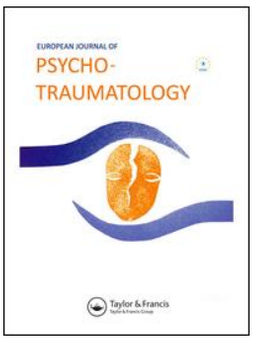

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A decennial review of psychotraumatology: what did we learn and where are we going?

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EDITORIAL

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A decennial review of psychotraumatology: what did we learn and where are we going?

Miranda Olff [a,b], Ananda Amstadter[c], Cherie Armour [d], Marianne S. Birkeland [e], Eric Bui [f], Marylene Cloitre[g,h], Anke Ehlers [i], Julian D. Ford[j], Talya Greene [k], Maj Hansen [l], Ruth Lanius[m], Neil Roberts [n,o], Rita Rosner[p] and Siri Thoresen [q]

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ABSTRACT

On 6 December 2019 we start the 10th year of the *European Journal of Psychotraumatogy (EJPT)*, a full Open Access journal on psychotrauma. This editorial is part of a special issue celebrating the 10 years anniversary of the journal and acknowledging some of our most impactful articles of the past decade. In this editorial the editors present a decennial review of the field addressing a range of topics that are core to both the journal and to psychotraumatology as a discipline. These include neurobiological developments (genomics, neuroimaging and neuroendocrine research), forms of trauma exposure and impact across the lifespan, mass trauma and early interventions, work-related trauma, trauma in refugee populations, and the potential consequences of trauma such as PTSD or Complex PTSD, but also resilience. We address innovations in psychological, medication (enhanced) and technology-assisted treatments, mediators and moderators like social support and finally how new research methods help us to gain insights in symptom structures or to better predict symptom development or treatment success. We aimed to answer three questions *1. Where did we stand in 2010? 2. What did we learn in the past 10 years? 3. What are our knowledge gaps?* We conclude with a number of recommendations concerning top priorities for the future direction of the field of psychotraumatology and correspondingly the journal.

Una revisión decenal de la Psicotraumatología: ¿qué aprendimos y hacia dónde vamos?

El 6 de diciembre de 2019 comenzamos el décimo año de la *European Journal of Psychotraumatogy (EJPT)*, una revista de acceso abierto completa sobre psicotrauma. Esta editorial es parte de un número especial que celebra el décimo aniversario de la revista y reconoce algunos de nuestros artículos más impactantes de la última década. En esta editorial, los editores presentan una revisión decenal del campo que aborda una gama de temas que son fundamentales tanto para la revista como para la psicotraumatología como disciplina. Estos incluyen desarrollos neurobiológicos (genómica, neuroimagen e investigación neuroendocrina), formas de exposición a traumas e impacto a lo largo de la vida, traumas masivos e intervenciones tempranas, traumas relacionados con el trabajo, traumas en poblaciones de refugiados y las posibles consecuencias de traumas como el trastorno de estrés postraumático (TEPT) o TEPT complejo, pero también resiliencia. Abordamos las innovaciones en tratamientos psicológicos, medicamentos (mejorados) y asistidos por tecnología, mediadores y moderadores como el apoyo social y, finalmente, cómo los nuevos métodos de investigación nos ayudan a obtener información sobre las estructuras de los síntomas o predecir mejor el desarrollo de los síntomas o el éxito del tratamiento. Nuestro objetivo fue responder tres preguntas *1. ¿Dónde nos encontrábamos en 2010? 2. ¿Qué aprendimos en los últimos 10 años?* y *3. ¿Cuáles son nuestras brechas de conocimiento?* Concluimos con una serie de recomendaciones sobre las principales prioridades para la dirección futura del campo de la psicotraumatología y, en consecuencia, la revista.

KEYWORDS
Trauma; Posttraumatic Stress Disorder (PTSD); genomics; neurobiology; exposure; lifespan; mass trauma; prevention; work-related; refugees; complex PTSD; treatment; medication; technology; research methods

PALABRAS CLAVE
trauma; TEPT; genómica; neurobiología; exposición; a lo largo de la vida; trauma masivo; prevención; relacionado al trabajo; refugiados; TEPT complejo; tratamiento; medicación; tecnología; métodos de investigación

关键词
创伤; PTSD; 基因组学; 神经生物学; 暴露; 生命全程; 大规模创伤; 预防; 工作相关; 难民; 复杂型PTSD; 治疗; 药物; 技术; 研究方法

HIGHLIGHTS

- Celebrating 10 years of the European Journal of Psychotraumatology the editors present a decennial review of core topics in the field and conclude with recommendations concerning top priorities for future research.

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Supplemental data for this artcile can be accessed at here.

回顾创伤心理学的十年：我们学到了什么，我们要去哪里？

在2019年12月6日，我们开始了《欧洲精神创伤杂志》（EJPT）的第十个年头，这是一份有关精神创伤的完整开放获取期刊。为了庆祝创刊十周年并致谢在过去十年中最有影响的文章，我们组织了一期特刊。这篇社论是其中的一部分。在这篇社论中，编辑们对该领域进行了十周年回顾，涉及期刊和创伤心理学这一学科的核心主题。其中包括神经生物学的发展（基因组学，神经影像学和神经内分泌研究）；在整个生命周期暴露创伤的形式和影响；大规模创伤和早期干预；与工作有关的创伤；难民人口中的创伤以及创伤的潜在后果，如创伤后应激障碍（PTSD）或复杂型PTSD，当然还有韧性。我们致力于促进心理、药物（增强）和技术辅助治疗方面的创新，探讨诸如社会支持之类的调节和中介因素，以及新的研究方法可以如何帮助我们了解症状结构或更好地预测症状发展或治疗成效。我们旨在回答三个问题：1.我们在2010年的情况如何？ 2.在过去的十年中，我们学到了什么？3.我们的知识空白是什么？最后，我们总结性地提出了许多建议，涉及创伤心理学领域以及本刊相应的未来发展方向要务。

1. Introduction

On December 6, 2010, the *European Journal of Psychotraumatogy* (*EJPT*) was launched. This resulted from an agreement within the board of The *European Society for Traumatic Stress Studies (ESTSS)* that the newsletter would be more impactful if transformed into a scientific journal which would be fully accessible and barrier-free to those with an interest in psychotraumatology from around the world, including researchers with no access to university libraries, clinicians, patients, policymakers, practitioners, etc. In turn, it became the first full *Open Access* journal on psychotrauma. To date, despite the general movement towards *Open* Science and the strong pressure from important funding bodies to publish *Open Access* (e.g. see Olff, 2019 and https://www.coalition-s.org), and several 'hybrid' journals offering authors the opportunity to publish their work as Open Access, it is still the only full gold *Open Access* journal in the field.

In this editorial, the editors have conducted a decennial review of our field with the main aim of answering three questions concerning a range of topics that are core to both the journal and to psychotraumatology as a discipline:

1. *Where did we stand in 2010?*
2. *What did we learn in the past 10 years?*
3. *What are our knowledge gaps?*

This editorial is part of a special issue/collection celebrating the 10 years anniversary of the journal where we will acknowledge some of our most impactful articles of the past decade (also discussed below and marked with * in reference list).

We have organized this editorial (see infographic, Figure 1) by starting with the more basic neurobiological aspects related to trauma, followed by exposure throughout the life span and in specific populations, then the mental health outcomes including symptoms and disorders as well as resilience and recovery, and ending with developments in treatment. Mediators and moderators are discussed and finally, we describe how new research methods have moved the field forward.

In concluding this decennial editorial, the editors have made a number of recommendations concerning top priorities for the future direction the field of psychotraumatology and correspondingly of the of journal.

2. Ten years of progress in genomics

In 2010, there was convincing evidence of the role of both genetic and environmental sources of variance in posttraumatic stress disorder (PTSD). Early twin studies in military populations and civilians estimated the heritability of PTSD to be in the range of 30–72% (Lyons et al., 1993; Sartor et al., 2011; Stein, Jang, & Livesley, 2002). Epidemiologic data with global representation has demonstrated that the majority of individuals (over 70%) will experience a traumatic event in their lifetime (Benjet et al., 2016; Kessler et al., 2017), yet the majority of those exposed do not develop PTSD. Taken together, the epidemiologic and behavioural genetic data suggest that preexisting genetic and/or physiological/neuroendocrine vulnerabilities may exist among those who develop PTSD in the aftermath of traumatic events. These studies helped lay the groundwork for a research agenda aimed at understanding the vast variability in posttrauma outcome from a biological and environmental perspective, as well as the complex ways that such risk has an interplay with the environment (Lanius, Frewen, Vermetten, & Yehuda, 2010). In 2010 there were approximately 30 molecular genetic studies of PTSD (Amstadter, Nugent, & Koenen, 2009), all of which were candidate gene designs of either variation, epigenetic modification, or expression – no agnostic genome, epigenome, or expression studies had been published. Much of this early work focused on the effects of genes in systems hypothesized to be important in the aetiology of PTSD (e.g. HPA-axis).

