Initial validation of the German version of the Attentional Function Index in a sample of haematological cancer survivors

Initiale Validierung der deutschen Version des Attentional Function Index in einer Stichprobe hämatologischer Krebspatienten

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Abbreviations

AFI Attentional Function Index

ADQ Attention Deficits Questionnaire

CNS Central nervous system

CRCI Cancer-related cognitive impairment

CRF Cancer-related fatigue

FLei Questionnaire of cognitive disturbance with mental disorders

HSCT Haematopoietic stem cell transplantation

NHL Non-Hodgkin lymphoma

QoL Quality of life

1 Introduction

Appropriate tools to validate the subjective level of cancer-related cognitive impairment (CRCI) are of growing importance. In this study we introduce a compact self-report instrument, the German version of the Attentional Function Index (AFI), that may help to address this need.

The first part of this work elaborates the growing burden of CRCI in cancer-society, its theoretical background and how it is diminishing their QoL (Quality of Life). Subsequently, currently available test instruments of cognitive impairment will be discussed and the advantages of the AFI highlighted. Finally, the characteristics of haematological cancer survivors used for the initial validation of the German version of the AFI will be introduced. In the second part the published article is inserted to display the psychometric properties of the AFI. A summary of the research and validation is given at the very end.

1.1 Cancer-related cognitive impairment

1.1.1 Definition and epidemiology

One of the negative effects cancer survivors may experience at all phases of their disease is cancer-related cognitive impairment (CRCI)[1]. Cancer support groups refer to it as “chemo-fog” or “chemo-brain”[2]. CRCI is cancer- or cancer treatment-related cognitive dysfunction in, e.g., attention, memory, or executive function[3,4]. Of all adversaries occurring in cancer survivorship, CRCI is one of the most feared[5]. In a German cancer consultation office, more than 40% of the visiting patients experienced memory and concentration problems[6]. Generally, it is reported that up to 50% or 75% of cancer patients suffer from CRCI during therapy or in clinical everyday life, and 15% to 30% of cancer survivors face CRCI months or years after therapy[7–9]. CRCI may persist for even more than twenty years[7].

Due to a growing incidence of cancer a rise in the quantity of CRCI in society is to be expected. In Germany, the yearly incidence of cancer has almost doubled since 1970[10]. The “Zentrum für Krebsregisterdaten” (center of cancer registry data) at the Robert Koch Institute registered 483.000 people primary diagnosed with cancer in the year of 2013. Marking the number of cancer survivors, around 1.6 million people had been diagnosed with cancer in the preceding five years and around 4 million people have or had cancer in the course of their lives in 2017[10].

1.1.2 Cancer survivorship

These survival rates are improving as over the course of the last decades, progress in cancers' early detection, diagnosis and therapy[10]. That makes the research in long term effects survivors may face increasingly important[10]. In this survivorship research a cancer survivor is defined as an individuals diagnosed with cancer from diagnose throughout the course of their life[8,11]. Their survival can be divided into three phases: acute, extended, and permanent survival[11,12]. Five or more years after primary diagnosis in the stage of permanent survival the term 'long-term survivor' is being used[12]. Survivorship research focuses on the health and life of a person in the physical, psychosocial, and economic dimensions of the cancer and its treatment. The goal is to improve health and QoL of survivors by providing knowledge about cancer- or treatment-related late or long-term effects. Gained insights can be used to screen and observe the development of these effects and the cancer itself, including recurrent or new cancers, comorbidities and psychosocial issues. The knowledge is also applied to optimize follow-up care and the intervention in oncological care programs[8,13].

1.1.3 Cancer-related cognitive impairment

At the same time as research on survivorship in general is getting increasingly important[13], studies on CRCI are of growing interest[1]. Research on CRCI began with investigations focused on cancer of the central nervous system (CNS) and expanded in the early 1990s to include investigations of CRCI in non-CNS cancer and systemic therapies[8]. It has been shown that CRCI is statistically related to a variety of cancer types and treatments[2,5].

1.1.3.1. Responsible mechanisms

Multiple factors related to cancer and its treatment have late or long-time effects on CRCI (Table 2)[12]. Their influence on cognition and thus QoL of the patient may be independent, interactive or even reciprocal[8].

Table 2: Possible factors causing CRCI	
Cancer treatment	Chemotherapy[7,11,14–18], surgery[15], radiation[11,15,18],immunotherapy[18], HSCT[3], endocrine therapy[14], other medication[7]
Affective factors	Depression/anxiety[7,8,15], fatigue[8,15,18], inactivity/ deconditioning[7], chronic social isolation/stress[7,8,15]

Individual factors	Other internal diseases[7], genetic factors[2,7,19], poor cognitive reserve[7], underlying vulnerability[16], nutrition[7], sleep disturbance[15]
Other factors	Cancer itself[8]

Regarding pathophysiology especially direct neurotoxic effects of chemotherapy and also oxidative damage, immune dysregulation, micro emboli and genetic predisposition have been connected to the damage of cognitive function[2,7,15,16,19]. For example, cancer, its treatment and the psychological stress of the process can enhance the production of various cytokines which can cause a syndrome called "sickness behaviour". Its features are similar to cancer-related comorbidities like depression, fatigue, impaired sleep, and CRCI[15]. At the same time, CRCI may be mediated by depression, anxiety, fatigue, and sleep disturbances[15].

1.1.4 Affected cognitive functions

CRCI affects the cognitive system which is divided into different constructs. Efforts have been made to figure out which areas of cognitive function are prone to CRCI. Neuroimaging investigations of cancer patients commonly showed alterations in structure and function in prefrontal and medial temporal regions of the brain, which are responsible for executive function and memory systems in cognitive studies[8]. After receiving chemotherapy, survivors may also especially experience diminished executive function and memory domains as well as problems in attention, processing speed, language, spatial abilities, and motor function[2,8,16,20–22].

1.1.4.1 Subjective CRCI

One needs to be aware that research has been shown that subjectively measured CRCI via self-report needs to be differentiated from objectively measured CRCI via neuropsychological measurements. In a review about CRCI following chemotherapy for cancer, only eight of 24 included studies found a significant relationship between objective and subjective measurements. These eight studies consisted mostly of breast cancer patients and assessed the relationship between memory and perceived CRCI[22]. Discrepancies between subjective and objective CRCI could be explained by the fact that neuropsychological tests are limited to a point of time, while self-reports reflect performance over a prolonged period of time in different settings. At the same time, it is not known how well neuropsychological tests reflect “real-world” skills and performance[2,7,23]. Furthermore, they may not be able to detect the

subtle changes perceived by cancer survivors[7,23]. It is also likely that subjective and objective CRCI are measuring different constructs.

