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Development of the Hyperfocus Concept and Analysis of an Initial Item Pool.

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Abstract

Hyperfocus (HF) refers to the phenomenon in which an individual presents an incremented state of selective attention, with a very engaging task, presence of time distortion; and less perceived irrelevant task stimuli. Most HF studies are done in the framework of ADHD, but HF also relates to psychiatric disorders that have severe consequences in attentional capacities. A few studies have attempted to develop questionnaires that measure HF, but they present shortcomings, as they tend to measure the consequences of HF, rather than the concept itself. In this study data from 369 subjects that answered an initial item pool was analysed. The item pool consisted of 45 items (items of the Hyperfocusing Scale, the dispositional subscale of the AHQ and new items). The goal was to develop an improved definition of the concept, by analysing the items of the item pool and to explore the multidimensionality of the concept. Preliminary results suggest that HF might be multidimensional and can be at least divided into Core HF and HF consequences. Nineteen items were identified as Core HF and clustered in seven factors: feelings of task engrossment, sustained attention, feeling of time contraction, ignoring personal needs, difficulty stopping tasks, failure to attend the world and single focus. This work broadened the scope of the HF definition and the scale that can be applied to a broad range of clinical populations in different contexts and can serve as a transdiagnostic tool.

Key words: hyperfocus, questionnaire development, initial item pool, core hyperfocus and attention.

Development of the Hyperfocus concept and analysis of an initial item pool.

Hyperfocus is a concept that refers to the phenomenon in which a person is completely absorbed in a task, to the point where the individual seems to lose the sense of perceiving himself and neglects the things and stimuli that surround him (Ashinoff & Abu-Akel, 2019; Ozel-Kizil et al., 2016).Ashinoff & Abu-Akel, (2019) have described four general standards to define and characterize hyperfocus. They consider hyperfocus as an intense state of selective attention (focus); where the task performed has to be incredibly engaging (it has a motivational component); the individual undergoes a distortion of the temporal experience (time); and the individual's perception of the environment or stimuli that are not relevant for the task is decreased. It is also believed that the task performance can be improved, but until now there is still a lack of consensus about this (Ashinoff & Abu-Akel, 2019; Hupfeld et al., 2019).

In general, the concept of hyperfocus had been mostly anecdotally mentioned and reported in the clinical practice, although in more recent years it has been scientifically studied by various research groups (Ashinoff & Abu-Akel, 2019; Ozel-Kizil et al., 2014, 2016). Hyperfocus has been related to disorders like ADHD (Attentional Deficit and Hyperactive Disorder), ASS (autism spectrum disorder) and SZ (Schizophrenia). These are neurodevelopmental and neurocognitive disorders that can have severe consequences in terms of attentional capacities (Hupfeld et al., 2019; Luck et al., 2019). Every of these psychiatric disorders, has also been reported to increase the extent of experiencing hyperfocus, which does not come to a surprise, since all three disorders seem to have a genetic component overlap (Consortium et al., 2013; Docherty et al., 2016; Smoller et al., 2013).

Although the study of hyperfocus is relatively new, and research into hyperfocus is still limited, most of its study has been done in the framework of ADHD, and there are a few

studies in the field of autism, and schizophrenia (Ashinoff & Abu-Akel, 2019). Even though there is no certainty that hyperfocus in these three groups refers to the exact same process (Ashinoff & Abu-Akel, 2019), in the clinical practice these disorders are strongly characterized by inattention symptoms (Clark, 2016; Sawaki et al., 2017) and executive functioning problems (Luck et al., 2014, 2019; Roberts et al., 2017). It seems then a little contradictory that patients can report and describe a phenomena like hyperfocus (American Psychiatric Association, 2013). But the presence of impairments and symptoms of inattention surely do not exclude the possibility to experience hyperfocus. This condition can be fairly explained by several theories. For the sake of this work, we will briefly mention two of them. The first one is for example, the theory of attention regulation deficits. Kaufmann et al. (2000), proposed that ADHD is not characterized by an inability to sustain attention, but rather by the inability to appropriately regulate the application of attention to tasks that are not intrinsically rewarding and/or that require effort (as cited in Groen et al., 2020). And the second one, for example in people with schizophrenia, the cognitive model proposes that hyperfocus impairs the ability of people to distribute attention among multiple locations, decreasing the number of representations that can simultaneously be maintained in working memory, and can cause attention to be abnormally captured by irrelevant inputs that share features with active representations which can also explain the cognitive and functional deficits in that disorder (Luck et al., 2019).It would then seem that hyperfocus is a construct that has been abstracted from sets of behaviours present in different psychiatric disorders. However, to these days there is no clear understanding of what the effect of experiencing hyperfocus would have in cognition for example, which is a domain particularly affected in people with psychiatric disorders (Millan et al., 2012), and it would be then important to develop tools that allow us to accurately assess hyperfocus in psychiatric disorders. It is then important to develop an instrument that can accurately measure hyperfocus and that can be

used as a transdiagnostic measure, because so far, no extensive research has been performed to know the incidence level of hyperfocus on psychiatric disorders.

As previously mentioned, most research in hyperfocus performed so far has been done in ADHD. In adults, experiencing hyperfocus states can have important consequences. For example, adults with ADHD that experience hyperfocus tend to have significant impairments related to social, academic, and occupational environments, which translates into functional daily life problems (Ozel-Kizil et al., 2016), as these daily life problems are positively related to the deficits in the regulation of attention, whether there is a lack of attention(inattention) or an exaggeration of it (hyperfocus). To these days there are only few scientific sources that have evaluated hyperfocus in relation to ADHD. One of the first attempts to measure hyperfocus was done by Ozel-Kizil et al., (2013, 2014), they developed the first clinical measure of hyperfocus "the Hyperfocus Scale" (HS), and showed that their instrument is a valid instrument to measure hyperfocus in adults with ADHD patients, and it seems to be more related to attention deficit and impulsivity than to hyperactivity. It also showed that people with ADHD have a higher level of hyperfocus than healthy controls (Ozel-Kizil et al., 2016). This work, was the first and a preliminary step towards measuring hyperfocus and its clinical features in ADHD. Another study is the one of Hupfeld et al., (2019), who introduced the "Adult Hyperfocus Questionnaire" (AHQ) which measures dispositional hyperfocus (the proneness to experience a heightened state of attentional focus during enjoyable or rewarding activities irrespective of the situation) and situational hyperfocus (the frequency of the phenomenon in specific dimensions like: timelessness, failure to attend to the world, ignoring personal needs, difficulty stopping and switching tasks, feelings of total engrossment in the task, and feeling "stuck" on small details; in three different settings or situations: "school", "hobbies" and "screen time"). This work showed that individuals with higher symptoms of ADHD had higher scores on the total HF (Hupfeld et al., 2019). This study was of clinical and

scientific relevance, as it was the first study that assessed HF in an adult sample with high ADHD symptomatology.

