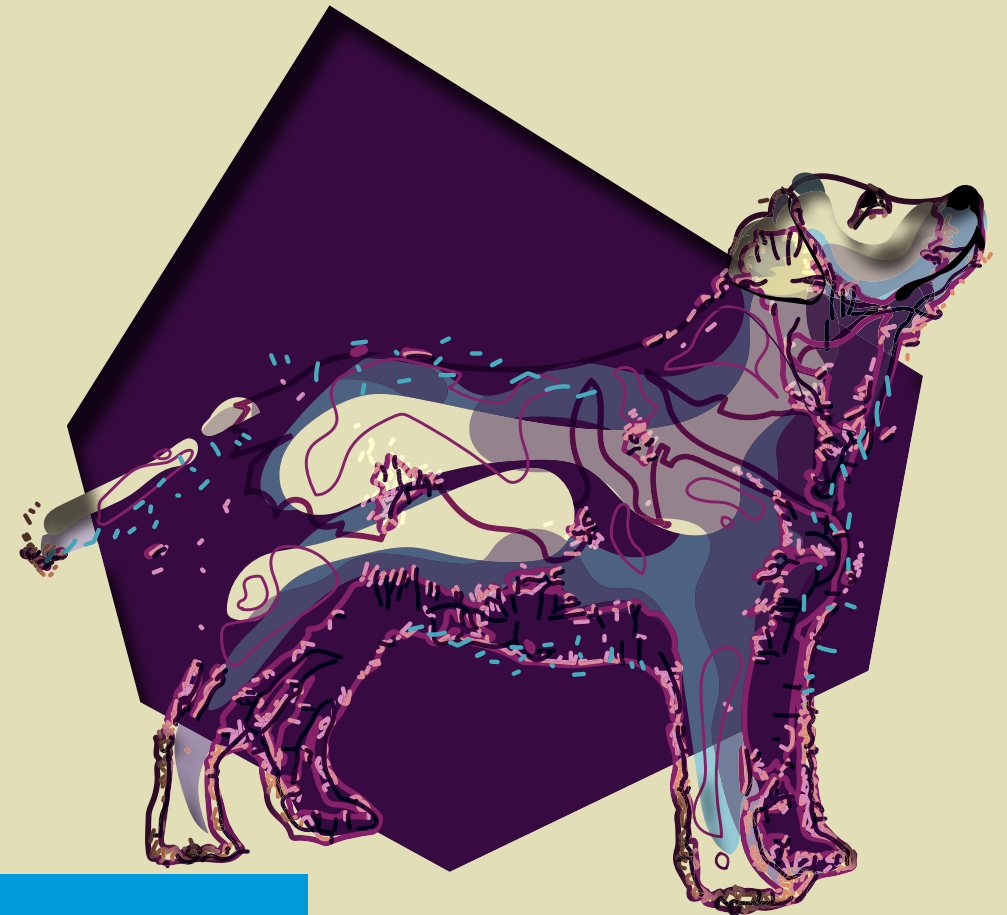


# Veterans PTSD Workingdog Research (VPWR)

The interaction between service dogs  
and veterans/first aid responders with  
Posttraumatic Stress Disorder (PTSD)



Veterans PTSD Workingdog Research (VPWR)

Emmy van Houtert

## **Veterans PTSD Workingdog Research (VPWR)**

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**Veteranen PTSS Werkhonden Onderzoek  
(VPWR)**

De interactie tussen hulphonden en veteranen/eerstehulpverleners met  
Posttraumatische Stress Stoornis (PTSS)

(met een samenvatting in het Nederlands)

**Proefschrift**

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# Preface

Dear reader,

The Thesis you are about to read regards the deployment of service dogs to individuals who suffer from a post-traumatic stress disorder. PTSD for short. For now I will forgo a clinical explanation of what PTSD exactly is. For this explanation will already be given at various points throughout this Thesis.

Instead I would like to take this opportunity to talk about the emotional aspects of PTSD. To talk about PTSD outside of its clinical or scientific understanding and think about why some consider a dog in combatting it.

PTSD is not an easy thing to combat. Having had contact with those suffering from it, I have glimpsed a little of the harm PTSD causes. I have witnessed restlessness, anger, pain, and suffering. Saw brave men and women reduced to tears by what they had seen. I witnessed them unable to cope with the cards that life had dealt them, and heard their stories about how PTSD not only destroyed their lives, but also the lives of their loved ones.