Although subjective CRCI does not necessarily correlate with objective neuropsychological impairments[24], it has the same importance and is even more prevalent[22]. It depicts the impact of CRCI on individuals' lives and daily function[22]. While objective CRCI is most frequent in processing speed, memory, and executive function[4], subjectively, patients complain about diminished attention, concentration, and memory[11,22]. In interviews following chemotherapy right after and up to 12 months after treatment completion, many cancer survivors report changes in memory and attention, e.g., difficulties in multitasking and making decisions in daily activities[22]. Similar complaints are described in other contexts. The reported changes are found in the cognitive functions attention, working memory, and executive function [18], which are especially affected by perceived CRCI[2,4,11]. A theoretical understanding of these functions is needed in order to understand the impact of their impairment on daily life.

1.1.4.2 Attention

Attention enables us to focus on fragments of all the information which flood our senses, are saved in our memory, and which are part of many cognitive processes[25]. Until now, there is no general accepted theory about that psychological function[25]. Three main features characterize attention: first, attention and thinking processes seem to have a limited capacity, second, due to that limited capacity, a selection of information is necessary, and third, attention is not limited to perception, but influences all of our thinking activities[25]. From literature on attention, the construct of cognitive control, namely executive function, has been developed. Both attention and executive function are quite closely connected. One of the most basic executive functions is provided by the characteristics of attention: to selectively focus on some processes while ignoring others[26,27].

1.1.4.3 Working memory

Although researchers disagree on the exact definition of working memory, it is mostly described by its characteristics of maintaining and manipulating information over a short period of time[25,27]. With those abilities, working memory is part of the overall memory system which is responsible to perceive, attend, and retrieve information[27]. Working memory provides an important link between short-term and long-term memory[25]. It is also considered

as part of the executive function[25]. The construct of working memory was even first derived out of the theories on executive function[26]. It is also closely connected to other psychological functions, such as attention[25], where it creates a link to the overall memory system[26].

Working memory is characterized by a limited storage in time and quantity, or said differently, duration and capacity[25]. More exactly, the capacity of the working memory is defined by how many memory-items or how well one memory-item can be kept fresh in spite of distractions and focus shifts in ongoing cognitive activities[26]. Some studies found that three correlated factors connect the working memory capacity and higher-order cognition: attentional control, retrieval from long-term memory, and simple short term memory[26].

Different models of working memory have been considered. All of them acknowledge the ability of the working memory to store information over a short period of time. The working memory is operating with the stored information through organizing, associating, and transforming them[25]. This information must be refreshed or stabilized (rehearsal)[25]. Baddeley (2010) shaped the classical model of working memory containing out of the central executive control and three subsidiary systems[25]. Another model of working memory, Oberauer (2009) described in his three levels: first, the focus of attention, second, the area of direct access, and third, the activated part of the long-term memory[25].

1.1.4.4 Executive function

The term “executive function” can be seen as a synonym for cognitive control and has a long history in psychological literature[26]. It is used in the context of clinical neuropsychology, neurology, and cognitive neuroscience[25] and is defined as the ability to pursue goals-directed behaviour, or as the control of complex cognition, especially in unexperienced situations[26–28].

These control functions of executive function relate to the inhibition of highly automatic responses to stimulation, shifting in focus of attention between related but different tasks or issues, monitoring and regulating performance, inhibiting ingrained behaviour, updating task demands, goal maintenance, planning, holding of information in working memory, and cognitive flexibility. These control functions give us the ability to organize our thoughts in the face of distraction, complexity, and stress[25,27–29], as well as to adapt to rapid, unexpected changes in the environment[28]. Although there is an accepted definition of executive function, the multiplicity of subfunctions is confusing and makes it hard to see what they have in

common[25]. To systematize executive function, Lezak formulated four categories of executive function: first, formulating goals, second, planning according to these goals, third, carrying out these plans, and fourth, effective performance through self-control and adapting behaviour[30].

There have been many efforts to describe executive functions more closely and to build other systematic models out of theoretical and empirical considerations. For some scientists, the concept of executive function is largely congruent to models of the working memory[25]. E.g. in Cowan's (2011) model of the working memory the executive function is part of the working memory and also responsible for attentional focus[25]. Models of executive function based on empirical findings do also reflect basic functions of the working memory, attention and the categories of executive function described by Lezak[25].

Altogether, executive function is used to orchestrate other psychological functions such as attention and working memory, and is a useful way to conduct the most appropriate behaviour as possible[25]. Working memory serves executive function with its ability to activate and maintain information[26,28], and executive function itself regulates the contents of this component of the working memory. The exact boundaries between working memory, executive function, and attention remain uncertain[25,26].

1.1.5 Effects of CRCI on daily life

Difficulty in concentration, or subjective CRCI, was identified as a significant stressor as frequently as dealing with death or mortality[22]. What patients may experience as increased distraction and inability to concentrate is a loss of attention leading to diminished effectiveness in executive function with a decreased sense of personal efficacy, irritability, impulsivity, and mental confusion[18]. Many aspects of everyday life, e.g., employment, social function, and community integration are affected by perceived CRCI[22]. In view of the high prevalence of experienced CRCI and the growing incidence of cancer survivorship, the potential public health impact on the function and QoL of a survivor is immense[8].

1.1.6 Associated psychosocial factors of cognitive impairment

Research has not only shown the connection of perceived CRCI to QoL[22], but also to depression[19,22] and cancer-related fatigue (CRF)[22,31]. All three name different constructs.

1.1.6.1 Quality of life (QoL)

In cancer survivorship research QoL describes a multi-dimensional construct subsuming physical, psychological, social, and spiritual aspects of well-being as well as functional abilities[11]. CRCI can have a significant impact on the QoL of a cancer survivor[21] with e.g. up to 12 months following the finishing point of chemotherapy[22].

1.1.6.2 Depression

During the experience of a life-threatening disease[31], cancer survivors are more prone to depression than the general population[8]. Depression is defined as persistent low mood and loss of interest or pleasure in activities[8]. The strong association of depression and subjective CRCI can be observed in both causal directions[4,19,22]. Depression may lead to late CRCI[32 8] as well as the other way around[16].

1.1.6.3 Cancer-related fatigue (CRF)

One of the most common impairments in cancer patients is CRF[8,33,34] with a prevalence varying between 59% and 90%[9,31]. It is defined as subjective, ongoing tiredness, exhaustion, and shiftlessness related to cancer or its treatment that does not improve by sleep, is not proportional to recent activity, and interferes with normal functioning[8,9,33]. The subjective tiredness associated with CRF can be on a physical (reduced physical capacity), emotional (listlessness, loss of motivation), and/or cognitive level (impairment of concentration or memory)[8,9].

All of these constructs (QoL, Depression and CRF) are associated with CRCI as well as with each other and should be taking into account when assessing subjective CRCI[4,7–9,11,12,22,24,31].