However, these studies have some limitations. The Ozel-Kizil et al. (2016) questionnaire (HS) had some methodological issues that were pointed out by the study of Hupfeld et al. (2019) and Ashinoff & Abu-Akel (2019). These limitations are related to the scale items, that might have been reflecting the executive functions issues or the negative consequences proper of ADHD as a disorder more than the hyperfocus phenomenon itself. Another limitation is the operationalization of the construct that focus on the clinical consequences hyperfocus (that only measures the negative consequences). The questionnaire developed by Hupfeld et al. (the AHQ) better represents the non-ADHD and ADHD populations. However, the AHQ instrument has some shortcomings as well. Even though they provide an operational definition of hyperfocus, their questionnaire does not isolate the concept from the consequences, and the items were phrased on a way in which participants answered by recognizing the situational aspect (activities that were rewarding), rather than considering a more general component (defining hyperfocus independently from this situational/motivational component). Although Hupfeld et al., (2019) gave an operational definition of hyperfocus, it did not differentiate between the construct itself and the consequences of experiencing hyperfocus. In addition, this study could only find some of the proposed dimensions (losing track of time, failing to notice the world, failing to attend personal needs, difficulty stopping and moving to a new task, feeling totally engrossed in the task and feeling “stuck) and they either explained too little variance or were not reliable (as were only represented by very few items). It is important then to bring attention to the development of an operational definition of hyperfocus that only focuses on the construct itself. This will facilitate the development of new research directed on the assessment of hyperfocus and its underlying mechanisms in psychiatric populations, but also in healthy

ones. For example, quite recently, Groen et al. (2020) published a study where they explored the association between the frequency, length and generality of hyperfocus in healthy adults and patients with ADHD in different circumstances. They found that ADHD traits in healthy adults are correlated with hyperfocus, and that hyperfocus in people with ADHD is less likely to occur in educational and social situations of this patients. Concluding that experiencing hyperfocus is not a specific trait of a psychiatric disorder.

An improved concept could then be used to create a new and proper instrument that measure the construct experience. Based on theoretical principles, practical issues and pragmatic decisions in the process of objective scale development (Clark & Watson, 1995, 2019), the content of an initial item pool was assessed. The creation of an initial item pool is a decisive step in scale construction (Clark & Watson, 1995). This is a new instrument intended to measure the hyperfocus construct and consisted of a series of items developed to systematically sample all the content that is potentially relevant for the target construct (hyperfocus). The initial item pool consisted of items from the HS scale, the AHQ scale and newly developed items that may reflect new dimensions that were not reported on both the HS and the AHQ questionnaires. It was important to contemplate the previous questionnaires to analyse the items content that could be of use for the new item pool. Some of the items borrowed from previous studies were modified to solve issues like items that are double-barrelled (items that measure the concept and the consequences of hyperfocus at the same time), to also include new dimensions like productivity, etc., and to evaluate the negative consequences. Taking into account the theoretical framework of scale construction, this work departed from the analysis and clarification of those items previously reported by previous studies (Ozel-Kizil et al., 2013, 2016; Hupfeld et al., 2019). The items used were categorized according to the six dimensions conceptualized by Hupfeld et al. (2019): (1) timelessness, (2) failure to attend to the world, (3) ignoring personal needs, (4) difficulty stopping and

switching tasks, (5) feelings of total engrossment in the task, (6) feeling “stuck” on small details, and also introduced new categories according to the factors of procrastination and time management (seen in novelty asks) identified by the EFA performed on the HS (Ozel-Kizil et al., 2016) and the dimension of increased productivity proposed by Hupfeld (2019). This is an important step, because in the current state of the scale development, it is useful to understand weather hyperfocus has positive and negative consequences, this is beneficial for the clinical relevance of the instrument.

To investigate the construct validity hyperfocus, the Loevinger's theoretical approach to scale development was followed and applied. The principle of initial item pool is articulated as follows: "The items of the pool should be chosen so as to sample all possible contents which might comprise the putative trait according to all known alternative theories of the trait" (p. 659; Loevinger 1957 in Clark & Watson, 1995, 2019). Because this study focused on the initial scale development, attention was only set to the substantive and structural components to address the internal validity of the hyperfocus initial item pool (Clark & Watson, 1995, 2019). Substantive validity was implemented to assess if the factors obtained can be interpreted as consequences and core hyperfocus (extent to which the measures are theoretically linked to the construct of hyperfocus; Holden & Jackson, 1979); structural validity was performed to assess how the items of te initial item pool correlate with each other. The main aspects of these approaches were to ensure that through the exploratory factor analysis of the initial item pool the underlying structure in the inter-item correlation of the item pool could be revealed. This allows to separate the items (explore dimensions) that measure the construct itself and those that measure the consequences of experiencing hyperfocus (positive and negative)., which were important shortcomings of the previous developed scales by Ozel-Kizil et al. (2013, 2016), and Hupfeld et al. (2019). The analysis also helps to extract and find the best structure and factors solution of the initial item pool that

is easier to interpret than the previous ones reported by Ozel-Kizil en Hupfeld (2013, 2016, 2019). This study focused on the elements of substantive and structural validity previously mentioned to distinguish between hyperfocus as a phenomenon and its consequences. Previous studies are valid from the structural point of view, but their substantive validity is quite poor, since they measure hyperfocus consequences rather than the concept itself. The goal of the study was to reveal the structure of the item pool which is composed of items that represent all the previous proposed definitions and operationalizations of the concept.

The aims of this thesis were then to develop and expand a clear conceptualization of hyperfocus as a target construct, separating it from its consequences, based on previous theoretical background and operationalizations of the concept. This include finding items that are double-barrelled (items that measure both the concept and its consequences), analyse the newly developed items that include the different dimensions proposed in the literature, perform an exploratory factor analysis that will reveal if the concept is unidimensional or multidimensional. Another goal of this work was to select items of the initial item pool that would be useful in the interpretation and assessment of the construct. And lastly to investigate the different situations in which hyperfocus occurs, not only on those specific activities that have been already related to the experience of hyperfocus. It is important to develop a measure that assess hyperfocus in more general activities, that can be used in the future as a transdiagnostic tool (for clinical relevance).