The past decade has seen rapid growth in molecular studies of PTSD. Developments in the field of molecular genetics, such as the decreasing costs of arrays, greater

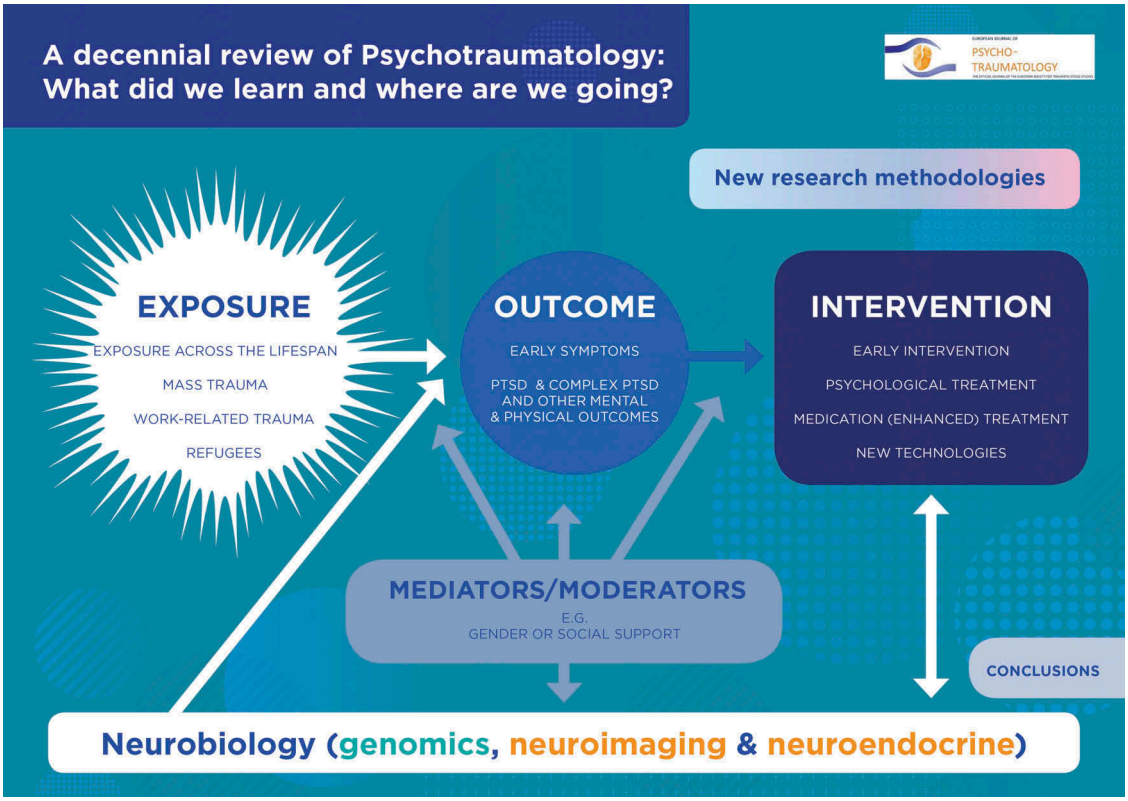

Figure 1. Infographic on key areas in psychotraumatology. Click on the infographic to meet the journal editors and hear them talk about what we've learnt.

accessibility of sample processing, team science (e.g. Psychiatric Genomics Consortia PTSD workgroup), and advancing analytic methods have been instrumental. Advances in this area have both been in the areas of 'big data' agnostic approaches, as well as in deeper dives into the molecular function of specific genes. Large-scale molecular platforms, such as those involved with genome-wide association studies (GWAS) allow for the examination of millions of variants in association with traits, and afford an agnostic approach to discover genes and biologic systems involved with disorders. The most recent meta-analyses of GWAS data from the PGC PTSD workgroup (n ~ 200,000) revealed numerous significant variants and quantified the molecular heritability of PTSD (Nievergelt et al., 2019). Collaborative efforts from the PGC have led to progress on finding epigenome-wide significant sites related to risk for PTSD (Smith et al., 2019). Systems biology advances, in large part driven by complex data-driven agnostic analytic approaches to multidimensional data (Neylan, Schadt, & Yehuda, 2014), are developing and hold promise and will be needed to co-analyse data on multiple omics platforms simultaneously. With regard to a detailed functional understanding of molecular mechanisms, studies conducted in the past decade have elucidated how functional genetic variants interact with environmental events (e.g. childhood trauma) to increase the risk for PTSD. Binder (Binder, 2017) provided an eloquent review of how a key gene within the stress response system, *FBKP5*, can increase the risk for PTSD. Specifically, with the combination of inherited genetic risk and childhood trauma a reduction in DNA methylation occurs at *FKBP5* which disrupts the homoeostasis and may results in lasting alterations of the neural circuits related to stress regulation. Another gene-environment (G x E) interaction study published in the journal did not find an interactive effect of the BDNF Val66Met polymorphism and child maltreatment on anxiety sensitivity in a sample of mixed-race adolescents, highlighting the need for replication in larger mixed-race samples (Martin, Hemmings, Kidd, & Seedat, 2018). Thus, there is a need for both 'big data' approaches, as well as lines of research that can further understanding of the molecular mechanisms that underlie risk.

With the recent proliferation of high dimensional molecular data there is a role for statistical methods development and application to best utilize data to understand risk, and ultimately inform treatment for PTSD. Translational impact of this work will be heightened by smaller, deeper phenotyped investigations of genes or systems, perhaps nominated by the agnostic systems biologic approach, to understand how risk unfolds in specific trauma contexts, cultures, developmental periods, and biologic sex and gender. There is a need for such studies to incorporate molecular risk

into other neurobiologically informed designs (e.g. imaging, immune functioning, stress responsivity) such as those reported in the *EJPT* 2017 special issue (Lanius & Olff, 2017). In sum, the era of high-throughput omics and systems biology offers the chance to more precisely identify the molecular features associated with increased risk for, or resilience to, PTSD; which may, in turn, facilitate the development of interventions targeting those most in need.

3. Neurobiology of PTSD: neuroimaging & neuroendocrine developments

In 2010, the predominant neurobiological model of post-traumatic stress disorder (PTSD) centred around fear conditioning (Shin & Liberzon, 2010), (Pitman et al., 2012) and delineating its underlying neurobiological correlates, including the ventromedial prefrontal cortex and the amygdala. *Neuroendocrine* research was trying to uncover the dysregulations associated with PTSD with a focus on the HPA-axis. However, at the time, the preparations for the new Diagnostic Statistical Manual-5 (DSM-5) criteria for PTSD and the proposed criteria for complex PTSD in the International Classification of Disease-11 (ICD-11) (Marinova & Maercker, 2015) suggested the importance of PTSD symptomatology extending beyond fear and needing to include dysregulation of a variety of emotional states, such as anger, guilt, and shame. In addition, emotional detachment, including symptoms of depersonalization and derealization, were beginning to be recognized as being critical to a subpopulation of individuals with PTSD in the DSM-5. These new symptom criteria laid the groundwork for the next decade of neurobiological research in PTSD.

In the past decade the *EJPT* contributed greatly to this new emerging theme of neurobiological research (e.g. Akiki, Averill, & Abdallah, 2018; Lanius, Frewen, Tursich, Jetly, & McKinnon, 2015). An early review paper in the journal outlined two different pathways examining the relationship between fear and dysregulation of other emotions (e.g. anger, guilt, and shame) in PTSD (Lanius et al., 2010). Here, the first pathway proposed that emotion dysregulation ensues as a result of fear conditioning and kindling/stress sensitization in response to (a) traumatic event(s). Neural networks involved here were proposed to centre around amygdala dysregulation. By contrast, the second pathway suggested that emotion dysregulation in PTSD may be a distal vulnerability factor related to genetic and developmental factors, which may lead not only to an exacerbation of fear but also to the dysregulation of other emotions in response to exposure to (a) traumatic event(s) during childhood, adolescence, or adulthood. These neural networks were proposed to extend beyond those involved in fear processing and include core networks involved in self-relevant processing, salience processing, and top-down emotion regulation.

The DSM-5 now also includes PTSD symptoms focusing on alterations in self- and other-relevant cognitions in response to traumatic events, such as 'It is my fault' or 'The world will never be the same again'. Here, results showed that women with a history of childhood trauma endorsed more negative and less positive words when describing themselves and others, respectively. These findings were mirrored by alterations in neural networks, including the default mode network (consisting of cortical midline and parietal regions), involved in the self-referential processing (Frewen, Thornley, Rabellino, & Lanius, 2017). Alterations in self- and other-relevant cognitions have also been associated with deficits in social cognition. Results published in *EJPT* demonstrated that childhood maltreatment was associated with alterations in the neural circuitry involved in the ability to understand the mental states of others (van Schie et al., 2017). Importantly, it has also been suggested that cultural differences in self-representation can have a profound impact on fear processing, emotion and autobiographical memory, and interpersonal functioning (Liddell & Jobson, 2016). Taken together, these findings suggest the importance of taking into considerations altered self- and other-related cognitions and deficits in social cognition when assessing and treating individuals with PTSD.