I finally heard how they had fought to turn their fate around. How they had completed therapy after therapy, had taken countless forms of medication, only to be confronted by the same nightmares at night. How some of them had no treatment options left anymore, yet wanted to become themselves again, willing to fight for that goal to the very end.

This is where the service dog comes into play. This moment that all other therapies and medications have been tried. For you see, the service dog is not a recognised form of PTSD treatment. It can be called experimental at best, and is often seen as a last resort.

Still there are countless individuals who are willing to give the service dog a chance. Maybe this is because it is a last resort, or perhaps because they genuinely believe in its benefits. Regardless of the reason though, the service dog is deployed. And in many cases, has been reported rather effective. Individuals who are supported by a service dog report that they feel better due to its presence. That the dog helps them be themselves again and strengthens their independence. Why this is however remains poorly understood. Even after more than a decade of the dog's existence.

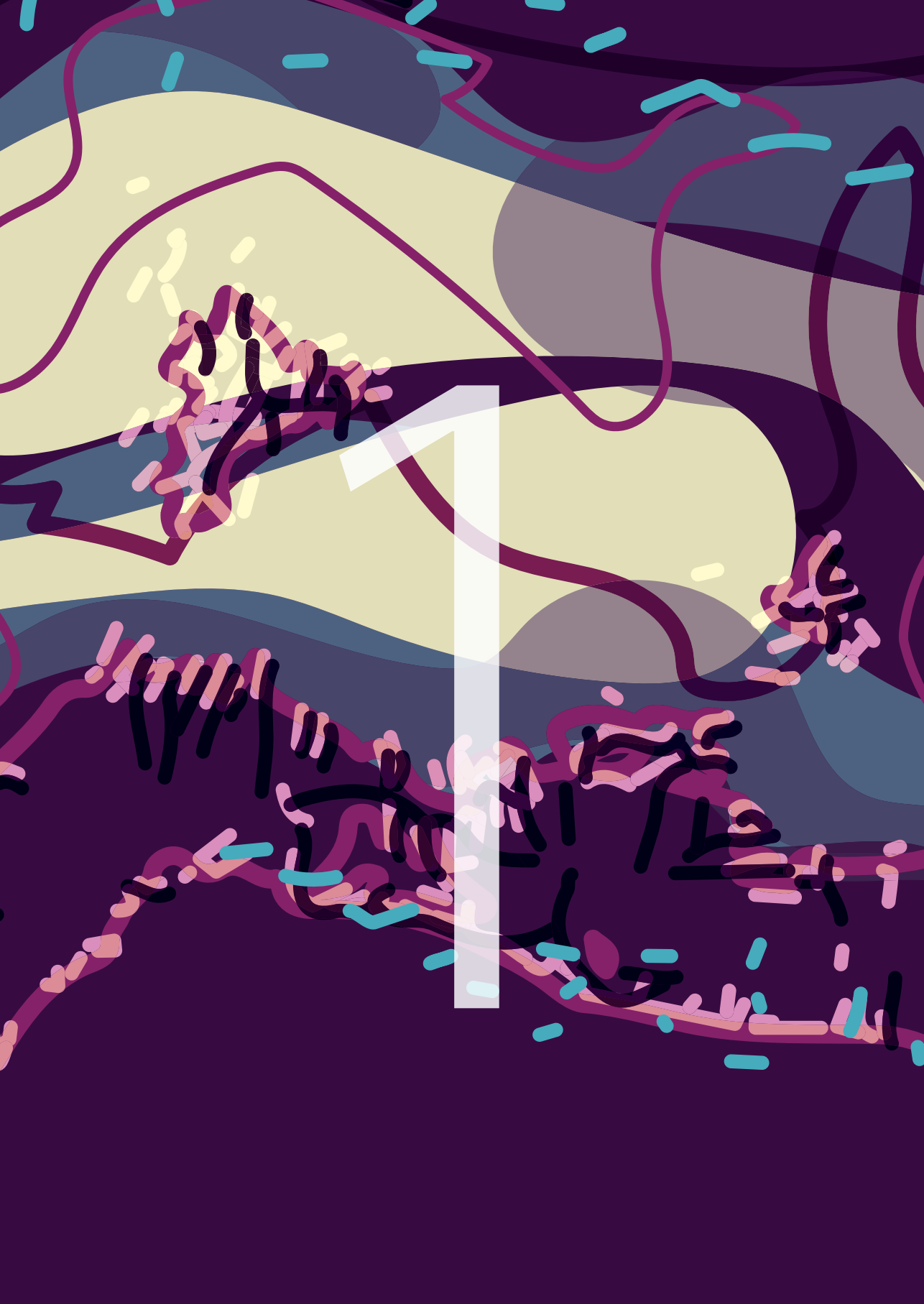
Perhaps service dogs are effective in combatting PTSD because they are an entirely different species from our own. Because they are not like us and are therefore less effected by our strong emotions. Instead they offer unwavering attention and positivity. Wanting nothing more than to be part of the group, a full meal, sleep, and play.