Elucidating and broadening hyperfocus as a construct will then help us to: 1) gain further clarification of the phenomenon, separating the concept itself from the consequences of experiencing it, 2) understand if it is a multidimensional or unidimensional construct, 3) develop scales that focus on the measurement of the concept and not the consequences, and 4) develop a transdiagnostic scale that measures the concept in general environments.

Methods

Participants

Five hundred and forty-seven participants were recruited in The Netherlands via the researcher's contacts, social media, and 1st year SONA students). Based on the exclusion criteria (correctly answer the BOGUS questions and having fully completed the questionnaire), a total of n=369 participants were recruited. The respondents participated voluntarily and received no monetary payment for completing the questionnaire, but for those students from the psychology 1st year SONA practicum pool a compensation of course credits was provided for taking part in the study. The SONA students were first year psychology students. Participants were aged between 18 and 73 years, with a mean of 25 years. 66% of the participants were females. Even though the participants sample had different nationalities, the most prevalent was Dutch with 18.46%. Most participants were students 58.8% which 43.8% had a university degree or higher All participants were healthy adults and completed the questionnaire in the English language (For more details see Table 1).

Table 1.

Demographic characteristics of participants answering the questionnaire.

Demographic Characteristic	N	%
Age		
18-30	351	86.02
31-40	29	7.11
41-50	11	2.70
51-60	15	3.67
60+	2	0.49

Gender		
Female	274	66
Male	140	33.7
Other	1	0.2
Ethnicity		
Dutch	101	18.46
German	118	21.57
Czech	26	4.75
Other nationalities	302	55.21
Education		
Primary school	3	0.07
Secondary school	74	17.8
Higher education	156	37.6
University (Bachelor's or Master's degree)	176	42.4
Doctorate	6	1.4
Current status		
Student	244	58.8
Working student	79	19
Working	92	22.2
Pre-existing medical conditions©		
Diagnosed	97	23.4
No medical condition	265	63.9
Never diagnosed, but suspected	53	12.8
Substance use **		
Yes	63	15.2

No	314	75.7
Yes, but not sure about effects on concentration	38	9.2

** Conditions or use of substances that can affect concentrations

Materials

An initial item pool was developed based on the eleven items of the Hyperfocusing Scale (OK, Ozel-Kizil et al., 2013), the 12 items of the dispositional subscale of the AHQ (Modified_AHQ, Hupfeld et al., 2019) and twenty-two new items (HS_item). The items were categorized according to their content-based definitions provided on the previous questionnaires and literature (procrastination, time management, increased productivity, etc). New items were developed to assess missing categories (e.g. productivity, procrastination, time management) in order to broaden the concept definition of hyperfocus. The item pool consisted of 45 items that must be answered for both situational and dispositional approaches. All items were required to be answered both in particular situations as in general situations.

The instructions to answer situational and dispositional items were given. For each item (e.g., "I try to give my best") participants were asked to indicate: (1) how often it occurs when they are doing something that is enjoyable, rewarding or interesting (i.e., taking into account only this kind of experience) and (2) how often it occurs when they are doing something in general (i.e., taking into account your overall experience irrespective of whether it was enjoyable, rewarding or interesting). To ensure validity responses, 6 “bogus” items were included to the questionnaire (3 situational and 3 dispositional), and participants were excluded of the analysis if they have more than one incorrect validity response. The questionnaire was administered to all participants. The participants indicated their level of agreement on a 6-point Likert scale, and after data was collected it was archived at the repository of the University of Groningen. All participants voluntarily filled the questionnaire

while reflecting on their own knowledge and experience during states of increased concentration. In addition, they were asked about difficulties in attention and cognitive control (such as how often do they have trouble wrapping up the final details of a project, or if they have difficulty getting things in order when you have to do tasks that requires organization, the frequency in which they have problems remembering appointments or obligations or make careless mistakes when they have to work on an unpleasant or difficult project, among others).

The questionnaire included extra items where questions about demographic characteristics including age, nationality, sex, level of education, current status, work, sex, neuropsychological or neuropsychiatric diagnoses that might affect the ability to concentrate, use of medication(s), and the use substances. A question about having been diagnosed with a mental illness that disrupts attention was also included and if the answer was yes, several other options were given to know what the condition was. The participants answered both the questionnaire and the form online via Qualtrics, and only participants that fully completed the questionnaire were considered for the data analysis. The study was approved by the Psychology Ethical Committee at the University of Groningen (RUG), the Netherlands. All the data was treated confidentially.

Procedure

Participants were requested to read the instructions. Then they voluntarily filled out the informed consent. The situational items were first presented, followed by the dispositional ones. Next, the questions about difficulties in attention and cognitive control were presented and lastly the participants hat to fill in the demographic questions.

Statistical Analysis

All statistical analyses were performed with the Statistical Package for the Social Sciences (SPSS), Version 25. The first step was to clean the data. Data was cleaned based on the questionnaire's percentage completion (100 to 99%) and the responses of the "bogus" items, that were used to control for thoughtless responding. Participants that had at least one bogus answer incorrectly answered were removed from the sample. Then, the next step was to perform a descriptive analysis for the demographic variables. Then the assumptions of normality and descriptive statistics of the forty-five dispositional items were checked, in order to look for items with low or high base rate (Mean, Std. Deviation, Median, Maximum. Minimum, Interquartile Range, Skewness, and Kurtosis). Taking these parameters into account we selected the items (twelve of the forty-five) that did not fulfil the assumptions for parametric tests (problems with Skewness and Kurtosis). These items had to be transformed, because skewed data violates the assumption of normally distributed data that aversively affect our models, and problems with kurtosis mean that the distribution either is flatter or elongated than a normal curve with the same mean and SD. The transformations used were square root, cube root, inverse, Log10 and Log transformations. After transformations, an analysis was performed to search for multivariate outliers (Mahalanobis distance test) and the outliers were also selected and excluded from further analysis. Linearity was also checked for each transformed variable against the rest of the forty-four items using bivariate scatter plots for residual versus predicted value. Then interitem correlation was checked and those values under values of 0.300 or over 0.800 were discarded for the next analysis.