An important focus of *EJPT* has also been the neural correlates underlying treatment interventions, including both novel pharmacotherapeutic (Flanagan et al., 2019; Kelmendi et al., 2016; Olff et al., 2015) and psychotherapeutic approaches (Lanius et al., 2015). Here, one study demonstrated altered electroencephalogram patterns before and after Eye Movement Desensitization and Reprocessing (EMDR) treatment in patients with breast cancer (Carletto et al., 2019). In addition, two studies described potential neural mechanisms underlying EMDR by examining the effects of eye movements during traumatic memory recall. Results demonstrated that engaging in eye movements during traumatic memory recall was associated with decreased activation and neural connectivity of brain areas engaged in emotion processing (i.e. amygdala and rostral anterior cingulate cortex) (Thomaes, Engelhard, Sijbrandij, Cath, & Van Den Heuvel, 2016). Moreover, eye movements during traumatic memory recall may also facilitate engagement of frontoparietal networks underlying autobiographical memory retrieval and top-down emotion regulation (Harricharan et al., 2019).

Over the past decade, *EJPT* has also concentrated on neuroendocrine research. Here, research has confirmed the dysregulations in the *HPA-axis* associated with trauma and PTSD, as well as that of the *immune system*, showing generally lower basal cortisol output, enhanced

glucocorticoid receptor function, and a proinflammatory state pre-, peri- and posttrauma (Olff & van Zuiden, 2017), associated with past trauma (De Kloet, Vermetten, Rademaker, Geuze, & Westenberg, 2012; Pervanidou, Agorastos, Kolaitis, & Chrousos, 2017), but also under ongoing threat (Fragkaki, Thomaes, & Sijbrandij, 2016). There are some indications that the HPA-axis dysregulations may recover with effective psychotherapy (Olff, de Vries, Güzelcan, Assies, & Gersons, 2007a) and that glucocorticoid administration may augment the effects of psychotherapy for PTSD (Yehuda, Bierer, Pratchett, & Malowney, 2017); however, appropriately designed clinical trials are much-needed in this area. The first studies on the bonding hormone *oxytocin* in our field began approximately a decade ago (Olff, 2012; Olff, Langeland, Witteveen, & Denys, 2010), with an exponential increase after that (e.g. Bui et al., 2019; Bradley, Davis, Wingo, Mercer, & Ressler, 2013; Flanagan et al., 2019; Frijling, 2017; Olff et al., 2015). The initial findings with regard to both prevention and treatment potential of intranasal oxytocin administration seem promising. However, well-powered clinical trials are needed to confirm these findings and to carefully examine sex/gender aspects (Engel, in prep).

Future research will need to examine further how we can use neurobiological markers to improve diagnosis at an individual level and how we can apply this knowledge for personalizing treatment. Moreover, the relevance of neurobiological work to the *public health burden* of psychological trauma remains understudied. As Akiki et al. (2018) argued, advancing the field of neurobiology can pave the way for scalable interventions that can not only improve outcomes but also help to address the public health problem. It will also be critical to examine the effects of current and novel adjunctive neuroscientifically informed treatments on core large-scale neural networks affected by traumatic stress. In addition, there is an urgent need to incorporate brainstem and midbrain regions involved in innate, reflexive functioning into current neurobiological models of trauma-related disorders (Lanius et al., 2018; Terpou et al., 2019). Here, it will also be crucial to delineate further how disruptions in *sleep* and the circadian system may play important roles in the development and maintenance of traumatic stress (Sopp, Brueckner, Schäfer, Lass-Hennemann, & Michael, 2019, see special issue). Finally, potential neurobiological distinctions between PTSD and its dissociative subtype as outlined in the DSM-5 and PTSD and complex PTSD as described in the ICD-11 will need to be a priority.

4. Trauma exposure and impact across the lifespan

In 2010, we had evidence that exposure to interpersonal psychotrauma in early childhood could profoundly alter biopsychosocial development, learning, and relationships not only in childhood but across the lifespan into adulthood (van Dijke et al., 2011). We knew that these adverse effects of early life psychotrauma exposure were potentially due to chronic alterations in fundamental psychobiological processes involved in not only fear processing but also, more broadly, self-regulation across the full range of fundamental emotion states (Lanius et al., 2010) – and that they could also lead to epigenetic alterations or reprogramming of genes and their expression (Amstadter et al., 2009; Broekman, 2011). We also had evidence that profound traumatic loss of a primary relationship (e.g. becoming orphaned or widowed as the result of genocide) could have adverse effects for adults that are comparable in severity (e.g. suicidality), or even more severe (e.g. PTSD), than those experienced by children (Schaal, Dusingizemungu, Jacob, & Elbert, 2011). Thus, we knew that interpersonal psychotrauma could have profound adverse impacts not only when its onset was in early childhood but also later in life, i.e. when primary relationships were shattered in adulthood.

Now, we know that by midlife adulthood, exposure to psychotrauma is the norm rather than the exception, with 70% of N = 68,894 adults surveyed in 24 countries reporting at least one (and on average 3.2) past types of trauma exposure (Kessler et al., 2017). We know that interpersonal psychotrauma, particularly in the relatively rare form of sexual trauma, is associated with the highest risk of leading to PTSD, but that traumatic grief due to unexpected loss of a loved one (see also *special issue*: Boelen, Olff, & Smid, 2019), occurs so often that its adverse public health impact due to PTSD is comparable to that of sexual trauma despite more rarely leading to PTSD (Kessler et al., 2017). And we also know that when midlife and older adults (i.e. ages 50–87 years old) experience PTSD symptoms, this is associated with an increase over time in their subjective age and with problems in successful ageing (Palgi et al., 2019). Thus, although the origins of the complex biopsychosocial impairments associated with exposure to interpersonal trauma (including violence, abuse, and disrupted primary attachments) often can be traced back to childhood (Van der Kolk, Ford, & Spinazzola, 2019), their impact can persist into old age and includes a potentially dose-dependent increase in the risk of serious physical health problems (e.g. obesity, hypertension) and illness (e.g. cardiopulmonary disease, cancer) across the lifespan (Clemens et al., 2018).

What we do not know is how the neurobiological (Lanius & Olff, 2017), psychological (Baekkelund, Frewen, Lanius, Ottesen Berg, & Arnevik, 2018; Schafer, Becker, King, Horsch, & Michael, 2019), affective (Strøm, Aakvaag, Birkeland, Felix, & Thoresen, 2018), and relational (Heeke, Kampisiou, Niemeyer, & Knaevelsrud, 2019; van Dijke, Hopman, & Ford, 2018) alterations associated with different forms, durations, and structures

(Armour, Fried, & Olff, 2017; Murphy, Elklit, Dokkedahl, & Shevlin, 2018) of psychotrauma exposure (and re-exposure) emerge and take different courses or trajectories across the lifespan – and across generations (Burnette & Cannon, 2014; Crombach & Bambonye, 2015; Schick, Morina, Klaghofer, Schnyder, & Muller, 2013). Biopsychosocial mechanisms and processes involved in the long-term adverse impact of childhood trauma over decades into mid-life and old age (Glück, Knefel, Tran, & Lueger-Schuster, 2016) and across generations (Kuffer, Thoma, & Maercker, 2016) have been preliminarily conceptualized but remain understudied. We do not know how, for whom, and under what circumstances trajectories of post-traumatic resilience emerge across the lifespan, although we are beginning to understand that resilience is a complex and multifaceted phenomenon that warrants much further study (Iacoviello & Charney, 2014; Nugent, Sumner, & Amstadter, 2014; Sheerin, Stratton, Amstadter, & McDonald, 2018; Southwick, Bonanno, Masten, Panter-Brick, & Yehuda, 2014), particularly in order to inform enhancements of trauma-focused therapies based on promoting resilience (Schnyder, 2014).

5. Mass trauma and early interventions

By 2010, we knew that mass trauma, defined as 'trauma that occurs as a result of a frightening, potentially life-threatening event that is experienced by a large number of people simultaneously' (Webb, 2004, p. 4), could have devastating consequences (Neria, DiGrande, & Adams, 2011; Neria, Nandi, & Galea, 2008; Norris et al., 2002). There were a number of studies with longitudinal assessments of the natural course of PTSD, therefore we understood that many individuals recovered on their own within months of a traumatic event, and a considerable number of individuals showed a resilient mental health trajectory (Bonanno, 2004; Karstoft, Armour, Elklit, & Solomon, 2013). Some of the key questions concerned whether one should offer early interventions, and if so, to whom and with what content. The earlier optimism regarding the preventive effects of early interventions was dampened by studies of psychological debriefing that indicated such interventions could also have harmful effects (Rose, Bisson, Churchill, & Wessely, 2002). In 2007, a group of researchers proposed that early interventions should promote a sense of safety, be calming, and provide a sense of self- and community efficacy, connectedness, and hope (Hobfoll et al., 2007).