Perhaps service dogs are effective because of what they symbolise. Because of the organisations and movements behind them which help someone with PTSD feel heard, recognised, and supported.

Or perhaps all this is idle hope of someone who has already lost so much. Only asking the right questions will tell.

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# Chapter 1

## **General introduction**

## Post-traumatic stress disorder

This thesis concerns the interaction between specialised service dogs Dutch military veterans and (ex)first-aid responders with Post-traumatic stress disorder (PTSD). PTSD is a trauma- and stressor-related disorder caused by the experience of one or multiple traumatic events during a person's life (American Psychiatric Association [APA], 2013). Due to the severe impact of the traumatic event an individual with PTSD is unable to fully cope with or process the severe stressors he or she was exposed to. This in turn results in flashbacks and nightmares of the event(s) in which the trauma is relived repeatedly. Because of the additional and continuous stress this causes for an individual, those with PTSD generally experience anxiety, a negative worldview, periods of depression, restlessness, flashes of anger, insomnia, and reckless behaviour (APA, 2013). Flashbacks or nightmares may additionally be triggered or exaggerated by contact with sounds, visual cues, people or places that remind of the traumatic event(s) that caused the PTSD to form, which causes individuals with PTSD to avoid these triggers. This may in turn isolate them from social interactions, social support, or society which in turn worsens the experience of the negative effects of PTSD. Individuals are finally more susceptible to suicidal behaviour and addiction, which leads to additional complications and poor quality of life (Smith et al., 2016; Glintborg & Hansen, 2017).

## A brief origin of the PTSD diagnosis

PTSD was first recognised as a mental disorder in 1980 when the American psychiatric association (APA) included it in the third volume of its 'Diagnostic and statistical manual of mental disorders' (DSM-III) (APA, 1980). Before this, the original DSM (DSM-I) of 1952 had contained the classification 'gross stress reaction', which described individuals who showed abnormal behaviour due to the experience of extreme stressors (APA, 1952). At the time these extreme stressors included civilian catastrophe or combat (APA, 1952), which meant that the classification was mainly geared to symptoms shown by victims of war and veterans.

Within the second version of the DSM a new term was introduced to describe trauma related psychological symptoms. This term was 'Adjustment reaction' and improved on 'Gross stress reaction' by considering the age of onset of symptoms (Brett, 1996; Kleber & Brom, 2003). Adjustment reaction was additionally increasingly geared towards other groups than victims of war and veterans, though the largest changes in this aspect occurred during the 1970's

During the 1970's various other causes of extreme stressors gained in attention. These were mainly spurred on by social movements, which demanded attention for victims of (marital) rape, child abuse, and (domestic) violence. This raise in attention and awareness fuelled increased research into the psychological effects on victims, which in turn lead

to the conception of the child abuse syndrome, rape trauma syndrome, and battered woman syndrome (Friedman et al., 2007). Because of the overlap of symptomatology with that of Vietnam war veterans though, the DSM pooled all reactions to traumatic events into one classification which was named PTSD (Friedman et al., 2007).

## PTSD treatment

With the growing insight in PTSD and other trauma related disorders, new methods are constantly developed to treat them. These methods can be classified in various manners, ranging between individual versus group, trauma oriented versus non-trauma oriented, and solution based versus insight based (Vermetten et al., 2012).

One of the most recent classifications classifies all current forms of PTSD therapy in one of the seven categories (Bisson et al., 2007; Bisson et al., 2009). These categories are stress management, trauma related group therapy, non-trauma related group therapy, psychodynamic therapy, hypnotherapy, supporting therapy, and trauma related cognitive therapy. This latter category can be divided in Cognitive Behaviour Therapy (CBT) and Eye movement Desensitisation and reprocessing (EMDR), while Cognitive behaviour therapy can then further be divided in Exposure Therapy (EX), Systematic desensitization, Cognitive Therapy (CT), stress inoculation training (SIT), and cognitive processing therapy (CPT) (Lee et al., 2002; Rothbaum et al., 2000; Rothbaum et al., 2005; Taylor et al., 2003; Steenkamp et al., 2015; Roberts et al., 2019; Steenkamp et al., 2020).