Afterwards a Principal axis factoring (PAF) was performed and based on those results; a parallel analysis and an exploratory factor analysis (EFA) were implemented to determine the number of factors to be retained. Different rotations were performed to measure and evaluate how the variables were associated with the identified factors. The parallel analysis

and the EFA were performed as many times as needed based on the number of items retained in each step of the process.

Results

Assumptions

Assumption of normality were met in most items. The distribution of the mean was normal. Descriptive statistics of every item showed items that have severe skewness and kurtosis problems (Table 2). Twelve items did not fulfilled the assumptions of normality for parametric: OK_1, OK_2, OK_4, OK_5, OK_11,, Modified _AHQ_3, Modified_AHQ_7, Modified_AHQ_8, Modified_AHQ_9, Modified_AHQ6_func, Modified_AHQ10_func, and HS_item_84. Ten items transformed with square root transformation resulted in normal distributions: OK_1, OK_2, OK_11, Modified _AHQ_3, Modified_AHQ_7, Modified_AHQ_8, Modified_AHQ_9, Modified_AHQ6_func, Modified_AHQ10_func and HS_item_84, and the remanent two items OK_4, OK_5 were transformed with Log transformation to achieve a normal distribution as the square root transformation did not correct the normality distribution issues for these two items. All analyses were performed including the transformed items and they were considered to meet the assumptions.

An analysis to search for multivariate outliers (Mahalanobis distance test) was performed and the unusual scores were also selected and excluded from further analysis. Linearity was also checked for each transformed variable against the rest of the forty-four items using bivariate scatter plots for residual versus predicted value to check that the relationship between variables was linear. Based on the scatterplots, no variables had to be removed.

Table 2.

Descriptive statistics of dispositional items before transformation.

	Skewness		Kurtosis	
Item	Statistic	SE	Statistic	SE
OK_1[a]	1.05	0.12	0.97	0.23
OK_2[a]	0.94	0.12	1.07	0.23
OK_4[a]	2.18	0.12	4.95	0.23
OK_5[a]	1.51	0.12	2.34	0.23
OK_6	0.64	0.12	0.26	0.23
OK_7	0.84	0.12	0.14	0.23
OK_8	0.40	0.12	0.20	0.23
OK_9	0.54	0.12	0.57	0.23
OK_10	0.63	0.12	0.53	0.23
OK_11[a]	1.06	0.12	0.75	0.23
Modified_AHQ_1	0.67	0.12	0.56	0.23
Modified_AHQ_2	0.83	0.12	0.23	0.23
Modified_AHQ_3[a]	1.07	0.12	0.63	0.23
Modified_AHQ_4a	0.55	0.12	-0.02	0.23
Modified_AHQ_4b	0.27	0.12	-0.71	0.23
Modified_AHQ_5	0.40	0.12	0.18	0.23
Modified_AHQ_6a	0.50	0.12	-0.20	0.23
Modified_AHQ_6b	0.46	0.12	0.21	0.23
Modified_AHQ_7[a]	1.04	0.12	0.98	0.23
Modified_AHQ_8[a]	1.07	0.12	1.66	0.23
Modified_AHQ_9[a]	0.99	0.12	0.60	0.23
Modified_AHQ_10a	0.74	0.12	0.74	0.23
Modified_AHQ_10b	0.21	0.12	-0.84	0.23
Modified_AHQ_11	0.46	0.12	0.07	0.23
Modified_AHQ_12a	0.64	0.12	0.24	0.23
Modified_AHQ_12b	0.35	0.12	-0.31	0.23
Modified_AHQ_4func	0.52	0.12	-0.08	0.23
Modified_AHQ_6func[a]	0.92	0.12	0.90	0.23
Modified_AHQ_10func[a]	0.88	0.12	0.87	0.23
HS_1.1.1__67	0.57	0.12	0.14	0.23
HS_1.1.2__68	0.67	0.12	0.10	0.23
HS_1.2.5__69	0.50	0.12	-0.12	0.23
HS_1.3.1__70	0.61	0.12	-0.13	0.23
HS_item_71	0.71	0.12	0.65	0.23
HS_1.4.1__72	-0.05	0.12	-0.49	0.23
HS_1.5.1__73	0.73	0.12	0.28	0.23
HS_1.7.1__74	0.39	0.12	0.09	0.23
HS_1.7.2__75	0.33	0.12	-0.02	0.23

HS_5.2.1__78	0.73	0.12	0.14	0.23
HS_5.2.4__79	0.31	0.12	-0.59	0.23
HS_5.3.1__80	0.83	0.12	0.55	0.23
HS_item_81	0.67	0.12	0.19	0.23
HS_item_82	0.55	0.12	0.06	0.23
HS_item_83	0.61	0.12	0.30	0.23
HS_item_84[a]	1.04	0.12	0.99	0.23

[a] = Items with skewness/kurtosis issues.

Initial extraction with PAF and communalities

An initial extraction was performed with a Principal Axis Factoring (PAF). The goal of this first extraction was to achieve a simpler structure in order to improve interpretability. To perform this analysis and to meet the factor analysis preconditions initial commonalities were looked for and if an item did not share variance with the others and had low commonalities (looked for the common variance, and checked how each item correlates with the others; a value of above 0.5 is considered to be ideal, and lower than 0.3 is then low), then it would not be considered for the second phase of the questionnaire construction. It was assured that there were no extreme correlations between items (<0.300 and >0.800 considered too low or too high correlations), as it can be indication that those items do not properly measure one underlying factor. Items with too low or too high correlations were excluded. Two items had to be excluded because they had too low commonalities and do not share variance with the others, and were not considered for the next analysis steps: items HS_1.4.1__72 and HS_1.5.1_73. They focused on measuring if during a hyperfocus state the task performance improves (e.g. the individual concentrate state is so high that doing other things at the same time do not distract him from he is doing).