Since 2010, we have continued to explore the predictors of mental health problems after mass trauma. For example, negative outcomes were linked to type of disaster and event characteristics – such as injuries and fatalities (Grimm, Hulse, Preiss, & Schmidt, 2012), psychological, rather than geographical, proximity (Thoresen, Aakvaag, Wentzel-Larsen, Dyb, & Hjemdal, 2012), and prior traumatic experiences such as sexual abuse and violence (Nordanger et al., 2014). There has also been a broadening of the scope of possible outcomes, for example, school performance (Strøm, Schultz, Wentzel-Larsen, & Dyb, 2016), subjective physical health (Deschepper et al., 2018), and use of health services (Haga, Stene, Thoresen, Wentzel-Larsen, & Dyb, 2017). We have increasingly acknowledged the needs of children in the aftermath of disasters (see, e.g., special issue Dyregrov, Yule, & Olff, 2018). Furthermore, long-term studies have established that an experience of a disaster can become a psychological burden that endures for decades (Arnberg, Hultman, Michel, & Lundin, 2013; Bakic & Ajdukovic, 2019; Thordardottir et al., 2016; Zaetta, Santonastaso, & Favaro, 2011).

Regarding the psychosocial response to mass trauma, here have been efforts to reach consensus and share important lessons across borders and disasters (Reifels et al., 2013), and we are now aware that intervention in groups with low risk of developing mental health problems is not uncomplicated. An evidence base for some early interventions has only recently begun to emerge (Bisson et al., 2019; Roberts, Kitchiner, Kenardy, Lewis, & Bisson, in press). Some have proposed implementing stepped care models which begin with minimal interventions, before introducing more intensive interventions only for individuals with symptoms that does not decline over time (McDermott & Cobham, 2014). There has been an increased focus on trauma as a public health issue (Frewen, Schmahl, & Olff, 2017; Magruder, Kassam-Adams, Thoresen, & Olff, 2016) and post-disaster psychosocial support can now involve many disciplines (Jacobs et al., 2019).

A timely estimate of the risk of PTSD or other disorder is a prerequisite for early intervention. Even though we have some knowledge which is pertinent in the identification of groups that are at risk of developing negative outcomes post mass trauma such as natural disaster or terrorism, this information is less accurate on an individual level. Screening measures have been developed in this regard (Olff, 2015a), but how these can be best applied cross-culturally is largely unknown (Schnyder et al., 2016). To address this, the global collaboration on traumatic stress (Schnyder et al., 2017) has developed the Global Psychotrauma Screen (GPS) as a brief tool to crossculturally asses the wide range of consequences of psychotrauma (see www.global-psychotrauma.net/gps). After acute injury there is some research available aiming to estimate the risk of PTSD (e.g. Shalev et al., 2019), but also here more work is needed in order to target populations at risk.

There is also a lack of early intervention studies aiming to prevent negative outcomes for high-risk groups. We still have only a small number of longitudinal studies specifically focusing on mass trauma

populations that enable us to describe and understand how posttraumatic stress symptoms decline or increase, particularly after the first 2 years. Notably, however, several studies exist which assess PTSD trajectories within a range of traumatized populations (e.g. sexual assault survivors, military personnel); whether these findings are generalizable to the mass trauma field remain to be confirmed. Moreover, we understand little about the course of PTSD post-mass trauma at the individual level. Among the prevailing challenges of mass trauma is that the management of psychosocial support and healthcare may require intensive collaboration across disciplines.

Furthermore, we now have a new peri- and posttraumatic factor: social media (Hall et al., 2019). The rest of the world watches the disaster as it unfolds, and the conceptualization of criterion A may be challenged by the social media's inbuilt possibilities to witness aversive details of the disaster through the smartphones of those present. Also, the available information may be confusing and based partly on rumours. What consequences does this have for individuals, and how can we plan psychosocial support in the channels that people use? How is trust in other people and institutions affected by crisis management, and how can trust influence health in the afflicted individuals and societies? A better understanding of the healing environment on individual, social, and societal levels is likely to benefit future psychosocial support.

6. Work-related trauma

In 2010, we knew that traumatic exposure at work was potentially associated with the development of a wide range of psychological distress. High-risk occupations alone may account for approximately one-quarter of all sick-leave (e.g. Hooftman, 2009).

Although there is still a general lack of research into many areas of work-related trauma including a clearer definition of work-related PTSD, secondary traumatization, vicarious traumatization, compassion fatigue, and burnout (e.g. Greinacher, Derezza-Greeven, Herzog, & Nikendei, 2019; Sodeke-Gregson, Holltum, & Billings, 2013; Yehuda, Vermetten, McFarlane, & Lehrner, 2014)) research has become a lot more comprehensive today than it was 10 years ago. Furthermore, the recognition of workplace trauma as a risk of both primary and secondary traumatization is becoming increasingly clearer not only in research but also in the diagnostic criteria. Indeed, over the past decade the research field of exposure to trauma at the workplace has expended greatly from being primarily focused within specific high-risk trauma occupational settings (e.g. military and first responders) to acknowledging a wider range of occupational settings associated with trauma. Thus, today's research reflects both primary and secondary traumatization as well as research into associated risk and protective factors in various occupational groups (e.g. bank employees, ministerial employees, humanitarian staff, military services, police officers, mental care professionals, journalists, first responders, industrial disasters, and therapists (Backholm & Björkqvist, 2012; Christiansen & Hansen, 2015; Greinacher et al., 2019; Hansen & Elklit, 2011; Koch et al., 2017; Nissen, Hansen, Nielsen, Knardahl, & Heir, 2019; Ponce de León, Andersen, Karstoft, & Elklit, 2018; Skogstad et al., 2013: Sodeke-Gregson et al., 2013; Strohmeier & Scholte, 2015; Yehuda et al., 2014). Specifically, this has included an increased awareness and focus on risk and protective factors not only at an individual level but also at an organizational level (Greinacher et al., 2019; Koch et al., 2017; Nissen et al., 2019).

At the same time, workplace-related trauma has also been explicitly recognized in diagnostic criteria for PTSD in the DSM-5 (American Psychiatric Association [APA], 2013). Indeed, the stressor criterion A in the DSM-5 explicitly states that exposure to actual or threatened death, severe injury or sexual violence can also be endorsed by experiencing repeated or extreme exposure to aversive details of traumatic events (e.g. first responders collecting human remains; police officers repeatedly exposed to details of child abuse) in addition to directly experiencing or witnessing traumatic events (APA, 2013). Thus, work-related trauma is now recognized both as being experienced directly or indirectly in different ways. However, the specification of traumatic exposure is intentionally less explicitly stated in the ICD-11 where the diagnosis emphasizes the presence of a specific set of symptoms generated by an event (i.e. PTSD is a disorder that may develop following exposure to an extremely threatening or horrific event or series of events, WHO, 2018). Thus, specifically for work-related trauma, it is important that the different health authorities are aware that symptoms define the diagnosis and grant access to the right treatment and compensation for the victims when the symptom profile is satisfied. Finally, there is a recent increasing recognition that there is a need of an overall global and interdisciplinary approach and collaboration in the field of psychotraumatology including the need to prioritize work-related trauma and research into first responders in this work (Hansen & Olff, 2018; Schnyder et al., 2017; Vallières et al., 2018).

Future research needs to include a clearer conceptualization of primary and secondary traumatization including research comparing potential differences between the two diagnostic systems in relation to PTSD prevalence rates and severity following work-related trauma. Due to variation within and between trauma type and culture (e.g. Schnyder et al., 2016; Yehuda et al., 2014), future research needs to include

both organizational perspectives as well as individual and cultural perspectives on the psychological sequalae of work-related trauma and associated risk and protective factors to facilitate preventive actions and treatment. Organizational factors are of special interest within this specific field of study (e.g. the focus on operational factors as a source of occupational stress in a systematic review of the health and wellbeing of Military Drone Operators and Intelligence Analysts – Armour & Ross, 2016) as they provide a unique opportunity for actions to be taken to reduce the risk of both facing traumatic exposure at the different workplaces (e.g. security measures) as well as reducing the psychological distress following traumatic exposure (e.g. special training). Indeed, research indicates that special training has been associated with decreased risk of PTSD (Nissen et al., 2019; Skogstad et al., 2013) and that certain factors, e.g. employee safety perception may be important factors to target interventions after (Hansen & Elklit, 2011; Nissen et al., 2019). However, more research is needed in relation to how perceived safety can be targeted in training and treatment, and whether it leads to the improvements in mental health and functioning (Nissen et al., 2019).