1.2 Measurements of subjective CRCI

As described above, subjective CRCI dissociates from objective CRCI[2]. Thus specific subjective assessments are needed in order to understand the effect of CRCI on the daily functioning of cancer survivors[18]. Only a few self-report instruments have been developed so far to specifically measure subjective CRCI as a primary outcome. Perceived CRCI was usually only measured as a subscale in associated studies[7]. Nevertheless, the National Comprehensive Cancer Network (NCCN) recommends to screen cancer survivors with questions regarding attention, e.g., find words, remember things, think clearly, perform functions, and cognitive

complaints, as well as to assess the trajectory over time. Associated problems such as anxiety, depression, fatigue, sleep disturbance, and pain ought to be assessed among cancer survivors as well[7].

1.2.1 Lack of German instruments

In Germany there are few self-report assessment tools for subjective CRCI. One of them, the Attention Deficit Questionnaire (ADQ), was originally developed for neurological patients. It contains two versions, one for self-report and another for third-party assessment[35]. Another test, the questionnaire of cognitive disturbance (FLei) in patients with mental disorders, was designed to measure cognitive disorders among the aimed patient group[36]. Both tests measure attention and other cognitive functions, and may be applicable in other patient groups as well. Nevertheless, they were not originally designed for cancer patients, which makes them less attractive for an application among cancer survivors. Additionally, they are relatively long to be practicable in a clinical setting. Concerning only the ADQ, detection of small neurocognitive impairments was not possible, which may be particularly relevant when assessing cancer survivors[35].

1.2.2 The Attentional Function Index (AFI)

Some of the most commonly affected cognitive functions among cancer survivors are attention, memory, and executive function[4,22,37]. There are few instruments assessing the subjective perception of effectiveness in activities of daily life that are supported by these basic cognitive processes[18]. In order to measure the perceived CRCI in daily functioning, the AFI was developed[18] in English for a study among breast cancer survivors[1]. The primary theoretical congruence and face validity of the AFI established by experts in cognitive psychology, neurobehavior, and cognitive neuroscience[18]. It is consisting of 13 statements (e.g. *keeping your mind on what you are doing*). Each item describes a practical daily functioning. Probands may rate their functioning in these area on a visual analogue scale at the point of assessment[18]. As a measurement of the perceived detrimental effect of CRCI, the AFI has already been applied in researches among different populations and conditions such as healthy populations, breast, and lung cancer patients. Within these, the AFI showed valid and reliable results[18]. The English version of the AFI has been primarily validated in a sample of 172 breast cancer patients[18]. In this validation study exploratory factor analysis revealed three factors: (I) *effective action*, reflecting individual's perceived effectiveness in carrying out

basic activities in daily life that require focused attention, (II) *attentional lapses,* assessing perceived difficulties in directing attention in daily tasks, and (III) *interpersonal effectiveness,* measuring perceived ability to interact in a deliberate manner that depends on attention or inhibitory effort. Showing adequate construct validity the AFI correlated positively with concentration, perceived cognitive failure, and negatively with confusion and mental fatigue[18]. Altogether results presented that the AFI is a valid and reliable instrument to measure perceived CRCI in attention, working memory and executive functioning [18].

1.3 Sample and aim of the initial validation of the German version of the AFI

1.3.1 Haematological cancer

The German version of the AFI has been translated and initially validated in a sample of haematological cancer survivors[38]. Haematological malignancies are systemic and are compound of various diseases (Hodgkin's lymphoma, non-Hodgkin's lymphoma (NHL), leukaemia and multiple myeloma)[39]. Testing measurements among survivors of haematological malignancies are targeting a cancer type which considerable contributes to the overall cancer burden in Germany. For example, NHL is the seventh most common cancer entity of women and the eighth of men. Leukaemia is the seventh leading cause of death due to cancer of both gender[40].

Compared to other malignancies haemato-oncological systemic diseases have an often more toxic and invasive therapy than other malignancies[41]. Also, they are heterogenous as they differ in age at primary diagnosis, prevalence and prognosis[42]. Statistics of haematological malignancies in the year of 2016 in Germany depict their heterogeneity in incidence and prognosis. Out of the four most common haematological cancers NHL had the highest incidence with 18.370 new cases and a comparably good five-year survival rate of 68% to 70%. Nevertheless mortality remains elevated for survivors of NHL in the following course of time[40]. Leukaemia had a lower incidence of 13.900, but worse prognosis. After 10 years one third of the patients are still alive. Full recovery is rare among leukaemia survivors, e.g., due to haematopoietic stem cell transplantation (HSCT)[40]. Multiple myeloma had an incidence of 6.910 cases. After five years, nearly half of the patients are still alive. For a long time, this disease can be symptom-free. Under therapy, a temporary remission is possible, but permanent healing is mostly not to be expected[40]. Hodgkin lymphoma had the least incidence of 2490 cases. With a five-year survival rate of 84 to 86%, prognosis is relatively good[40].

The average number of physical symptoms in haematological malignancies and the level of psychological burden is comparable to non-haematological and metastasized malignancies[42].

Research is needed among haematological malignancies. The reason is a prognosed rising incidence of haematological cancer pointing to a growing confrontation of the health care system with an increasing number of survivors. As described above, these cancer survivors face specific late or long-term effects of their diagnose or treatment[12,40,41].

As other cancer survivors, haematological cancer survivors suffer from CRCI. It has been reported e.g., in chronic lymphoblastic leukaemia patients[39]. Some studies show that CRCI has accompanied haematological cancers prior to any treatment, e.g., in acute myeloid leukaemia and myelodysplastic syndrome[7,15,43], and can be relevant long time after diagnose as survivors from NHL also showed lower cognitive performance, especially in executive function and attention, than non-cancer controls[37].

Thus, the AFI seems to be reasonably applicable among haematological cancer survivors as they experience CRCI.

1.3.2 Aim of this study

The aim of this study was to provide a short German self-report measurement, assessing subjective CRCI for a broad variety of cancer survivors. For this purpose, the AFI was translated into German and psychometric properties have been presented in the following publication among a sample of 1312 haematological cancer survivors. In the resulting article the factorial structure of the German translation of the AFI, the internal consistency among the total score and each subscale, construct validity and the associations of the AFI sum score with medical and socio-demographic variables are provided. Comparisons to the English version are additionally drawn. With the validated AFI, researchers and clinicians in German-speaking countries may now have new tool to assess, and thus improve an important component of QoL in cancer survivors[38].

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Abstract

Objective: To date, no German instrument exists to assess subjective levels of cancer-related cognitive impairments (CRCI) in cancer survivors. We translated the validated Attentional Function Index (AFI) into German and explored its psychometric properties.

Methods: The validation sample consisted of 1,111 haematological cancer survivors mainly recruited from two cancer registries. Factorial structure was explored using principal component analysis, internal consistency via Cronbach's α, construct validity through correlational analyses (Pearson's r) and associations of patient characteristics with the AFI score via regression analyses.