Parallel analysis

The same two items excluded on the PAF (HS_1.4.1__72 and HS_1.5.1_73) had low loading factors (which are the correlation of an original item with a factor and are used to

determine the importance of a variable to a factor and therefore to interpret and name the factor), which made the decision to exclude these items final. After excluding those items, the factor loadings obtained were considered definitive. Therefore, after the initial extraction and the deletion of items with low commonalities, a parallel analysis was performed on the forty-three items that were preserved. This analysis was used to determine the number of factors to retain from the factor analysis. Essentially a random dataset with the same numbers of observations and variables as the original data (MonteCarlo Simulation) was created and then the eigen values were generated based on a 5000 random sample of the current data, that included a total of 370 participants and 43 variables. All raw data values that were lower than the generated data, were discarded. The PFA EFA calculated the eigen values, and extremely low eigenvalues were excluded because eigenvalues close to zero imply that there is multicollinearity between items. The EFA then suggested that only eight factors with an eigenvalue of 0.5 or more should be retained. The Kaiser-Meyer-Olkin Measure of sample adequacy was 0.935 which indicated an adequate sampling and the Bartlett's test of sphericity indicated that the variables used were related and suitable for structure detection ($X^2(43) = 7652.089$, $p<.001$).

Table 3.

Pattern Matrix of the eight factors obtained with the EFA and Promax rotation.

	Factor							
Item	1	2	3	4	5	6	7	8
Modified_AHQ_10func_8	**0.883**							
sqrtModified_AHQ_6func_8	**0.759**						0.217	
Modified_AHQ_12a_8	**0.695**							
Modified_AHQ_4func_8	**0.669**							
OK_6_8	**0.568**		0.337					0.206
Modified_AHQ_6a_8	**0.553**					0.230		
Modified_AHQ_10a_8	**0.402**			0.237				
OK_7_8	**0.372**				0.328	-0.202		

OK_10_8	**0.345**						0.294
HS_1.7.2__75__8		**0.816**					
HS_1.7.1__74__8		**0.632**					
HS_5.2.1__78__8		**0.482**		0.264			
sqrtOK_2_8			**0.708**				
logOK_5_8			**0.650**				
sqrtOK_1_18			**0.552**	0.332			
logOK_4_8			**0.536**				
Modified_AHQ_2_8				**0.705**			
sqrtModified_AHQ_8_8				**0.683**			
Modified_AHQ_1_8				**0.560**	0.202		0.222
sqrtModified_AHQ_7_8				**0.544**	0.296		
Modified_AHQ_11_8				**0.272**			0.259
sqrtModified_AHQ_9_8		-0.295		0.261	**0.731**		
sqrtHS_item_84_8					**0.658**		
HS_item_83_8					**0.652**		
sqrtModified_AHQ_3_8		-0.205			**0.630**		
HS_5.2.4__79__8		0.249			**0.518**		
HS_5.3.1__80__8					**0.478**		
HS_item_81_8		0,232			**0.444**		0.235
Modified_AHQ_4a_8	0.322				**0.374**		
HS_item_82_8	0.363				**0.367**		
sqrtOK_11_8			0.259		**0.303**		
Modified_AHQ_10b_8						**0.793**	
Modified_AHQ_12b_8						**0.754**	
Modified_AHQ_4b_8						**0.587**	0.298
Modified_AHQ_6b_8	0.224					**0.516**	
HS_1.1.2__68__8							**0.738**
HS_1.1.1__67__14							**0.634**
HS_1.2.5__69__8							**0.395** 0.327
OK_9_8							**0.622**
OK_8_8							**0.580**
HS_1.3.1__70__8		0.324					**0.356**
HS_item_71_8		0.227				0.245	**0.286**
Modified_AHQ_5_8				0.236	0.201		**0.256**

Principal Axis Factoring. Rotation Method Promax. Rotation converged in 8 interactions.

Table 3 shows the factor loadings for the 43 different items on the eight different factors (only loading greater than ±0.2 are displayed). Factors one, two and six contain high loading items that focus on measuring consequences of experiencing hyperfocus (like forgetting to complete other tasks or activities, getting stuck in small details, postponing things, etc). Factors four, seven and eight have also high loading items that focus on measuring core hyperfocus (like ignoring the environment, lose track of time, ignoring self

needs among others). And factors three and five are conformed of high loading items that are a mix of items that measure both, core hyperfocus and consequences of hyperfocus (not noticing what is going on outside, difficulty to stop with the task, neglecting the self and others, disruption in relationships, exhaustion, etc). In general, these eight factors identified core characteristics or consequences of hyperfocus. The analysis indicated that nineteen of the items that loaded in one or more factors are related to core hyperfocus and twenty to the hyperfocus consequences.

The items correlated to core hyperfocus were: sqrtOK_1, logOK_4, OK_8, OK_9, Modified_AHQ_1, Modified_AHQ_2, sqrtModified_AHQ_3, Modified_AHQ_5, sqrtModified_AHQ_7, sqrtModified_AHQ_8, sqrtModified_AHQ_9, Modified_AHQ_11, HS_1.1.1__67, HS_1.1.2__68, HS_1.2.5__69**,** HS_1.3.1__70, HS_item_71, HS_item_81, HS_item_83. A detailed description of these items can be found on supplementary table 1. The items correlated to hyperfocus consequences were: sqrtOK_2, logOK_5, OK_6, OK_7, OK_10, sqrtOK_11, Modified_AHQ_4a, Modified_AHQ_6a, Modified_AHQ_10a, Modified_AHQ_12a, Modified_AHQ_4func, sqrtModified_AHQ_6func, Modified_AHQ_10func, HS_1.7.1__74, HS_1.7.2__75, HS_5.2.1__78, HS_5.2.4__79, HS_5.3.1__80, HS_item_82 and sqrtHS_item_84. A detailed description of these items can be found on the supplementary table 1.

Core Hyperfocus extraction and communalities

Given that one of the goals of the current study find items that properly evaluate the concept of hyperfocus apart from its consequences, it was decided to proceed with another extraction, on the nineteen items that were correlated to Core Hyperfocus after the first extraction. The extraction was again performed with the PAF method with a Promax rotation. The inter-item correlation between these nineteen items showed no change between the first and second analysis, so no items were discarded.

Parallel analysis Core Hyperfocus items

A second parallel analysis with the nineteen items that measure Core Hyperfocus was performed to determine the number of factors to retain in the factor analysis. This parallel analysis suggested that only seven factors with an eigenvalue of 0.19 or more should be retained. The Kaiser-Meyer-Olkin Measure of sample adequacy was 0.935 and indicated that the sampling for the factor analysis was adequate. The Bartlett's test of sphericity suggested that there was significant correlation in the factor analysis ($X^2(19) = 7352.09$, $p < 0.001$). Table 4, shows the factor loadings for the nineteen core hyperfocus items on the seven different factors (only loading greater than ±0.2 are displayed).