7. Refugees

Flight and refuge as a research area has always been intertwined with the field of psychotraumatology, but was often regarded as especially challenging compared to other areas of research in mental health. Language barriers, cross-cultural issues, resettlement and acculturation, difficult and often dangerous living conditions, and human rights and legal considerations around changing laws in the host countries need to be considered when planning and researching prevention and intervention approaches (see, for example, Schnyder et al., 2015) – while at the same time we are confronted with a rapidly increasing number of refugees worldwide. From its beginning, *EJPT* encouraged submitting research on refugees (e.g. Schaal et al., 2011; Ter Heide, Mooren, Kleijn, de Jongh, & Kleber, 2011). Both papers stand for important topics in the field, namely treatment research in a most challenging setting and the multiple risks for survivors of mass trauma. Also, Schaal and colleagues were among the first to report on the effects of traumatic events in combination with losses, shedding more light on the interconnection between losses, posttraumatic stress disorder (PTSD) and depression. Later three special issues on refugees came out (Hall & Olff, 2016; Knaevelsrud, Stammel, & Olff, 2017; Purgato & Olff, 2015). In the following, some of the recent developments are highlighted.

While early publications discussed the applicability of concepts or even doubted that PTSD is a valid construct in non-western cultures (Summerfield, 1999), we have moved beyond this discussion for good. Today's focus is on adapting standard *measures* to different cultures and languages and on measurement invariance. Here the field has made tremendous progress (e.g. Kaltenbach, Härdtner, Hermenau, Schauer, & Elbert, 2017, with a psychometric evaluation of the Refugee Health Screener-15, a short instrument with good feasibility, reliability, and validity). Given the special conditions of refugees, measures covering specific aspects such as particularly stressful experiences during the flight, which are not covered well by standard measures of traumatic experiences, had to be developed (e.g. the Stressful Experiences in Transit Questionnaire; Purić & Vukčević Marković, 2019). Hopefully, we soon will be able to recommend a core battery of instruments, freely available in many languages – as we have done for trauma research in general (Olff, 2015a).

Developments with regard to human rights and the legal status of refugees became more explicit. At the height of the so-called 'European migrant crisis' or 'refugee crisis', Turner (2015) described the politics of deterrence and its detrimental effects in the context of the UK and Europe as a whole (see also Alisic and Letschert (2016) who describe an initiative to foster interdisciplinary collaboration of young researchers with the aim to influence European politics). In their review, Herlihy and Turner (2015) describe the role of lay assumptions on memory in legal hearings during the asylum process. Psychological findings that inconsistent memories, recall and report may be connected to the PTSD-specific symptoms of avoidance and memory distortions as well as to emotions like shame are still not adequately considered in courts. Schock, Rosner, and Knaevelsrud (2015) evaluated the impact of asylum interviews on the mental health of asylum seekers. While posttraumatic avoidance and hyperarousal symptoms decreased after the hearing, intrusion increased, with perceived justice of the interview as a predictor. And in a severely burdened and highly comorbid sample of refugees in Germany, the connection of symptom load (PTSD, depression and prolonged grief) to asylum decisions became evident. Those with processing and appeal status showed higher symptom load than those who had a temporary residence permit (Comtesse & Rosner, 2019).

Ten years ago, most publications focused on the uncontrolled results of single studies. The overall notion was that treatments need to be specifically developed for refugees and that already known evidence-based interventions would not be transferable. Now, due to the increasing numbers of studies, it is possible to summarize findings in systematic reviews and meta-analyses and to derive first recommendations (Turrini et al., 2019).

A meta-analysis on the effectiveness of psychosocial interventions for displaced war-traumatized minors (Nocon, Eberle-Sejari, Unterhitzenberger, & Rosner, 2017) identified a lack of evidence-based interventions for children and adolescents. Many interventions were tested only once, quite often in small samples and in designs with methodological shortcomings. Another significant contribution to the field is the recently published meta-analysis on the effectiveness of narrative exposure therapy (NET; Lely, Smid, Jongedijk, Knipscheer, & Kleber, 2019). NET has been widely discussed as the treatment of choice in low to middle-income countries and has been studied in various contexts among traumatized refugees and other trauma survivors. The authors based their analysis on 16 randomized controlled trials and found large effect sizes for PTSD in comparison to wait-list and moderate effects when compared to active treatment. There is quite a number of studies that successfully evaluated trauma-focused cognitive behaviour therapy (Tf-CBT) for children in non-western cultures and/or low-income countries. Given that we now know more about helpful interventions, these interventions should be made available in routine care. And – not yet addressed in research – we might need to gain knowledge about the de-implementation of unhelpful interventions.

8. Diagnosis of PTSD and complex PTSD

What we knew in 2010 was that the diagnosis of PTSD as represented the DSM-IV and ICD-10 was insufficient to capture the range and diversity of symptoms experienced by trauma-exposed populations, particularly those who experienced prolonged or chronic trauma but there were no accepted diagnostic alternatives (Sar, 2011). Attempts to articulate salient and reliable core symptoms of more complex forms of PTSD had either not been accepted (DSM) or been weakly adopted (ICD). The presence and position of dissociation as an integral part of post-traumatic responses was undefined and the well-recognized presence of multiple other types of outcomes such as depression, addiction, phobias and physical disorders created challenges in the conceptualization and treatment of the consequences of trauma. Trauma-related diagnoses for children were poorly represented in both DSM and ICD. Lastly, many trauma-related diagnoses were scattered across the diagnostic system and there was a call to organize trauma-related disorders under a single parent umbrella.

Since 2010, revisions of both the DSM and ICD diagnostic systems have emerged (for a comprehensive systematic review of DSM PTSD revisions see – Armour, Műllerová, & Elhai, 2016). Both now organize all trauma-related diagnoses under one conceptual umbrella which will facilitate conceptual coherence, differential diagnosis, and identification of similarities and differences in treatment implications. DSM-5 (APA, 2013) has expanded to include 'negative adaptations in mood and cognitions' as well as a dissociative subtype (see – Hansen, Ross, & Armour, 2017). ICD-11 has introduced a conceptually similar update of ICD-10 PTSD and introduced a new diagnosis complex PTSD (CPTSD) which includes the symptoms of ICD-11 PTSD as well as symptoms representing disturbances in self-organization (DSO) the latter of which has been demonstrated to be associated with early life and chronic trauma (WHO, 2018). Evidence for discriminability (e.g. Cloitre, Garvert, Brewin, Bryant, & Maercker, 2013) and symptom structure (e.g. Murphy et al., 2018) of the two ICD disorders has been reported across several different countries and cultures (Karatzias et al., 2018) and is expected to support the clinical utility of the diagnoses at a local and global level. Development of reliable and brief self-report measures for ICD-11 PTSD and CPTSD (Cloitre et al., 2018) have been developed using item response theory and other-related methods (Shevlin et al., 2018).

Ongoing and future research involve comparisons of the structure of ICD and DSM diagnoses and determining whether they generate different prevalence rates. The most comprehensive factor model analyses to date suggest the superiority of the ICD-11 PTSD relative to the DSM model as a fit to the data (Hansen, Hyland, Armour, Shevlin, & Elklit, 2015). At least one study of children has also found a superior fit for ICD-11(LaGreca, Danzi, & Chan, 2017). Different answers have emerged regarding prevalence rates with some finding little differences in overall prevalence rates (Hansen et al., 2017; Kuester et al., 2017) and others indicating that ICD is associated with lower rates of disorder (Stammel, Abbing, Heeke, & Knaevelsrud, 2015). Clear answers to both the fit of the data and the prevalence rates associated with ICD and DSM disorders require the use of reliable measures, which have been established. While there has been an initial investigation of the presence of different kinds of dissociation in individuals with DSM-5 PTSD compared to ICD-11 PTSD and CPTSD (Powers et al., 2017), how best to characterize the type and severity of dissociation as related to ICD-11 PTSD and CPTSD remains to be investigated. While initial evidence suggests that CPTSD is distinghishable from a borderline personality disorder (Cloitre, Garvert, Weiss, Carlson, & Bryant, 2014), additional investigations using other methodological approaches such as network analysis (Knefel et al., 2019) are needed to assess the discriminability of CPTSD from BPD and other disorders. In addition, while there is substantial progress in understanding the impact of trauma on development and assessment (Kolaitis, 2017; Verlinden et al., 2013), better characterization and measurement of PTSD and CPTSD among children and adolescents, as well as in the elderly is needed and underway. Lastly, the delivery of treatments

adapted to the complexity of the individual symptom profile in both adults and child populations is important, and models to develop and test personalized therapies are available (Cloitre, 2015), indicating a potentially rich and productive future for treatment research.