Results: In line with the original version, we revealed three factors, that is "effective action" (seven items), "attentional lapses" (three items) and "interpersonal effectiveness" (three items). The overall reliability α was .91. Verifying construct validity, the AFI score correlated positively with cognitive functioning (r = .64, $p \leq .01$) and global QoL (r = .44, $p \leq .01$), but negatively with fatigue (r = −.60, $p \leq .01$) and depressive symptomatology (r = −.6, $p \leq .01$). Older age (β = .12, $p < .001$), higher comorbidity (β = −.07, p = .02) and being male patient (β = .07, p = .01) were significantly associated with the AFI scores, but effect sizes were small.

Conclusion: The German translation of the AFI shows good psychometric properties and thus may be reasonably applied to measure the subjective level of CRCI in German-speaking oncological populations.

KEYWORDS

cognitive functioning, haematological cancer, patient-reported outcomes, survivorship, test validation

1 | INTRODUCTION

Among the variety of issues that might impair quality of life (QoL) in cancer patients, a particularly important concern is cancer-related cognitive impairments (CRCI) (Ahles & Root, 2018; Joly, Rigal, Noal, & Giffard, 2011; Tannock, Ahles, Ganz, & van Dam, 2004). In a study among cancer patients approaching a psycho-social counselling office, more than 40% reported distressing impairments regarding

memory or concentration (Lehmann-Laue et al., 2019). Even if such impairments may be small in size, they considerably worsen the QoL of a cancer survivor (Anderson-Hanley, Sherman, Riggs, Agocha, & Compas, 2003; Asher, 2011; Joly et al., 2011), including problems with reintegration into the social community or return to work (Ahles & Root, 2018; Asher & Myers, 2015).

Cancer-related cognitive impairments may include deficits in attention, concentration and working memory (Stewart, Bielajew, Collins, Parkinson, & Tomiak, 2006; Tannock et al., 2004). Suggested mechanisms responsible for CRCI include psychological and social stress, the treatment of the cancer, comorbidities such as hypothyroidism, anaemia or liver disease, as well as hormonal changes or nutritional deficiencies (Ahles & Root, 2018; Asher, 2011; Asher & Myers, 2015; Buchbinder et al., 2018; Joly et al., 2011; Schagen et al., 2014; Stewart et al., 2006; Tannock et al., 2004; Wu et al., 2018).

Given the practical relevance of CRCI, the National Comprehensive Cancer Network (NCCN) suggests to screen cancer survivors for cognitive impairments via self-report in order to develop and improve adequate intervention strategies (Asher & Myers, 2015). Even though several tests on neuropsychological functioning exist, such instruments do not determine the subjective level of impairment experienced by the patient, but measure objective outcomes such as the time to complete a task or the quality of the fulfilment of the task (Asher & Myers, 2015; Cimprich, So, Ronis, & Trask, 2005; Cimprich, Visovatti, & Ronis, 2011; Tannock et al., 2004).

However, the application of such objective assessment methods may be problematic for use in cancer patients, as this population may suffer from cognitive deterioration that cannot be detected by objective neurocognitive tests. More importantly, objectively measured CRCI seems to be qualitatively different from subjectively reported CRCI: Many studies demonstrate that objective and subjective measures of CRCI do not correlate with each other (Cimprich et al., 2005; Hutchinson, Hosking, Kichenadasse, Mattiske, & Wilson, 2012; Mehnert et al., 2007). Thus, objective and subjective CRCI have to be measured separately to ensure a comprehensive assessment of the patients' impairments and needs. To date, however, only few assessment instruments on the subjective level of CRCI exist (Asher & Myers, 2015; Cimprich, Visovatti, & Ronis, 2011). Few self-report assessment tools for cognitive functioning are available in German: The *Attention Deficits Questionnaire* (ADQ) was developed for neurological patients and was published in two versions, one as self-report version and one as a third-party assessment tool (Volz-Sidiropoulou et al., 2007). Another test, the *Questionnaire of Cognitive Disturbance with Mental Disorders*, is measuring the level of cognitive disturbance and was developed for patients with mental disorders (Beblo et al., 2010). However, items of the ADQ were not able to differentiate between patients with small neurocognitive impairments (Volz-Sidiropoulou et al., 2007), which may be particularly relevant when assessing cancer patients. Furthermore, both tests are relatively long which complicates their application in clinical care.

In need of a comprehensive self-report tool for assessing CRCI, Cimprich et al. (2011) developed the Attentional Function Index (AFI). This instrument, originally released in English language, assesses the perceived level of specific cognitive functioning domains, that is directed attention, working memory and higher-level executive functions in daily life activities impaired by life-threatening and chronic illnesses such as cancer (Cimprich et al., 2011). The development of the AFI was accomplished in collaboration of several experts including researchers and theorists in cognitive psychology, neurobehavior and cognitive neuroscience (Cimprich et al., 2011). The English original version of the test has already been applied in various oncological groups including breast and lung cancer patients (Cimprich et al., 2011), but also pregnant women (Stark, 2006). It could also be shown that the AFI did not correlate with objective measurements of CRCI and thus reflects a different important construct of QoL (Cimprich, 1992; Cimprich et al., 2005).

The exploratory factor analysis of the 13-item questionnaire revealed three factors named *effective action*, *attentional lapses* and *interpersonal effectiveness* (Cimprich et al., 2011). Testing for convergent and divergent validity, significance and direction of the correlations of the AFI score with theory-based criteria such as levels of concentration, cognitive failure, confusion and mental fatigue supported the hypothesis of good construct validity (Cimprich et al., 2011). Furthermore, internal consistency was found to be satisfactory. As an important covariate, age was found to be associated with the scores of the AFI (Cimprich et al., 2011).

In order to provide a comprehensive and short self-report instrument for assessing subjective CRCI in German-speaking cancer survivors, we translated the AFI into German and tested its psychometric properties using a sample of 1,312 survivors of haematological malignancies, a population which is at high risk for developing neuropsychological impairments (Harder et al., 2002; Scheibel, Valentine, O'Brien, & Meyers, 2004; Scherwath et al., 2013). We aimed to explore (a) the factorial structure of the German translation, (b) the internal consistency among the total score and each of its subscales, (c) the construct validity and (d) the associations of the AFI sum score with medical and socio-demographic variables. As a secondary aim, we compared our results with the English original version. Our results are supposed to enable researchers and clinicians in German-speaking countries to use this instrument for assessing an important component of QoL in cancer survivors.

2 | METHODS

2.1 | Study design and recruitment

This test validation is part of a cross-sectional study among haematological cancer survivors. Participants were recruited between October 2014 and August 2017. Patients were eligible if they had been diagnosed with a malignant neoplasm of lymphoid, hematopoietic and related tissue (ICD-10: C81-C96), having a minimum age of 18 years at time of diagnosis and a maximum age of 85 at time of

assessment, sufficient knowledge of the German language to fill in the questionnaire as well as cognitive ability to provide written informed consent for study participation.