The EFA with Promax rotation (table 4) showed the high loadings items that have the most influence on each factor. Factor rotation made the loading structure simpler, which facilitates the interpretation of the factor loadings. Items sqrtModified_AHQ_8, Modified_AHQ_2 and sqrtModified_AHQ_7 have large positive loadings on factor one which reflects feelings of total engrossment in the task (e.g. AHQ2: I can be so focused that I do not notice the world around me, and I won't realize if someone calls my name or if my phone buzzes; AHQ8: I can be so focused that I don't react to any distractions); this factor explains 38.62% of the variance. Item Hs_1.3.1_70 has a large factor loading in factor two which describes that the subjects can have periods of prolonged attention without needing a break (e.g. HS_70: I can concentrate for long periods of time without needing a break), this factor explains 8.36% of the variance. Items OK_9 and OK_8, have high loadings on factor three which reflects feelings of time contraction (e.g. OK_8: Although I have been concentrating for a long time, it seems to me as if it was shorter; OK_9: I can be so focused that it feels that time flies by); this factor explains 6.45% of the variance. Item SqrtModified_AHQ_3 has a large loading factor in factor four which describes neglecting basic needs like eating, sleeping or going to the bathroom (e.g. AHQ_3: I can be so focused

that I might accidentally miss meals, stay up all night, or keep doing the activity until I absolutely must get up to go to the bathroom); this factor explains 5.40% of the variance. Items HS_item_81 and HS_item_83 have large loading factors in factor five which describes the difficulty to stop or switching a task (e.g. HS_81: I can be so focused that I find it very difficult to stop doing it; HS_83: I can be so focused that it is hard to put it aside and leave it for another time); this factor explains 4.74% of the variance. Item OK_1 has a high loading on factor six which reflects failure to attend the world (e.g. OK_1: I can be so focused that I don't notice, hear or react to things around me even when repeatedly addressed); this factor explains 4.35% of the variance. And finally, item HS_1.1.2_68 has a large factor loading on factor 7, which describes the capacity to set the attention on a single object or task (e.g. HS_68: I can fixate my attention strongly on a particular aspect of an image or object and fail to notice everything else around it); this factor explains 3.98% of the variance. Together, all seven factors describe 71.88% of the variation in the data. Although some items have many loadings on different factors, these are not high enough to have a strong influence on the factor they describe. A full description of the items per factor and the dimension they reflect is given on table 5.

Table 4.

Core Hyperfocus items Pattern Matrix of the seven factors obtained with the PFA and Promax rotation.

Item	Factor						
	1	2	3	4	5	6	7
sqrtModified_AHQ_8	**0.768**					0.248	
Modified_AHQ_2	**0.753**						
sqrtModified_AHQ_7	**0.700**						
Modified_AHQ_1	**0.642**						
Modified_AHQ_11	**0.490**				0.278		
Modified_AHQ_5	**0.424**				0.261		
HS_1.3.1__70		**0.792**					
HS_item_71		**0.513**					

HS_1.2.5__69		**0.466**				0.250
OK_9			**0.784**			
OK_8			**0.756**			
sqrtModified_AHQ_3				**0.892**		
sqrtModified_AHQ_9	0.225			**0.490**	0.212	
HS_item_81					**0.813**	
HS_item_83					**0.810**	
sqrtOK_1						**0.636**
logOK_4						**0.564**
HS_1.1.2__68						**0.829**
HS_1.1.1__67__						**0.655**

Principal Axis Factoring. Rotation Method Promax. Rotation converged in 7 interactions.

Table 5.

Full description of the seven factors for Core hyperfocus.

Factor	Items	Dimensions
1	AHQ2 ...I can be so focused that I do not notice the world around me, and I won't realize if someone calls my name or if my phone buzzes. AHQ8 ...I can be so focused that I don't react to any distractions (e.g., if someone talks to me). AHQ1 ...I can be so focused that I tend to completely lose track of the time. AHQ7 ...I can be so focused that I can be unsure of what time of day it is or how much time has passed since I started the activity. AHQ11 ...I can be so focused on an activity that I feel completely engrossed or fixated with it. AHQ5 ...I can be so focused that I feel totally captivated by or "hooked" on the activity.	Feelings of total engrossment in the task
2	HS70 ... I can concentrate for long periods of time without needing a break. HS71 ... I can be so focused that I find it difficult to move my attention away from it. HS69 ... I can be completely engrossed or fixated with an activity for hours.	Sustained attention
3	OK9 ...I can be so focused that it feels that time flies by. OK8 ...Although I have been concentrating for a long time, it seems to me as if it was shorter.	Feeling of time contraction
4	AHQ9 ...I can be so focused that I forget to attend to my personal needs (e.g., I forget to sleep or eat or I wait until the last minute to go to the bathroom). AHQ3 ...I can be so focused that I might accidentally miss meals, stay up all night, or keep doing the activity until I absolutely must get up to go to the bathroom.	Ignoring personal needs.

5	HS83 …I can be so focused that it is hard to put it aside and leave it for another time. HS81 ...I can be so focused that I find it very difficult to stop doing it.	Difficulty stopping and switching tasks
6	OK1 ...I can be so focused that I don't notice, hear or react to things around me even when repeatedly addressed OK4 ...I can be so focused that the world could fall apart and I would not notice.	Failure to attend the world
7	HS68 ...I can fixate my attention strongly on a particular aspect of an image or object and fail to notice everything else around it. HS67 ... I can become so completely focused on a single thing that I'm oblivious to everything else.	Single focus

Factor's correlations

As mentioned before, the parallel analysis showed that the 19 Core hyperfocus items can be classified in seven factors. We inspected the correlation among these factors. This is an important aspect to consider, because if the factors correlations are too low (<0.300), it can be an indication that the factors are not measuring the same underlying construct. On the other hand, if the correlations are too high (>.700), it can be an indication that the factors might be overlapping. Our results (table 6), show that factor six has low correlations with factors two and three, which can indicate that these particular factors are not particularly/strongly measuring the underlying concept of hyperfocus or can be measuring different things. Factor five has a very high correlation with factor one, which can be indicating that these factors reflecting feelings of total engrossment and difficulty stopping with a task can be overlapping and share similarities.

Table 6.