9. Psychological treatment development and delivery

By 2010, several effective trauma-focused psychological treatments for PTSD had been developed and shown to be efficacious in randomized controlled trials. We now also know these are not only effective in the short-term, but also in the long-term (see Kline, Cooper, Rytwinski, & Feeny, 2018). We also have evidence from health economic studies that these treatments are cost-effective (De Bont et al., 2019; Shearer et al., 2018). On the basis of comprehensive meta-analyses, recent national and international clinical guidelines have recommended several trauma-focused cognitive behavioural treatment programmes and EMDR as first-line treatments for PTSD (APA, 2017; International Society for Traumatic Stress Studies, 2019; National Institute of Health and Care Excellence, 2018).

Since 2010, we have seen innovations in the modes of treatment delivery, which have increased patient choice and access to treatment. For example, we have learned that trauma-focused psychological treatments can be safely and effectively delivered in an intensive format (Ehlers et al., 2014; Hendriks, de Kleie, Broekman, Hendriks, & van Minnen, 2018; Méndez, Nijdam, June Ter Heide, van der Aa, & Olff, 2018; Van Woudenberg et al., 2018). We have also seen that therapist input can be shortened through the use of self-study modules (Wild & Ehlers, 2010) and that rotation of therapists is feasible (Van Minnen et al., 2018). Digital treatment delivery via online treatment modules or virtual reality has opened up new ways of working with patients and has made treatments more accessible (see section 11).

Despite the large mean improvement with trauma-focused psychological treatments for PTSD, not everyone responds and some responders only achieve moderate improvement. Analyses of common ingredients of effective treatments have identified some common mechanisms such as change in negative personal meanings of the trauma and activation and change of trauma memories, which may help with making interventions more focused and possibly increasing their efficacy and efficiency further (Brown, Belli, Asnaani, & Foa, 2019; Olff et al., in press; Schnyder et al., 2015). In addition, research into innovative approaches such as pharmacological enhancers in exposure therapy (De Kleine, Rothbaum, & van Minnen, 2013) or neurofeedback (Lanius et al., 2015) may offer new avenues for treatment if reliable effects are demonstrated. Many people with PTSD seek complementary and integrative treatments, and their efficacy and mechanisms of action need to be better understood (see *EJPT* special issue).

There have been increased efforts to adapt and evaluate evidence-based interventions for children and adolescents (Kramer & Landolt, 2011; Nocon et al., 2017) and patients with multiple traumatic events and complex needs such as military veterans (Kitchiner, Roberts, Wilcox, & Bisson, 2012), refugees (see also section 7) (Lely et al., 2019; Nocon et al., 2017), survivors of childhood sexual abuse (Cloitre et al., 2010; Steil et al., 2018) and patients with comorbid personality disorders (Slotema, van Den Berg, Driessen, Wilhelmus, & Franken, 2019). Meta-analyses suggest that the same types of treatment, trauma-focused treatments, obtain the greatest effect sizes in most of these populations (Ehring et al., 2014; NICE, 2018). However, there is some evidence that such treatments are less effective for current military personnel and veterans than in the general population (Kitchiner, Lewis, Roberts & Bisson, 2019).

We have also seen an increased commitment of government institutions to creating access to evidence-based trauma-focused treatments internationally, for example, we have seen large roll-outs into the Veterans Administration Services in the USA (Karlin et al., 2010), and the National Health Service in the UK (Clark, 2018). However, dissemination programmes have a range of difficulties and obstacles to overcome, and decreases in overall effectiveness have been observed under some conditions. There is a need for further studies of optimal institutional conditions and training programmes for such large-scale implementations (Foa, Gillihan, & Bryant, 2013), and the need for cultural adaptations should be considered (Schnyder et al., 2016). With the greater dissemination of evidence-based treatments, individual differences in treatment response can be more reliably studied than in the relatively small randomized trials. Moderator analyses may help identify indicators of the likelihood that people will respond to different treatments and thus help provide guidance for clinical decision-making.

The large influx of traumatized refugees from Syria and other countries has challenged health-care systems in Europe and trauma researchers have been involved in shaping policies to address their mental health needs (Munz & Melcop, 2018; Sijbrandij et al., 2017; see section 7 on refugees).

10. Medication (enhanced) treatment

In 2010, first-line pharmacotherapy approaches for the treatment of PTSD relied mainly on selective serotonin reuptake inhibitor (SSRI) and serotonin and norepinephrine reuptake inhibitor (SNRI) antidepressants (VA/DOD, 2010). In particular, the level

of evidence was highest for the SSRIs paroxetine and sertraline, and for the SNRI venlafaxine, although most recommendations suggested that other SSRI would have similar efficacy. There was also emerging evidence for the alpha-adrenergic blocker prazosine for reducing trauma-related nightmares, and for antipsychotics agents as adjunct treatments.

In 2010, combining SSRIs/SNRIs with evidence-based psychotherapy was also relatively common although there was no strong evidence supporting such combinations (Hetrick, Purcell, Garner, & Parslow, 2010), nor a strong scientific/mechanistic rationale to support them.

What did we learn in the past 10 years? Previous advances in pharmacological treatments for PTSD had relied mainly on clinical trials investigating the efficacy of compounds developed and marketed for commonly comorbid conditions, as it was the case for SSRIs and SNRIs or atypical antipsychotics. This was also the case more recently, with ketamine that has been shown to be efficacious for depression, with trials underway for PTSD (Abdallah et al., 2019).

Recent treatment research has sought to build on our knowledge of PTSD's pathophysiology by targeting fear processing and extinction learning. Thus, systems implicated in the consolidation of fear memories including oestradiol and progesterone system (Garcia, Walker, & Zoellner, 2018), and the renin–angiotensin system (Terock et al., 2019) have become the focus of attention of recent translational research. A few clinical trials in humans are now underway, for example, for the angiotensin II receptor antagonist losartan (NCT02709018), however, to date, this translational approach has not yielded clinical results yet. Perhaps more importantly, these advances in our understanding of fear consolidation and extinction have led to novel strategies to combine pharmacotherapy and psychotherapeutic approaches, with the emergence of brief and targeted administration of drugs as a way to pharmacologically manipulate memory processes during psychotherapy sessions. This is a major shift in the way drugs are used to treat psychiatric disorders. These strategies focused either on *enhancing fear extinction learning* through the administration of pharmacological compounds during sessions of exposure (De Kleine et al., 2013), including, for example, the N-methyl-D-aspartate receptor (NMDA) agent D-cycloserine (Mataix-Cols et al., 2017), or on *blocking memory reconsolidation* with administration of a beta-adrenergic blocker, propranolol, during sessions of reactivations of traumatic memory (Brunet et al., 2018). Further, ±3,4-methylenedioxymethamphetamine (MDMA), also known as the street drug ecstasy has also been studied as a potential enhancer of psychotherapy. In this case, it is posited that MDMA might enhance the fear memories to facilitate their processing during therapy (Mithoefer et al., 2018), although the specific mechanism is still unclear.

These novel combination approaches are all the more interesting as emerging data over the past decade suggest that combining SSRIs and trauma-focused therapy may not yield additional therapeutic benefits over a single treatment strategy (Rauch et al., 2018).

Further, recent efforts in the past 10 years have tried to leverage growing advances in our understanding of the cognitive neurobiological, and genetics bases of PTSD, with a number of pharmacological approaches moving away from the fear-based models of PTSD (and monoaminergic system) being proposed (Kelmendi et al., 2016). The oxytocin system implicated in pro-social behaviours (Flanagan et al., 2019) and resilience (Bradley et al., 2013) has been proposed as a potential new avenue for treating or preventing PTSD (Olff et al., 2014; van Zuiden et al., 2017). Similarly, recent data on the cannabinoid system suggest that inhibiting the fatty acid amide hydrolase (FAAH) might be efficacious in treating PTSD (Ney, Matthews, Bruno, & Felmingham, 2019).

What are our knowledge gaps? Despite major changes in the way pharmacological treatments for PTSD are conceptualized developed, and tested, we still have a long way to go. In 2020, the only FDA- and EMA-approved medications for PTSD are still SSRIs and SNRIs. It is now established that the pathophysiology of PTSD involves a deficit in fear processing and/or extinction learning. This could be leveraged to support a translational programme of research to systematically identify, repurpose, (or develop), and test the efficacy of pharmacological compounds on different memory processes, in the same fashion as the field of cancer treatment research has evolved years ago. Combining drugs to enhance psychotherapy approaches have the potential to be transformative not only for PTSD, but also across all psychiatric disorders; however, if these approaches eventually deliver on their promises, they will require some adaptation of how treatments are delivered in real world, for their wide implementation, as to date, prescribers rarely deliver trauma-focused therapy, and psychotherapists do not usually prescribe. Finally, while current pharmacotherapy research have heavily relied on a fear-based model of PTSD, future treatment research will likely focus on new neurobiological pathways.