Participants were gathered from two main sources. One part of the sample was recruited from the cancer registries of the city of Leipzig and the Federal State of Schleswig-Holstein respectively (response rate: 46%). Thereby, eligible patients were contacted via mail and reminded in case they did not respond. The other part of participants was approached through social media, patient congresses, established doctors and self-help groups. Further details can be found in the study protocol (Esser, Kuba, Götze, & Mehnert, 2017). The study was approved by the Ethics Committee of the Medical Faculty of the University of Leipzig (approval number: 292–15-24082015).

2.2 | Attentional Function Index

The Attentional Function Index was developed and validated in a sample of 172 breast cancer patients (Cimprich, 1992; Cimprich et al., 2011). The instrument has 13 items in total. The first nine items are positively formulated (e.g., *following through on your plans*), whereas the last four items are negatively worded (e.g., *forgetting to do important things*) and thus have to be inverted before any statistical analyses. A visual analogue scale serves as response format. Each item can be answered with a mark on a 100 mm horizontal line ranging from "not at all" (0 mm) to "extremely well" and "a great deal" (100 mm) for positively and negatively formulated items respectively. The distance from 0 mm to the mark made by the patient defines the respective score for each question. The total score is calculated as the mean across the 13 item scores. A higher score indicates a higher, that is better level of perceived cognitive function.

2.3 | Translation process of the AFI

The steps of the translation process of the AFI were guided by current state of the art (Bracken & Barona, 2016; World Health Organization). Forward translation from English into German was done by one of the co-authors whose native language is German. A German psychologist who graduated in the UK used this translated version for a blind-backward translation into English. Two German native speakers subsequently compared both English versions and discussed any necessary changes for the German translation. Nevertheless, only minor adjustments were necessary in the final German version, which can be found in the Appendix 1.

2.4 | Validation instruments

Cognitive functioning and *QoL* were assessed with the European Organization for Research and Treatment of Cancer Quality of Life Questionnaire (EORTC QLQ-C30), a validated and well-established measurement used across cancer sites (Jocham, Dassen, Widdershoven, & Halfens, 2009). It consists of 30 items which form a total of 15 subscales. For our study, we used a two-item scale assessing cognitive functioning (Cronbach's α = .80), rated on a four-point Likert scale ranging from "not at all" to "very much," and a two-item scale measuring global QoL (Cronbach's α = .93), rated on a seven-point Likert scale ranging from "very poor" to "excellent" (Esser et al., 2017; Fayers et al., 2001; Jocham et al., 2009). All outcomes are transformed to a scale ranging from 0 to 100, with higher scores indicating higher cognitive functioning and QoL respectively (Fayers et al., 2001).

Fatigue was assessed with the Brief Fatigue Inventory (BFI) (Cronbach's α = .95) (Radbruch et al., 2003), in which patients report on their level of fatigue and its impact on different domains of the patient's life. The items can be scored on an eleven-point Likert scale ranging from "no fatigue"/"does not interfere" to "as bad as you can imagine"/"completely interferes." The BFI total score is calculated as the mean across all items, with higher values indicating higher levels of fatigue.

Depression was assessed with a module of the Patients Health Questionnaire (PHQ-9) (Cronbach's α = .85) (Kroenke, Spitzer, & Williams, 2001), a nine-item instrument assessing the frequency of DSM-IV criteria of depression on a four-point Likert scale, ranging from "not at all" to "almost every day." The sum score can be used as an indicator for the severity of depressive symptomatology (Hinz et al., 2016), with higher values indicating higher levels of depressive symptomatology.

Comorbidity was assessed with a slightly adapted version of a comorbidity assessment instrument (Cronbach's α = .82) (Bayliss, Ellis, & Steiner, 2005). Altogether, 24 comorbidities were assessed. In the adaptation process, similar comorbidities were summarised (e.g., "congestive heart failure" and "coronary heart disease" were summed up to "heart disease") and comorbidities which are typical for haematological cancers and their treatments (e.g., anaemia) were added. Details of the adaptation can be found elsewhere (Esser et al., 2017).

2.5 | Statistical methods

We first provided descriptive statistics on socio-demographic and medical variables. Responder analyses could be conducted for patients recruited from the cancer registry via Mann–Whitney *U* tests (continuous variables) and chi-squared tests (categorical variables).

Since multivariate outliers are known to bias results of factor analyses (Finch, 2012) as well as measures of internal consistency (Liu & Zumbo, 2007), we identified such cases via Mahalanobis distance above the critical value of the chi-square distribution ($p < .001$) and excluded them for all analyses.

Principal component factor analysis (PCA) with varimax rotation was used to explore the factor structure of the German AFI. This procedure was chosen to enable comparability with the English validation study, which applied the same method. Kaiser-Meyer-Olkin and Bartlett's test were applied to determine sampling adequacy.

Kaiser's criterion was used to extract the number of factors. Factor loadings with $r \geq .4$ were considered meaningful. To check the stability of our findings, we reanalysed the factorial structure among two subsamples (patients from the cancer registries vs. patients from other sources) and with another type of factor analysis (principal axis factoring, PAF) among the total sample and both subsamples. In doing so, we ran a total of six exploratory factor analyses.

The internal consistency was computed via Cronbach's α for the total scale and each of the subscales. We also investigated the corrected item-scale and item-total correlations in order to test whether the single item reflects the respective scales and the overall test result, that is whether the items would correlate with the respective scale and the overall test with an $r > .3$ (Field, 2013; Park & Kim, 2012).

Construct validity was assessed via correlation analyses (Pearson's *r*). Thereby, the AFI sum score was correlated with various variables to investigate convergent (i.e., positive correlations) and divergent validity (i.e., negative correlations). Based on theory and empirical findings, we hypothesised that the AFI correlates positively with cognitive functioning of the EORTC questionnaire and global QoL (Cimprich et al., 2011; Tannock et al., 2004) and negatively with fatigue and depressive symptomatology (Cimprich et al., 2011; Janelsins et al., 2017; Mehnert et al., 2007).

The relationship of patient characteristics with the AFI was determined by univariate regression analyses. In line with the English validation study (Cimprich et al., 2011), we investigated associations with age, education and presence of any comorbidities. Additionally, we tested the relationship with gender given that the validation sample was based on female breast cancer patients (Cimprich et al., 2011).

Practical relevance of significant findings was determined by effect sizes using the recommendations of Cohen (1992). Data were analysed using IBM SPSS Statistics 24 for Windows (IBM). The significance level was set at $\alpha < .05$. Missing data were deleted listwise.