Factor's correlations

Factor	1	2	3	4	5	6	7
1	-						
2	0.540	-					
3	0.601	0.592	-				
4	0.627	0.305	0.415	-			

5	0.713	0.657	0.668	0.588	-	
6	0.524	0.229	0.239	0.352	0.341	-
7	0.551	0.567	0.422	0.452	0.595	0.401	-

Factor correlation matrix. Extraction method: Principal axis factoring. Promax rotation with Kaiser normalization.

Discussion

The present study intended to get a first overview of the core concept of hyperfocus based on previous research definitions and operationalizations of the construct. Based on previous research and hyperfocus questionnaires developed in the past years, an initial item pool was developed to further explore the components that define the hyperfocus concept, to determine if the concept has or not different dimensions, and to further disentangle the concept from its consequences.

Hyperfocus was evaluated on different elements previously established by the work of Ozel-Kizil et al., (2013, 2016) and Hupfeld et al., (2019): Failure to attend the world, ignoring personal needs, feeling of total engrossment in the task, difficulty stopping and switching tasks, timelessness, and feeling "stuck" in small details. The previous studies that developed scales to measure hyperfocus, considered other dimensions like productivity, procrastination and time management but their analysis did not reported them as part of the construct. Our results showed that t initial item pool consisted of seven factors: feelings of engrossment in the task, sustained attention, feeling of time contraction, ignoring personal needs, difficulty stopping tasks, failure to attend the world and single focus.

In the past research, the dimensions of hyperfocus have been overlooked and it was not clearly established if hyperfocus was a unidimensional or multidimensional construct. Some of the items took and adapted from previous questionnaires (HS and AHQ), were focused on measuring the consequences and associations of experiencing hyperfocus (e.g.,

intrinsic motivation), rather than measuring the concept on its own (core hyperfocus). Based on the seven emerging factors and how they related to each other it is possible to have the idea of whether they represent the same or different dimensions. However, although after the analysis of multidimensionality of the concept emerged, due to the limited reliability on most factors (and low variance explained) it is still not possible to assure that hyperfocus is a multidimensional construct, these results only point out that many different aspects of the related phenomena are been assessed (items represented either Core HF and HF consequences). The factor analysis suggested that the items related to core hyperfocus dimension are relevant for the definition of the concept. Overall, this provides the first impression that in the initial item pool consists of items that assess different aspects of hyperfocus that can now be disentangled and further investigated in the next phase of the study.

In those identified items from Core HF, our analysis revealed seven factors, in comparison with the study of Ozel-Kizil et al. (2016), were only one factor or dimension was found. However, in the present study factors three, four, six and seven presented only two items, which limit the measurement of reliability. In contrast, the work of Ozel-Kizil et al., (2013, 2016) found very small factors, and there was no distinction in their factors between Core HF and HF consequences. A similarity between our results and those of the work previously mentioned, is that our analysis also found the factor “failure to attend the world” (dimension found on the Ozel-Kizil work), but we also collected evidence of other strong dimensions like: feelings of total engrossment in the task, and sustained attention. The EFA outcomes, suggested then that the hyperfocus dimensions found: feeling total engrossment in a task, sustained attention, feeling of time contraction, ignoring personal needs, difficulty stopping and switching tasks, failure to attend the world and single focus are important to determine a profile of hyperfocus. From these factors obtained, sustained attention, feeling of

time contraction and single focus seem to be “new factors” relative to what previous studies have found, revealed by the analyses performed. Although as previously mentioned it is premature to fully establish if hyperfocus is a multidimensional construct, finding dimensions previously found in other questionnaires and finding new possible dimensions represents a good advance in the definition of the construct. However further work need to be done and more items need to be developed, so that the dimensions can be measure on a more reliable way and then and further enrich and complete a scale that can purely assess the construct.

Although this is not the first study that tries to create a clearer definition of hyperfocus as a construct (Ashinoff & Abu-Akel, 2019), this is the first study that clearly suggests that some of the items of the previous questionnaires load on “core factors” and others on “consequences factors”, which suggests that it is very possible that the previous questionnaires were measuring both factors together (core hyperfocus as much as its consequences). Some examples of these items are: OK_6: I can be so focused that I postpone important things I have to do; OK_10: I postpone other things that I have to do because I am completely absorbed in an activity for hours; AHQ_4func: I can be so focused that I postpone other important things I should be doing; and AHQ_6func (OK3): I can be so focused that I fail to complete other important parts of the current task.

Lastly, the definition given by Ashinoff and Abu-Akel of hyperfocus is: “a phenomenon that reflects one’s complete absorption in a task, to a point where a person appears to completely ignore or ‘tune out’ everything else” (Ashinoff & Abu-Akel, 2019). With the information extracted, this work shows that the core hyperfocus could be composed of several dimensions, some of which were not included in this definition. Compared to those seven dimensions, this definition seems to be a bit narrow, and it might need to be expanded once the factors can be more reliably measured.

Limitations

Although this study suggests that hyperfocus might be a multidimensional construct, the explained variance of the last factors obtained in the analyses was very small (between 3 and 5% for factors four, five, six and seven), which provides the advantage of not missing potential dimensions of core hyperfocus that could be relevant for the second phase of the item pool development, but on the other hand can make the factors a bit less reliable, especially because these factors are also conformed of two items each (reliability is usually achieved with at least four items per dimension).

Another aspect that is important to consider and highlight, is the extent in which the sample studied represents the target group population (clinical population). This could have implications in the validity of our study (internal and external). The main differences between the population used in the study and a more general/clinical population relies on the fact that the sample used tend to be healthier, younger and with a higher education level than the general populations and the target population. It is important to consider this aspect and to broaden the population sample on further stages of the item pool assessment, because then a hyperfocus scale would be most useful in clinical populations (Adams et al., 2013; Leentjens & Levenson, 2013; Lumley & Jasinski, 2013). Another important aspect to consider is that although the population used on the pilot gave their consent to participate in the study, in general, the students of the population also had an obligation to participate in research as part of their programs which can decrease the voluntary aspect of the study. Therefore an important aspect that should be considered on the next phase is to use a sample that involves a good deal people that are not considered students (a more general sample). This could be for instance add external validity to the scale, and then it could be consider that the participants take part completely voluntarily, adding internal validity. Only then we could control for group variables that can influence the generality of hyperfocus.