11. New technologies and trauma interventions

In the 2000's we began to see the emergence of a number of new technologies, with the potential to radically alter the provision of care for those with trauma-related difficulties. In that decade, there was little evidence to make specific recommendations on

any new technology approach as a feature of standard care, although some approaches such as the use of virtual reality were starting to excite a great deal of interest (Rizzo & Shilling, 2017). The last 10 years have seen the rapid proliferation of these new technologies (Olff, 2015b) and the trauma field has been keen to explore this new world, as often reported in this journal. Research into the use of virtual reality has continued to develop (Kothgassner et al., 2019; Rizzo & Shilling, 2017), evolving in recent years to incorporate cognitive-motor components as an innovative element in a personalized virtual interactive intervention, aimed at individuals with treatment-resistant PTSD (Nijdam & Vermetten, 2018).

The internet has become a key source of information and advice for trauma survivors and PTSD sufferers. Internet and app based mental health interventions have increasingly been investigated by researchers, with encouraging results. (Cernvall, Sveen, Bergh Johannesson, & Arnberg, 2018; Ruzek et al., 2011). Over the past 10 years researchers have been increasingly exploring the delivery of therapy via the internet (Wild et al., 2016). Researchers have begun to demonstrate the feasibility and acceptability of delivering established treatments online (Simon et al., 2019; Wild et al., 2016) and via Skype (Ashwick, Turgoose, & Murphy, 2019). Several studies are also underway to explore the possible efficacy of new technologies such as internet-based virtual reality (Freedman, Dayan, Kimelman, Weissman, & Eitan, 2015), digital reappraisal training (Beer, Neerincx, Morina, & Brinkman, 2017) and novel game-based interventions (Asselbergs et al., 2018) as early interventions.

Drawing on work undertaken with individuals with serious mental illness, some researchers are starting to identify the *digital phenotype* or signature of disorders such as PTSD via computerized measurement tools, through a variety of mediums, including smartphone, electronic biometric data collection and artificial intelligence (Bourla, Mouchabac, El Hage, & Ferreri, 2018). It is argued that these types of approaches have the potential to radically alter the way that we approach assessment and evaluation (for example, see Price et al., 2018). This field is in its infancy but a number of studies aiming to identify PTSD related digital phenotypes are underway (Bourla et al., 2018).

The pace of development of new technology approaches provides huge opportunities to the field. New Smart technologies such as m-health provide flexibility and anonymity for users, offer immediate availability and support, put users in control, and potentially increase capacity to deliver interventions and lowers health service costs (Olff, 2015b). They also have the potential to reach many people in low- and middle-income countries, in ways that have never been possible before (Schnyder et al., 2017). The growth of these technologies also poses many challenges to the field (Olff, 2015b). The pace of innovation can appear breath-taking and it is easy for developers, researchers and clinicians to be seduced by the spectacular (Olff, 2015b). As new technologies proliferate a key challenge for clinicians and trauma sufferers is how to ensure that interventions are acceptable to users and have been appropriately and rigorously evaluated. We are still grappling with the most effective ways to evaluate these new tools; we know little about adverse reactions; and we are still trying to understand the optimal role of the clinician in this new world (Olff, 2015b). We also know little about the response to new technologies of those with the most complex needs, where a relationship with a real person is usually perceived as being crucial to the process of recovery (Ashwick et al., 2019). We do know that new technologies are changing our field in astounding ways and that rigorous research is essential to the way that we embrace this world.

12. Social support and sex/gender research

There are many factors that potentially mediate or moderate the risk of health problems in individuals who are exposed to trauma. Social support is probably the most studied in psychotraumatology. In 2010 the relationship between perceived social support and mental health problems, such as depression and PTSD, was well established (Thoits, 2011). The link between social support and health has been primarily understood as a buffer effect of social support (*the buffer hypothesis*). In other words, individuals who experience high levels of support are better equipped to cope with major life adversities. Within trauma populations, a lack of social support had been identified as one of the most important risk factors for PTSD following traumatic events (Brewin, Andrews, & Valentine, 2000; Ozer, Best, Lipsey, & Weiss, 2003). Further, social support was found to impact on symptom severity and recovery (Charuvastra & Cloitre, 2008). Although the association between social support and mental health is robust and has been replicated in various trauma samples in many different settings across age and gender, an understanding of the mechanisms involved was limited due to the cross-sectional designs and short follow-up time of many studies.

Today, we acknowledge that the relationship between social support and mental health is much more complicated than the buffer hypothesis suggests, and causal directions are far from clear. Some results support previous notions that social support may protect against later PTSD (*the social causation hypothesis*) (Freedman, Gilad, Ankri, Roziner, & Shalev, 2015). A high level of social support also relates to a rapid decline in symptoms (Birkeland, Nielsen, Hansen, Knardahl, & Heir, 2017), while poor social support may increase the risk of complex PTSD (Simon, Roberts, Lewis, van Gelderen, &

Bisson, 2019). Other studies suggest an opposite causality, in which mental health problems lead to social erosion (*the social selection hypothesis*) (Lai, Osborne, Piscitello, Self-Brown, & Kelley, 2018; Nickerson et al., 2017). A few studies suggest a primary social causation effect which later reverses to a social selection effect (Kaniasty & Norris, 2008). Recent research has shed light on barriers that may prevent people from making use of social support, and hence miss out on the potential positive effect social interactions can have on emotion regulation and cognitions. Examples of such barriers are the need to protect others from distress, an expectation that other people cannot understand, or an expected loss of status in the eyes of others (Arnberg et al., 2013; Evans, Pistrang, & Billings, 2013; Thoresen, Jensen, Wentzel-Larsen, & Dyb, 2014). The latter may relate to shame-inducing trauma in particular, because shame is related to hiding, withdrawal, and negative responses from other people which may erode social relationships over time, resulting in loneliness (Strøm et al., 2018). Some of these studies indicate important gender differences in the pathways between trauma, social relationships, and health.

These recent advances certainly open up new clinical perspectives, but also underscore the need for a better understanding of the driving forces in the link between social support and mental health in the aftermath of trauma. New and promising perspectives include the role of oxytocin in social relationships and bonding after trauma (Olff, 2012; Olff et al., 2014), although the neurobiology behind social support, and e. g. the role of sex/gender still is far from understood (Engel et al., subm) and the development of interventions for victims of violence that aim to increase levels of social support (Hansen, Eriksen, & Elklit, 2014). It seems that social interactions cannot be fully understood from a purely individual perspective, and new contributions highlight the need for a societal or ecological approach (Ajduković, 2013; Biruski, Ajdukovic, & Stanic, 2014; Bryant, 2016; Maercker & Hecker, 2016). More research is also needed on how to manage a lack of recognition or worse disapproval by society as we may see after, e.g. certain military operations. Further, a unidimensional construct of social support can hardly capture the multifaceted and dynamic web of social interactions that people engage in. We need research that considers social connectedness or loneliness, social support structure, and potential positive or negative responses from other people or from society. There is a need for more refined conceptualizations and measurements that capture the social processes associated with positive health. We also need to explore potential age or gender differences in social interaction and its relationship with health.

One other important factor to consider is that of *sex or gender* (e.g. Olff et al., 2007; Olff, 2017; Christiansen & Hansen, 2015. There is a clear need to enhance our understanding of the way sex and gender influence (mental) health experiences after exposure to trauma, how they affect our measures, and how they can inform psychosocial care, ranging from public health to specialized treatment. At a minimum we need to report the sex of research subjects, justify single-sex studies, discriminate between sex and gender (mostly for human research), analyse how sex or gender impact the results, and discuss sex and gender issues when relevant (see *EJPT*'s gender policy, Olff, 2016).

13. How new methods affect psychotraumatology

The last decade of psychotraumatology has been characterized by methodological innovation across different domains. The results of many of these advances have been outlined in this editorial, including those related to brain imaging, genetic research, online data collection and treatment delivery.

Alongside the aforementioned advances, technological developments have transformed analytic approaches in psychotraumatology. In 2010, there was much interest in using *structural equation models* to investigate PTSD through *exploratory factor models* (Elklit & Shevlin, 2007; Lancaster, Melka, & Rodriguez, 2009), exploring the ways in which traumatic stress symptoms group together, as well as in relation to other disorders. Over the last 10 years, as evidence accumulated, researchers started to apply *confirmatory models* to examine various diagnostic conceptualizations and groupings. In addition, there was a great deal of interest in studying heterogeneity in people's responses to traumatic events, both in terms of symptom profiles using *latent class/profile analyses* (Cloitre et al., 2013), and in terms of long-term trajectories using *latent growth mixture models* (Armour, 2013; van de Schoot, 2015). These methods helped researchers to clarify the differences between PTSD and complex PTSD, to inform changes regarding the diagnostic criteria for PTSD, and to understand the importance of tailoring prevention and treatment approaches for people with different symptom profiles and recovery trajectories.