TABLE 1 Demographic and medical sample characteristics (if not else noted: raw values, valid percentages in brackets)

	Total sample (*N* = 1,111)
Age (*M*, *SD*)	60.91 (14.3)
Gender	
Female	497 (44.7)
Male	615 (55.3)
Education	
≤10 years	616 (56.2)
>10 years	481 (43.3)
Years after first hemato-oncologic diagnosis (*M*, *SD*)	9.2 (5.2)
Diagnosis	
Lymphoma[a]	472 (43.3)
Acute leukaemia[b]	161 (14.8)
Chronic leukaemia[c]	158 (14.5)
Multiple myeloma	140 (12.8)
Others[d]	159 (14.6)
Therapy	
Chemotherapy	905 (81.7)
Radiotherapy	418 (37.6)
Antibody therapy	236 (21.3)
Autologous SCT	196 (17.7)
Allogeneic SCT	165 (15.0)
Surgery	149 (13.4)
Any comorbidities	1,038 (94.3)

Abbreviation: SCT, stem cell transplantation.

[a]Hodgkin Lymphoma, Non-Hodgkin Lymphoma.

[b]ALL, acute lymphoid leukaemia; AML, acute myeloid leukaemia AML.

[c]CLL, chronic lymphoid leukaemia; CML, chronic myeloid leukaemia.

[d]Osteomyelofibrosis, myelodysplastic syndrome, severe aplastic anaemia, hairy cell leukaemia.

3 | RESULTS

The total number of participants was 1,312, of which 937 (71%) and 375 (29%) were recruited from the cancer registries and other sources respectively. A total of 152 participants provided incomplete data on the AFI and thus were not included in the analyses. Another 49 patients were identified as multivariate outliers and subsequently excluded, which resulted in a final study sample of 1,111 patients. Detailed sample characteristics are shown in Table 1.

According to the size of the respective factor loadings, a three-factor model could be revealed. In detail, seven items were assigned to the first factor "effective action," three items to the second factor "attentional lapses" and three items to the third factor "interpersonal effectiveness." Both the number of factors and respective items on these factors were identical with the results of the English validation study. Nevertheless, four items loaded above the minimum loading of $r = .4$ on several factors and three items could not be clearly assigned to only one factor, that is *getting easily annoyed or irritated*, *remembering to do all the things you started out to do* and *keeping your mind on what others are saying* (for detailed factor loadings see Table 2). The total variance explained by the factors was 71.2%. Concerning stability of our findings, we reanalysed the structure across different subsets (cancer registry vs. other sources) and statistical analyses (PCA vs. PFA): in summary, the structure was kept for all re-calculations. As only exception, the item *getting easily annoyed or irritated* loaded slightly higher on factor 2 than on factor 3 among patients from the cancer registries for both PC and PF analyses (data not shown).

Reliability of the total score was high, with $\alpha = .91$ (Tavakol & Dennick, 2011). Alphas for each subscale are presented in Table 3. Additionally, corrected item-scale and item-total correlations *r* were found to be ≥.46 for all items. In detail, corrected item-scale correlations ranged between .71–.81 (items on factor 1), .73–.81 (items on

TABLE 2 Factor loadings using principal component analysis with varimax rotation

	Factor 1: Effective action	Factor 2: Attentional lapses	Factor 3: Interpersonal effectiveness
Getting started on activities you intend to do	**0.84**	0.13	0.32
Following through on your plans	**0.85**	0.15	0.14
Doing things that take time and effort	**0.81**	0.09	0.17
Making your mind up about things	**0.72**	0.21	0.21
Keeping your mind on what you are doing	**0.69**	0.43	0.27
Remembering to do all the things you started out to do	**0.60**	0.51	0.25
Keeping your mind on what others are saying	**0.52**	0.47	0.43
How often you make mistakes on what you are doing	0.18	**0.88**	0.13
Forgetting to do important things	0.18	**0.86**	0.11
How hard you find it to concentrate on details	0.21	**0.83**	0.12
Being patient with others	0.25	0.13	**0.83**
Keeping self from saying or doing things	0.20	0.08	**0.79**
Getting easily annoyed or irritated	0.13	0.49	**0.55**

Note: The assignment of items to their respective factor is indicated with bold font.

factor 2) and .46–.64 (items on factor 3); the corrected item total correlations ranged between .46 and .78.

As hypothesised, we found significant positive correlations of the AFI sum score with cognitive functioning (r = .64, $p \leq .01$) and global QoL (r = .44, $p \leq .01$) as well as significant negative correlations of the AFI sum score with levels of fatigue (r = −.60, $p \leq .01$) and depressive symptomatology (r = −.65, $p \leq .01$). The sizes of correlations could be interpreted as medium to large (Cohen, 1992).

Univariate regression analyses showed positive significant relationships of the AFI sum score with age (β = .12, $p < .001$), presence of one or more comorbidities (β = −.07, p = .02) and gender (being male) (β = .07, p = .01). However, these effects were small according to Cohen, with explained variances of ≤1.5% (Cohen, 1992). The relationship between the AFI and education level was not significant (β = −.01, p = .70).

4 | DISCUSSION

4.1 | Main findings

This article investigated the psychometric properties of the German translation of the AFI among a sample of haematological cancer survivors. A three-factorial structure could be revealed and measures of reliability and construct validity indicated good psychometric properties. Results largely corresponded with the English original version.

4.2 | Comparison with previous results

Despite the translation into German and the differences between the validation samples, our findings were very similar to those of the English validation study (Cimprich et al., 2011). In detail, the

TABLE 3 Descriptive statistics and internal consistency for the three subscales and the total score

Scale	*M*	*SD*	Reliability[a]
Factor 1: effective action (7 items)	72.92	18.21	.911
Factor 2: attentional lapses (3 items)	66.68	23.71	.880
Factor 3: interpersonal effectiveness (3 items)	68.55	19.63	.698
Total score	70.49	16.48	.911

[a]Cronbach's α.

three-factor structure and their respective items were identical to the English validation study (Cimprich et al., 2011). The fact that the item *getting easily annoyed or irritated* loaded high on factors 2 and 3 is also in line with the English validation study (Cimprich et al., 2011). A reason for the low factor discrimination of this item between the two factors *attentional lapses* and *interpersonal effectiveness* could be that it does not clearly refer to interpersonal relationships and thus may also be interpreted as an item assessing negative emotional responses to the attentional lapses. We also could replicate the finding that the items *remembering to do all the things you started out to do* and *keeping your mind on what others are saying* loaded high on more than one factor (Cimprich et al., 2011). As these two items were conceptually associated with factor 1 (Cimprich et al., 2011), they were kept to this subscale, which was also statistically indicated since these two items loaded highest on this factor.

Internal consistency was satisfactory for the total score and each of the subscales and largely in line with the English validation study (Cimprich et al., 2011), indicating high consistency of the measure. The corrected item-scale and item-total correlations were relatively high, suggesting that the items are well reflecting the results of their scales and the total score. These correlations also indicate sufficient ability of the test to discriminate between high and low scores of perceived attentional function (Field, 2013; Park & Kim, 2012).

Also in line with Cimprich et al. (2011), construct validity was verified by showing positive relationships of the AFI score with self-rated cognitive impairment and QoL as well as negative correlations of the AFI score with mental fatigue and depression.

