\sqcup$ Contamination obsessive image $\sqcup$ Contamination obsessive urge.
Sexual Obsession	$\sqsubseteq$ Obsession. $\equiv$ Sexual obsessive thought $\sqcup$ Sexual obsessive image $\sqcup$ Sexual obsessive urge.
Symmetry Obsession	$\sqsubseteq$ Obsession. $\equiv$ Symmetry obsessive thought $\sqcup$ Symmetry obsessive image $\sqcup$ Symmetry obsessive urge.

Table 5 – continued from previous page

Concept	Description Logic
Somatic Obsession	⊑ Obsession. ≡ Somatic obsessive thought ⊔ Somatic obsessive image ⊔ Somatic obsessive urge.
Religious Obsession	⊑ Obsession. ≡ Religious obsessive thought ⊔ Religious obsessive image ⊔ Religious obsessive urge.
Doubt Obsession	⊑ Obsession. ≡ Doubt obsessive thought ⊔ Doubt obsessive image ⊔ Doubt obsessive urge.
Intrusive thoughts	≡ (Thoughts ⊓ (∃ hasAssociateEmotion.Emotion) ⊓ (∃hasAssociateImpairment.FunctionalImpairment) ⊓ (∃hasAssociatedDuration.SeverityDurationLevel))
Morbid Thoughts	⊑ Thoughts
Intrusive Thoughts	⊑ Thoughts
Persistent Thoughts	⊑ Thoughts
Recurrent Thoughts	⊑ Thoughts
Aggressive Thoughts	⊑ Morbid Thoughts
Sexual Thoughts	⊑ Morbid Thoughts
Somatic Thoughts	⊑ Morbid Thoughts
Symmetry Thoughts	⊑ Morbid Thoughts
Religious Thoughts	⊑ Morbid Thoughts
Hoarding Thoughts	⊑ Morbid Thoughts
Contamination Thoughts	⊑ Morbid Thoughts
Doubt Thoughts	⊑ Morbid Thoughts
Aggressive Intrusive Thought	≡ Aggressive Thought ⊓ Intrusive Thought
Sexual Intrusive Thought	≡ Sexual Thought ⊓ Intrusive Thought
Contamination Intrusive Thought	≡ Contamination Thought ⊓ Intrusive Thought
Somatic Intrusive Thought	≡ Somatic Thought ⊓ Intrusive Thought
Symmetry Intrusive Thought	≡ Symmetry Thought ⊓ Intrusive Thought
Doubt Intrusive Thought	≡ Doubt Thought ⊓ Intrusive Thought
Religious Intrusive Thought	≡ Religious Thought ⊓ Intrusive Thought
Hoarding Intrusive Thought	≡ Hoarding Thought ⊓ Intrusive Thought
Intrusive Mental images	≡ Mental Image ⊓ Intrusive Thought
Aggressive Mental images	⊑ Mental images
Sexual Mental images	⊑ Mental images

Table 5 – continued from previous page

Concept	Description Logic
Somatic Mental images	⊑ Mental images
Symmetry Mental images	⊑ Mental images
Religious Mental images	⊑ Mental images
Hoarding Mental images	⊑ Mental images
Contamination Mental images	⊑ Mental images
Doubt Mental images	⊑ Mental images
Aggressive Intrusive Image	≡ Mental Image ⊓ Intrusive Thought
Sexual Intrusive Image	≡ Mental Image ⊓ Intrusive Thought
Contamination Intrusive Image	≡ Mental Image ⊓ Intrusive Thought
Somatic Intrusive Image	≡ Mental Image ⊓ Intrusive Thought
Symmetry Intrusive Image	≡ Mental Image ⊓ Intrusive Thought
Doubt Intrusive Image	≡ Mental Image ⊓ Intrusive Thought
Religious Intrusive Image	≡ Mental Image ⊓ Intrusive Thought
Hoarding Intrusive Image	≡ Mental Image ⊓ Intrusive Thought
Persistent Mental Image	⊑ Mental Images
Recurrent Mental Image	⊑ Mental Images
Intrusive urge	≡ (urge ⊓ (∃ hasAssociateEmotion.Emotion) ⊓ (∃hasAssociateImpairment.FunctionalImpairment) ⊓ (∃ hasAssociatedDuration.SeverityDurationLevel))
Intrusive urge	⊑ Urge
Aggressive intrusive urge	≡ Feeling of Aggressive urge ⊓ Intrusive urge
Sexual intrusive urge	≡ feeling of Sexual urge ⊓ Intrusive urge
Contamination intrusive urge	≡ feeling of Contamination urge ⊓ Intrusive urge
Somatic intrusive urge	≡ feeling of Somatic urge ⊓ Intrusive urge
Symmetry intrusive urge	≡ feeling of Symmetry urge ⊓ Intrusive urge
Doubt intrusive urge	≡ feeling of Doubt urge ⊓ Intrusive urge
Religious intrusive urge	≡ feeling of Religious urge ⊓ Intrusive urge
Hoarding intrusive urge	≡ feeling of Hoarding urge ⊓ Intrusive urge
Persistent urge	⊑ urge
Recurrent urge	⊑ urge
Feeling of aggressive urge	⊑ urge
Feeling of contamination urge	⊑ urge