In addition to therapy various forms of medication can be prescribed to reduce PTSD symptomatology. These substances include antidepressants, antipsychotics, sleep medication, and small controlled dosages of MDMA (van Liempt et al., 2006; Ahearn et al., 2011; Sessa, 2017; Shiner et al., 2020). Even with all these treatment options however there are individuals with PTSD that have trouble reaching full recovery. These individuals are often called therapy resistant, as they do not show significant further improvement due to conventional treatment methods. This lack of further improvement already implies that some individuals are left with residual symptoms of PTSD which can range from mild to severe. For some this prompts them to look for aid outside of conventional medicine, which has given rise to a wide variety of complementary and alternative medication (CAM) for PTSD. Examples of CAM for PTSD include: Acceptance and Commitment Therapy, Dialectical Behaviour Therapy, and Mindfulness-Based Cognitive Therapy (Friedman et al. 2001)

## PTSD service dogs

Another CAM for PTSD is the use of specialised service dogs. Service dogs are a form of Animal Assisted interventions (AAI), which entails that an animal is purposefully trained to facilitate an improvement in human wellbeing and/or health. This improvement can



take many forms, ranging from therapeutic interventions, to individualised physical assistance, signalling, or assistance with (the symptoms of) mental diagnoses. Different species of animals may be used to carry out these tasks, though dogs appear most common. They additionally appear to be the most versatile service animals, helping individuals with blindness (Sanders, 2000), hearing loss (Stuttard et al., 2021), physical disabilities (Winkle et al., 2012), diabetes (Gonder-Frederick et al., 2013), seizures (Krauss et al., 2007), Autism spectrum disorder (ASD; Lindsay & Thiyagarajah, 2021) and of course PTSD.

With PTSD service dogs an improvement in human health and wellbeing is envisioned via individualised assistance with the symptoms of a mental diagnosis. Mostly this entails the performance of learned behaviours that assist humans with PTSD in their daily life (Krause-Parello et al., 2016). Examples of such behaviours include pointing out negative emotions like anxiety and anger. By being aware of these emotions those with PTSD are made aware of their presence and can take action to cope with them or remove their source if possible. PTSD service dogs further accompany a human with PTSD in stressful situations, which provides a source of social support. Service dogs finally facilitate social interactions between humans, reducing social isolation in those they come into contact with.

To attain dogs that are capable of all these skills, service dogs are specifically bred, selected, and trained to assist those with PTSD (Krause-Parello et al., 2016). During selection the most widely used breeds are the Labrador Retriever, Golden Retriever, German Shepherd, Saint Bernard, Collie, Cocker Spaniel, and mixes of these breeds (Parenti et al., 2015). This is mainly due to the presence of favourable behavioural traits in these breeds like even temperament, intelligence, human directed behaviour, and willingness to work (Parenti et al., 2015). Because these traits naturally occur at high frequency within these breeds, the chance of finding a suitable candidate for a service dog training program among puppies is high. Still only about 50 % of candidate dogs (Batt et al., 2008) successfully finishes their 18 month training (Parenti et al., 2015), which together with a growing demand for service dogs has given rise to long waiting lists (Winkle et al., 2012).

### **PTSD service dogs in the Netherlands**

In the Netherlands the first PTSD service dogs were assigned to veterans in 2012. This was done by service dog provider 'Stichting Hulphond Nederland' who distributed eight service dogs that year (Stichting Hulphond Nederland, 2012). That same year Stichting Hulphond Nederland received a patronage from former Dutch Chief of Defence, General Peter van Uhm, and an endorsement from the Dutch Minister of Defence, Jeanine Hennis-Plasschaert (Stichting Hulphond Nederland, 2014). These successes paved the

way for other service dog providers in the Netherlands to also distribute PTSD service dogs, among which was the oldest service dog provider in the Netherlands 'Koninklijk Nederlands Geleidehonden Fonds' (KNGF; KNGF 2021a).