View studies exist on CRCI in older cancer populations (Loh et al., 2016). We found that older participants rated their attentional function better than younger patients did, which indicates that younger patients perceive their CRCI as more severe than older patients do. An explanation might be that older respondents do not have such a high expectation of effective functioning in daily life anymore; in contrast, younger patients are still involved in many challenges in all-day life and thus may already detect small changes in attentional functioning (Cimprich et al., 2011; Janelsins et al., 2017). Although the English validation study also described this association between age and the AFI (Cimprich et al., 2011), it is to note that an earlier study among breast cancer patients did not find such a correlation (Cimprich, 1992). These contradictory results could imply that age does not have a strong effect on the subjective level of CRCI, an assumption which would be statistically supported by the small effect size for this association in our study.

We also showed that male participants reported less cognitive impairment on the AFI than female individuals. This effect could not be shown in the English original version given that this sample consisted of female breast cancer patients (Cimprich et al., 2011). Nevertheless, our finding corresponds with previous literature implying that female cancer survivors generally report higher levels of psychological/emotional distress than male cancer survivors (Lehmann-Laue et al., 2019; Zebrack, Yi, Petersen, & Ganz, 2008). Therefore, this finding additionally supports the construct validity of the AFI.

We could also show that higher comorbidity is associated with higher subjective level of attentional functioning. In the English validation study, no significant associations could be shown (p = .98) (Cimprich et al., 2011). This discrepancy may be due to the fact that the English validation study used a different battery of chronic illness (e.g., hypertension, heart disease and diabetes) (Cimprich et al., 2011). Another reason may be the large sample size in our study, which could have resulted in significant findings without practical relevance. In fact, effects of covariates on the AFI score were only small in size and therefore have to be interpreted with caution.

Also in line with the English original version, our study showed no significant associations between education level and the AFI (Cimprich et al., 2011).

4.3 | Strengths and limitations

The current study has several strengths: first, it benefits from a relatively large sample size increasing the generalisability and replicability of the factor structure (Costello & Osborne, 2005) and the preciseness of the reliability and validity measures (Biau, Kernéis, & Porcher, 2008) of the German version of the AFI. Second, we could show the robustness of our factorial structure via replication of the analyses across subgroups and different analyses. Third, the variety of sources of recruitment may have enhanced the representativeness of the population, and thereby increased the generalisability of the results. Another advantage is that we kept to the methodological strategy of the English validation study as close as possible, which enabled us to compare our findings with the original version.

However, the study also has limitations: first, the cross-sectional design does not provide data on which conclusions about causal relationships of the AFI with any of the tested outcomes and covariates could be drawn. Another limitation is that most medical data, particularly among those patients who were not recruited from the cancer registries, are based on self-report and thus have limited validity.

4.4 | Practical implication and future research

The German AFI translation showed adequate psychometric properties and thus can be reasonably applied to screen for subjective level of CRCI. In addition to measurements that assess cognitive function objectively (Cimprich et al., 2011; Tannock et al., 2004), this questionnaire might provide important information on how the patients themselves rate their CRCI and thus to determine whether this issue may negatively affect the QoL of the patients. In doing so, the AFI score can be used to monitor the subjective level of attentional functioning throughout the illness and treatment trajectory in order to detect perceived deficits and to intervene as early as possible to maintain or improve QoL (Mehnert et al., 2007). Given the strong associations between the AFI with

psychological distress and fatigue, low subjective levels of attentional function of patients may also guide screening for a variety of other outcomes of QoL.

Our sample differed from the English original version in gender and cultural background and other important patient characteristics that may have affected the self-perception of individuals (Allen et al., 1998; Ito & Hofmann, 2014; Stone et al., 2014). Together with the unknown effect of the translation process, we applied exploratory factor analyses to explore the factorial structure of the items. In future studies, confirmatory factor analysis should confirm our factor structure for the German AFI. Nevertheless, the stability of the factors across the two studies and within our study (across the different subsamples) suggests that the structure is relatively robust. In order to test the sensitivity of the AFI to assess intra-individual change, the instrument should be applied in longitudinal studies.

5 | CONCLUSION

The German translation of the AFI is a valid and reliable instrument to measure the subjective level of CRCI and thus may be reasonably used in German-speaking oncological populations. Psychometric findings should be confirmed and expanded in future studies.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interest. The funding source was not involved at any stage of the research process.

ETHICAL APPROVAL

The study was approved by the Ethics Committee of the Medical Faculty of the University of Leipzig (approval number: 292–15-24082015).

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APPENDIX 1

FIGURE 1 German version of the Attentional Function Index (AFI)

Appendix: German version of the Attentional Function Index (AFI)

Im Moment: Wie gut funktionieren Sie Ihrem Gefühl nach in den unten aufgeführten Bereichen?

Markieren Sie entlang der Linien jeweils diejenige Stelle, die am besten beschreibt, wie Sie zurzeit im jeweiligen Bereich zurechtkommen.

1. Ich nehme Aktivitäten, die ich mir vorgenommen habe (Arbeit, Freizeit), in Angriff.

überhaupt nicht ——— äußerst gut

2. Ich führe Aktivitäten, die ich begonnen habe, zu Ende.

überhaupt nicht ——— äußerst gut

3. Ich tue Dinge, von denen ich weiß, dass sie Zeit und Aufwand mit sich bringen.

überhaupt nicht ——— äußerst gut

4. Ich kann Entscheidungen treffen.

überhaupt nicht ——— äußerst gut

5. Ich kann mich auf das konzentrieren, was ich gerade mache.

überhaupt nicht ——— äußerst gut

6. Ich kann all die Dinge im Kopf behalten, die ich angefangen habe.

überhaupt nicht ——— äußerst gut

7. Ich kann mich auf das konzentrieren, was andere mir erzählen.

überhaupt nicht ——— äußerst gut

8. Ich kann mich zurückhalten, etwas zu sagen oder zu tun, was ich nicht sagen oder tun will.

überhaupt nicht ——— äußerst gut

9. Ich habe mit Anderen Geduld.

überhaupt nicht ——— äußerst gut

Im Moment: Wie würden Sie sich in den folgenden Bereichen einschätzen?

10. Ich finde es schwer, mich auf Details zu konzentrieren.

überhaupt nicht ——— erheblich

11. Bei der Ausführung von Tätigkeiten unterlaufen mir Fehler.

überhaupt nicht ——— erheblich

12. Ich vergesse, wichtige Dinge zu erledigen.

überhaupt nicht ——— erheblich

13. Ich bin schnell gereizt oder verärgert.

überhaupt nicht ——— erheblich

3 Summary

Dissertation zur Erlangung des akademischen Grades Dr. med.