Taking a more fine-grained approach to the way that symptoms co-occur, the *network approach* to psychopathology started to emerge around a decade ago (Borsboom, 2008; Borsboom, Cramer, Schmittmann, Epskamp, & Waldorp, 2011), in part, reflecting a general rise in complex systems research across many disciplines. Network models of psychopathology conceptualized mental health disorders as causal systems, in which symptoms interact and reinforce each other and themselves, leading to the build-up and maintenance of disorder, and potentially to additional comorbid phenomena (Cramer, Waldorp, van der Maas, &

Borsboom, 2010). Network analytic studies of PTSD aim to use statistical tools to estimate and vizualise the relationships between different symptoms or elements that comprise PTSD. Network analysis has the potential to probe the structure of PTSD in various ways, including identifying symptoms central to the network, investigating comorbidity, and detecting symptom clusters, among others (Armour, Fried, Deserno, Tsai, & Pietrzak, 2017; Bryant et al., 2017; Frewen, Schmittmann, Bringmann, & Borsboom, 2013; Fried et al., 2017; McNally, 2017). In 2017, *EJPT* led the way by being the first journal to publish a special issue on network analysis in psychotraumatology (Armour, Fried, & Olff, 2017). This special issue contained network analyses of PTSD in refugees (Spiller et al., 2017), sexual abuse survivors (McNally, Heeren, & Robinaugh, 2017), and terror attack survivors (Birkeland & Heir, 2017), as well as a study exploring comorbidity of ICD-11 PTSD symptoms with anger and shame (Glück, Knefel, & Lueger-Schuster, 2017).

Another important development has been the rising use of *machine learning* approaches, which emphasize prediction over explanatory models (Yarkoni & Westfall, 2017). Recent studies in the field of psychotraumatology indicate that machine learning might help us to identify variables of different types that are highly predictive of subsequent psychopathology, and thus give an indication to which individuals are at higher risk of PTSD following trauma exposure due to particular constellations of individual, social, environmental and exposure factors (Karstoft, Galatzer-Levy, Statnikov, Li, & Shalev, 2015), as well as early responses following exposure (Galatzer-Levy, Karstoft, Statnikov, & Shalev, 2014; Galatzer-Levy, Ma, Statnikov, Yehuda, & Shalev, 2017).

Bayesian methods have also increasingly been applied in the field of psychotraumatology, in part due to their ability to handle computationally complex models, sometimes with limited sample sizes (van de Schoot, Schalken, & Olff, 2017). Bayesian statistics have been integrated into some of the other statistical approaches listed here. Indeed, combining different statistical approaches may be the most successful strategy.

Despite these promising developments, we still have many knowledge gaps. We are not sufficiently able to predict who will develop PTSD or other long-term negative outcomes following trauma exposure, nor to successfully predict who will successfully respond to which kind of treatment. While network analysis, machine learning approaches, Bayesian methods, and other analyses are developing at an extremely rapid pace, they have limitations. The emerging body of PTSD network studies indicates there is a great deal of heterogeneity among the findings (Birkeland, Greene, & Spiller, in press). Furthermore, it is not clear what role central symptoms play in a network, or whether central symptoms in a network should be considered good intervention targets (Bringmann et al., 2019). Dynamic network analyses utilizing intensive longitudinal data may help to answer these questions, but few dynamic network PTSD studies have been published so far (Greene, Gelkopf, Epskamp, & Fried, 2018; Greene, Gelkopf, Fried, Robinaugh, & Lapid Pickman, 2019; Hoffart, Langkaas, Øktedalen, & Johnson, 2019), and there is a need for many more in this vein. Another important question is how to derive idiographic PTSD models in order to provide personalized interventions, given that recent work indicates that there is little agreement both about how to derive idiographic models of psychopathology, as well as the translation of these models to clinical recommendations (Bastiaansen et al., 2019). An additional challenge facing researchers is the development of analytic tools that successfully identify and separate out the common or core features of PTSD that are shared by all those with the disorder, from the more idiographic elements that vary from person to person.

While the predominant aetiological models of PTSD and other stressor-related conditions mostly rely on linear causality (i.e. A causes B), emerging evidence from the network analyses models of mental disorders, studies utilizing intensive longitudinal data, as well as studies on the role of the social environment indicate that the development of PTSD does not necessarily result from a direct causation but is likely to be far more complex (e.g. A causes B that causes C that causes A …), may also involve a number of different moderators (i.e. A causes B only if M is present), and may develop along different timeframes (i.e. A causes B to occur almost immediately, A causes C to occur the next day, while A causes D to develop over some weeks).

Smartphone technology has facilitated an intensive longitudinal data collection. This, along with the emergence of artificial intelligence, and of the field of computational psychiatry, is an opportunity to develop and test increasingly complex (and accurate) aetiological models. More studies in a wide variety of samples with different kinds of trauma exposure, utilizing novel analytic approaches, based on prospective data, ideally with many measurement points for each participant, are needed to clarify the heterogeneous dynamic and complex processes that lead to PTSD, and eventually improve the early detection and more personalized treatment of individuals at risk for long-term negative outcomes.

14. Conclusion

We have seen important developments over the past 10 years. The introduction of DSM-5 and ICD-11 has increased research with regard to diagnosis and symptom structure. The progress in neurobiology and treatment research, as well as the exciting methodological

advances as summarized above, are impressive. Without repeating the recommendations in the sections above we highlight the following:

With regard to neurobiology, psychotraumatology research should continue to harness the power of team science to harmonize phenotypes to allow for well-powered genomics analyses of PTSD. Specifically needed will be the co-analysis across multiomics platforms that allows for the integration of genetic sequencing, epigenetic, and gene expression analyses. This will allow for a comprehensive picture of the systems biology of PTSD. More research is needed to develop neurobiological models that extend beyond the conceptualization of PTSD as a disorder of fear and include symptoms of emotion dysregulation, altered self-processing, interpersonal dysfunction, and dissociation. Research on how cognitive neuroscience or neurobiological markers can improve diagnosis at an individual level and on how to better personalize treatment as well as true longitudinal neurobiological studies are much-needed. Another new area to address is that of neurobiology in relation to the *public health burden* of trauma.

Trauma exposure and sequelae should be considered across the lifespan (and across generations), accounting for variation by age/developmental epoch, sex/gender and sexual identity, race/ethnicity, culture, socioeconomic status, disability, and social support, to examine a variety of potential courses of outcomes, including resilience. A comprehensive network-based theoretical model for lifespan and transgenerational trajectories of exposure to traumatic stressors and adversities, and outcomes could be developed and tested.

Predicting symptom development and improving recovery requires more research on prognostic screening instruments to increase early detection of individuals at risk for long-term negative outcomes, especially after a mass trauma, as well as how to better target individuals with indicated preventive intervention or at a later stage with personalized treatment. *Computational psychiatry*, Bayesian inferences and machine learning techniques, network approaches as well as latent class analyses offer exciting potential for improved prediction of symptom development or treatment success.

With regard to transdiagnostic and person-centred approaches, we note that treatment advances come both from attending to already identified trauma groups (such as refugees, work-related trauma) or alternatively from consideration of a transdiagnostic approach that might define patient needs by the development of symptom profiles. Here we might simplify the number and nature of treatments by identifying mechanisms of action or algorithms that identify best treatments for certain symptom profiles (e.g. such as seen in Personalized Advantage Index (PAI), DeRubeis, Cohen, Forand, Fournier, & Gelfand et al., 2014). Future research should thus focus on identifying specificities across sex, age groups, as well as specific circumstances, including refugees and work-related trauma, as well as on person-centred outcomes that are tailored to each individual, that may or may not necessarily include DSM/ICD symptoms.

Advancing clinical practice both requires new treatments and implementation research. Exciting new technologies, new treatment formats, neurobiological enhancements and integrative interventions have been appearing but still require rigorous research. At the same time, treatment advances come from the better implementation of effective treatments (including de-implementing non-effective treatments) and one might prioritize research on investigating the best ways of training therapists in scalable effective interventions. Improving implementation also implies that we need to tighten relationships between policy and the evidence base. Political decisions may play a role in exposure to traumatic experiences and in how individuals adapt to such exposures. It would be important that the evidence base from our research can also influence these political decisions, and support effective policymaking.

These research questions are often best addressed with multidisciplinary research teams, addressing state-of-the art complexity science, crossculturally and sex/gender-sensitive, while at the same time focused monodisciplinary research identifying single determinants, culture or environment specific, testing experimental paradigms for specific settings will be needed. We need micro-level (i.e. within a person), meso-level (interactions between individuals in different environments) and macro-level (socio-polito-cultural context). We encourage global collaboration (e.g. https://www.global-psychotrauma.net/), within an Open Science framework, sharing data and research methods (like in FAIR), and of course publishing Open Access.

With all this, we should have another productive decade ahead of us and in 10 years will hopefully be able to report on the next big steps of progress in psychotraumatology.

Disclosure statement

Miranda Olff is Editor-in-Chief of the European Journal of Psychotraumatology, all other authors are associate editors. Julian Ford is co-owner of Advanced Trauma Solutions, Inc., the sole licensed distributor by the University of Connecticut of the TARGET © intervention and curriculum.

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