Table 5 – continued from previous page

Concept	Description Logic
Feeling of sexual urge	$\sqsubseteq$ urge
Feeling of somatic urge	$\sqsubseteq$ urge
Feeling of symmetry urge	$\sqsubseteq$ urge
Feeling of doubt urge	$\sqsubseteq$ urge
Feeling of hoarding urge	$\sqsubseteq$ urge
Feeling of religious urge	$\sqsubseteq$ urge
Compulsion	Compulsion $\equiv$ Compulsive behavior. $\equiv$ (Behavior $\sqcup$ Activity) $\sqcap$ ($\exists$ hasAssociateEmotion.Emotion) $\sqcap$ ($\exists$ hasAssociateImpairment.FunctionalImpairment) $\sqcap$ ($\exists$ hasAssociatedDuration.SeverityDurationLevel).
Compulsive Behavior	$\sqsubseteq$ Behavior.
Avoidance behavior	$\sqsubseteq$ Behavior
Reassurance behavior	$\sqsubseteq$ behavior
Physical compulsive behavior	$\equiv$ Physical activity $\sqcap$ compulsion
Physical activity	$\sqsubseteq$ Activity
Repeating rituals	$\equiv$ Compulsive behavior
Compulsive checking	$\equiv$ Compulsive behavior
Compulsive cleaning	$\equiv$ Compulsive behavior
Compulsive hoarding	$\equiv$ Compulsive behavior
Compulsive washing	$\equiv$ Compulsive behavior
Compulsive cleaning	$\equiv$ Compulsive behavior
Compulsive counting	$\equiv$ Compulsive behavior
Compulsive ordering	$\equiv$ Compulsive behavior
Mental compulsive behavior	$\equiv$ Mental act $\sqcap$ Compulsion
Mental act	$\sqsubseteq$ Activity
Mental praying	$\sqsubseteq$ Mental act
Mental counting	$\sqsubseteq$ Mental act
Compulsive checking	$\equiv$ Checking $\sqcap$ Compulsion
Checking	$\sqsubseteq$ Physical activity
Cleaning	$\sqsubseteq$ Physical activity
Hoarding	$\sqsubseteq$ Physical activity
Washing	$\sqsubseteq$ Physical activity
Counting	$\sqsubseteq$ Physical activity

Table 5 – continued from previous page

Concept	Description Logic
Ordering	⊑ Physical activity
Environmental Factor	⊑ Risk factor.
Social factor	⊑ Risk factor
Suicide factor	⊑ Risk factor
Genetic factor	⊑ Risk factor
Temperamental factor	⊑ Risk factor
Thought Appraisal	⊑ Appraisal process
Inflated responsibility	⊑ Thought appraisal
Overestimation of threat	⊑ Thought appraisal
Perfectionism	⊑ Thought appraisal
Over-importance	⊑ Thought appraisal
Intolerance of uncertainty	⊑ Thought appraisal
Assessment criteria	⊑ diagnostic process
Severity control level	⊑ Assessment criterion
Severity duration level	⊑ Assessment criterion
Severity resistance level	⊑ Assessment criterion
Severity distress level	⊑ Assessment criterion
Severity interference level	⊑ Assessment criterion
Normal routine impairment	⊑ Functional impairment
Occupational impairment	⊑Functional impairment
Relationship impairment	⊑ Functional impairment
Social impairment	⊑Functional impairment