Initial validation of the German version of the Attentional Function Index in a sample of haematological cancer survivors

Initiale Validierung der deutschen Version des Attentional Function Index in einer Stichprobe hämatologischer Krebspatienten

Eingereicht von:	Esther Baumann
Angefertigt an der:	Abteilung für Medizinische Psychologie und
	Medizinische Soziologie, Universität Leipzig
Betreuer:	Prof. Dr. Anja Mehnert-Theuerkauf
Ko-Betreuer:	Dr. Peter Esser
Eingereicht:	Februar 2021

3.1 Theoretical background

The growing number of cancer survivors[10,13] is experiencing a loss in cognitive function, namely cancer-related cognitive impairment (CRCI)[2,5,16]. That burden of CRCI can be caused by the cancer or its treatment[4,22,37]. It can affect up to 75 % of cancer patients during treatment [7] and may last for more than 20 years[7]. CRCI is negatively affecting the Quality of Life (QoL) in everyday situations of cancer survivors[2,5,16]. How the patient perceives his own CRCI subjectively is correlating not only to their QoL but also to depression and cancer related fatigue[22]. Self-rated, subjective CRCI is not measurable with objective assessment tools[19]. Therefore, subjective measurements of CRCI are needed additionally to objective tests in order to ensure a comprehensive assessment of the patients' impairments and need[22]. Subjective CRCI mostly affects three cognitive functions: attention, working memory and executive function[4,22,37]. These three should be taken into account by an adequate measurement of subjective CRCI. Despite the described clinical relevance of perceived CRCI in

cancer survivorship, to date only two German instruments to assess subjective cognitive function exist, i.e., the Attention Deficits Questionnaire (ADQ)[35] and the questionnaire of cognitive disturbance with mental disorders (FLei)[36]. Nevertheless, they are not adapted for oncological populations, are relatively long for clinical routine care and may not be adequate to detect small neurocognitive impairments[35].

A validated, comprehensive and short self-report instrument assessing subjective CRCI among cancer patients has been available in English, i.e., the Attentional Function Index (AFI)[18]. The AFI measures the subjective level of cognitive function with respect to attention, working memory and executive functions in daily life activities[18]. It has been developed by a collaboration of several experts and has been applied in various clinical subgroups[18,44]. The English validation study explored three factors: *effective attention, attentional lapses* and *interpersonal effectiveness[18].* It also demonstrated good construct validity by showing significant correlations of the AFI with well-known associated factors, i.e., levels of concentration, cognitive failure, confusion and mental fatigue[18].

To overcome the need of a short German instrument to assess self-reported CRCI, we translated the AFI into German and tested its psychometric properties within a sample of 1312 haematological cancer survivors who are repeatedly shown to suffer from various cognitive impairments[37,42]. We also compared our results with those of the English validation study. Altogether, our results aimed to provide a German instrument practicable for research and clinical setting to assess subjective CRCI, an important aspect of QoL, in cancer survivors.

3.2 Main findings

In line with the original version, we identified three factors by exploratory factor analysis, namely *effective action*, *attentional lapses* and *interpersonal effectiveness*. This factor structure was robust across re-calculations in split subsamples and another method of analyses, principal axis factoring. Internal consistency was satisfactory for both the total score and each of the subscales. Pre-hypothesized positive correlations of the AFI scores with self-rated cognitive impairment and QoL as well as negative correlations of the AFI scores with mental fatigue and depression demonstrated good construct validity. Patient characteristics as age, gender and comorbidity influenced the self-rating only with small effect sizes. A significant relationship of educational level could not be shown. All results, as far as respective analyses were applicable, were largely in line with the English validation study[38].

3.3 Implications

With adequate psychometric properties, the German AFI is a valid and reliable instrument assessing subjective CRCI. Thus, the AFI may reasonably applied to assess and regularly monitor the subjective level of CRCI among cancer survivors across cancer survivorship phases. Such a monitoring in turn may provide the basis for targeted interventions to maintain or improve QoL among this patient group. Patients with low subjective CRCI should be also screened for CRF and depression. Our results were largely in line with those of the English validation study, presenting adequate stability of the results. For further research confirmatory factor analysis should be applied on the AFI. Also, the sensitivity of the instrument to assess intra-individual change should be tested in longitudinal studies[38].

3.4 Conclusion

Our results show that the German version of the AFI is a valid and reliable instrument measuring the subjective level of CRCI and thus can be reasonably applied to assess self-rated CRCI in German-speaking oncological populations[38].

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5 Appendix

5.1 Darstellung des eigenen Beitrags

Darstellung des eigenen Beitrags

Hiermit versichere ich, Esther Baumann, dass ich folgende Beiträge an der Publikation „Initial Validation of the German Version of the Attentional Function Index in a Sample of Haematological Cancer Survivors" hatte:

- Idee und Konzeption
- Statistische Datenanalyse
- Aufbereiten der Ergebnisse (Grafiken, Tabellen etc.)
- Literaturrecherche und Erstellen der Publikation als Erstautor

Eichwalde, 16.01.2021
Ort, Datum

Unterschrift, Esther Baumann

Unterschrift von 3 der 4 Ko-Autoren/innen

Heide Götze

Anja Mehnert-Theuerkauf

Peter Esser

5.2 Erklärung über die eigenständige Abfassung der Arbeit

Hiermit erkläre ich, dass ich die vorliegende Arbeit selbstständig und ohne unzulässige Hilfe oder Benutzung anderer als der angegebenen Hilfsmittel angefertigt habe. Ich versichere, dass Dritte von mir weder unmittelbar noch mittelbar eine Vergütung oder geldwerte Leistungen für Arbeiten erhalten haben, die im Zusammenhang mit dem Inhalt der vorgelegten Dissertation stehen, und dass die vorgelegte Arbeit weder im Inland noch im Ausland in gleicher oder ähnlicher Form einer anderen Prüfungsbehörde zum Zweck einer Promotion oder eines anderen Prüfungsverfahrens vorgelegt wurde. Alles aus anderen Quellen und von anderen Personen übernommene Material, das in der Arbeit verwendet wurde oder auf das direkt Bezug genommen wird, wurde als solches kenntlich gemacht. Insbesondere wurden alle Personen genannt, die direkt an der Entstehung der vorliegenden Arbeit beteiligt waren. Die aktuellen gesetzlichen Vorgaben in Bezug auf die Zulassung der klinischen Studien, die Bestimmungen des Tierschutzgesetzes, die Bestimmungen des Gentechnikgesetzes und die allgemeinen Datenschutzbestimmungen wurden eingehalten. Ich versichere, dass ich die Regelungen der Satzung der Universität Leipzig zur Sicherung guter wissenschaftlicher Praxis kenne und eingehalten habe.

15.02.2021 ..... E. Jansen .....

Datum Unterschrift

5.4 Verzeichnis der wissenschaftlichen Veröffentlichung

Baumann E, Kuba K, Götze H, Mehnert-Theuerkauf A, Esser P. Initial validation of the German version of the Attentional Function Index in a sample of haematological cancer survivors. *Eur J Cancer Care (Engl)*. 2020:e13226.