Another limitation is related to the way items had to be responded. In this pilot phase a Likert scale was implemented, and although practical, one of the down sides of using this type of scales is that it results difficult to deal with neutral options, because they can generate acquiescence bias (the tendency for survey respondents to agree with research statements, without the action being a true reflection of their own position or the question itself). The formulation of the way the items are responded could be changed on the next phase of the research.

To be able to develop a broader scale that can in fact measure hyperfocus and can be of clinical use, it is important to get proper reliability values that allow the expansion of the scale, and develop better new items that can allow us to improve the definition of the concept. Therefore on the second phase of the scale development, measurements of reliability, and further structural validity studies with the inclusion of new items will have to be provided as well as to stablish test-retest reliability to prove that the construct is stable would have to be done. It is important to consider that the new cluster of items need to not only be reliable, but homogeneous (the breath of the construct or dimension), because these are important factors to validate the factors and therefore the questionnaire.

Conclusion

This study contributed to get a better understanding of hyperfocus as a construct in healthy subjects. It gave the preliminary idea that hyperfocus might be a multidimensional concept, and showed that both, its core characteristics and consequences can be measured, and that previous studies were assessing in part the consequences of hyperfocus, not only the concept itself. The results also showed that there are more dimensions of hyperfocus to consider, than the ones already proposed in previous studies, and therefore the definition given by Abu-Akel seems to be a narrow definition. However, further research is needed to reach this point, as even though the factor analysis showed that core hyperfocus can be

constituted of seven dimensions, some of them lack sufficient reliability, which is a problem that needs to be addressed in the near future by developing new items.

The preliminary results of this study and the further development of the instrument, can have relevant future implications in the field of Clinical Neuropsychology, as hyperfous has been recognized as a trait of clinical populations with severe mental illness and disorders like ADHD, Austism spectrum disorder and Schizophrenia. If an instrument that reliably assess hyperfocus on a healthy population (produces similar results under consistent conditions) is developed, it can then be considered to use it on clinical populations, and even so consider its use as a transdiagnostic tool.

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Appendix Supplementary table 1

Hyperfocus Questionnaire

	Item
1	OK1 ...I can be so focused that I don't notice, hear or react to things around me even when repeatedly addressed
2	OK2 ...I can be so focused that I neglect myself and those around me.
3	OK4 ...I can be so focused that the world could fall apart and I would not notice.
4	OK5 ...I spend so much time concentrating on something that my relationships with others are disrupted.
5	OK6 ...I can be so focused that I postpone important things I have to do.
6	OK7 ...I am late to places where I should be because I cannot stop what I am doing.
7	OK8 ...Although I have been concentrating for a long time, it seems to me as if it was shorter.
8	OK9 ...I can be so focused that it feels that time flies by.
9	OK10 ...I postpone other things that I have to do because I am completely absorbed in an activity for hours.
10	OK11 ...I can focus for so long that afterwards I feel pain in various parts of my body that I didn't notice while I was doing it.
11	AHQ1 ...I can be so focused that I tend to completely lose track of the time.
12	AHQ2 ...I can be so focused that I do not notice the world around me, and I won't realize if someone calls my name or if my phone buzzes.
13	AHQ3 ...I can be so focused that I might accidentally miss meals, stay up all night, or keep doing the activity until I absolutely must get up to go to the bathroom.
14	AHQ4a ...I can be so focused that I find it very difficult to quit and move on to doing something else, even if I have a lot of other important things I should be doing instead.
15	AHQ4b ...I can be so focused that I find it very difficult to quit and move on to doing something else, but I can still stop if I have other more important things to do.
16	AHQ5 ...I can be so focused that I feel totally captivated by or "hooked" on the activity.
17	AHQ6a ...I can be so focused that I sometimes focus for far too long on a small detail of the task and avoid other important parts.
18	AHQ6b ...I can be so focused that I tend to focus for far too long on a small detail of the task, but without neglecting other important parts.
19	AHQ7 ...I can be so focused that I can be unsure of what time of day it is or how much time has passed since I started the activity.

20	AHQ8 ...I can be so focused that I don't react to any distractions (e.g., if someone talks to me).
21	AHQ9 ...I can be so focused that I forget to attend to my personal needs (e.g., I forget to sleep or eat or I wait until the last minute to go to the bathroom).
22	AHQ10a ...I can be so focused that I feel like I can't stop doing the activity, even if I have other more important responsibilities.
23	AHQ10b ...I can be so focused that I feel like I can't stop doing the activity, but I can still bring it to an end if there are other more important responsibilities.
24	AHQ11 ...I can be so focused on an activity that I feel completely engrossed or fixated with it.
25	AHQ12a ...I can be so focused that I get "stuck" on little details that keep me from finishing other important parts of the task.
26	AHQ12b ...I can be so focused that I get "stuck" on little details, but I am still able to finish other important parts of the task.
27	AHQ4func ...I can be so focused that I postpone other important things I should be doing.
28	AHQ6func (OK3)...I can be so focused that I fail to complete other important parts of the current task.
29	AHQ10func ...I can be so focused that I forget to meet other more important responsibilities.
30	HS67 ... I can become so completely focused on a single thing that I'm oblivious to everything else.
31	HS68 ...I can fixate my attention strongly on a particular aspect of an image or object and fail to notice everything else around it.
32	HS69 ... I can be completely engrossed or fixated with an activity for hours.

33	HS70 ... I can concentrate for long periods of time without needing a break.
34	HS71 ... I can be so focused that I find it difficult to move my attention away from it.
35	HS72 ... It is clear to me what aspects I need to focus on and what to ignore.
36	HS73 ... I can concentrate so well that other things I need to do simultaneously (e.g., replying to an email) or interruptions (e.g., getting a phone call) do not distract me from what I'm doing.
37	HS74 ...I can be so concentrated that I am much faster in doing, learning and remembering things.
38	HS75 ...I can be so concentrated that I am much more productive or creative.
39	HS78 ...I can be so absorbed that I totally ignore unpleasant sensations of my body (e.g., pain, discomfort, muscle tension, bad posture).
40	HS79 ...My concentration is so intense that I feel exhausted afterwards.
41	HS80 ...I can be so absorbed that I feel alienated from the rest of the world.
42	HS81 ...I can be so focused that I find it very difficult to stop doing it.
43	HS82 …I can be so focused that I find it very difficult to start doing other more important things.
44	HS83 …I can be so focused that it is hard to put it aside and leave it for another time.
45	HS84 …I can be so concentrated that I lose control over other aspects of my behavior (e.g., emotions, eating).