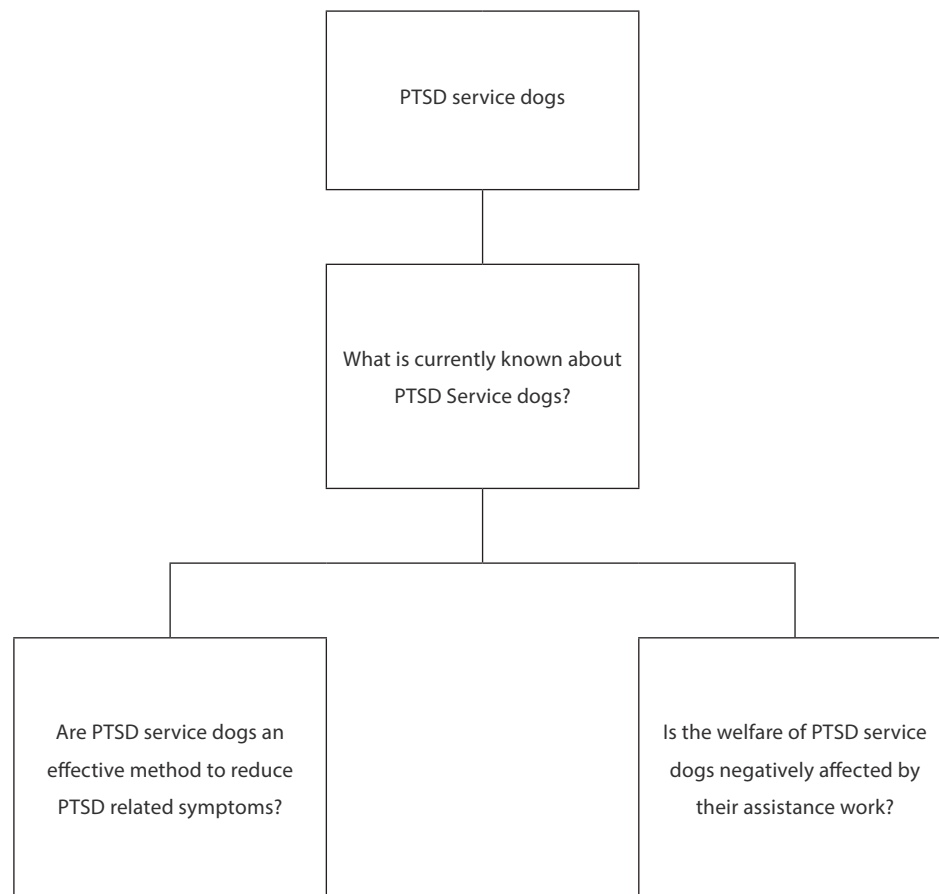
Besides Stichting Hulphond Nederland and the KNGF there were also several smaller organisations who started training service dogs. Exactly how many is difficult to determine however. This is mainly due to the fact that the selection, training, and distribution of service dogs is not a protected or unionised profession in the Netherlands. This lack of centralisation entails a lack of general standards to which the various organisations need to adhere, though various organisations are recognised by international organisations like Assistance dogs international (ADI) (ADI, 2021). As a result specific training and selection criteria differ vastly between organisations, as do the requirements an individual has to meet before they qualify for a PTSD service dog. KNGF and Stichting Hulphond Nederland for example only distribute PTSD service dogs to veterans or (ex) first-aid responders (KNGF, 2021b; Stichting Hulphond Nederland, 2021). They additionally train and select dogs themselves and are not open to training pre-owned pet dogs (ADI, 2021). Smaller organisations on the other hand are also open to civilians (BMA, 2021), and may be open to training pet dogs (ADI, 2021). Taken together this leads to vastly different organisational approaches between service dog organisations and a wide variety of PTSS service dogs in the Netherlands.

### **The study of PTSD service dogs**

Once a PTSD service dog is selected, trained and placed with a handler, it will assist that handler until its retirement. Despite the earlier given description however, the exact form of this assistance is not always known. Dogs are trained to fit an individual human and to respond to their specific needs and behaviours. Whether or not these needs are met and in what manner is not always clear however. This lack of clarity regarding service dogs remains largely untouched by scientific study. The main question asked in this thesis is therefore if PTSD service dogs are an effective method to reduce PTSD related symptoms. Additionally it will be investigated if the welfare of PTSD service dogs is negatively affected by their assistance work? In this question, good welfare is defined as the ability of an animal to actively adapt to their environment and to reach a state which it experiences as positive (Ohi & van der Staay, 2012). The capability to maintain such a state is important to service dogs because they are asked to perform trained behaviours at irregular intervals which might be experienced as stressful or disrupting by the animal. The experience of stress could lead to both reduced welfare and loss of function as a service dog which makes stress in service dogs undesirable from both an ethical and a practical point of view.



A third and overarching question is finally, which information is already discussed in the available literature regarding PTSD service dogs? (See Figure 1). Answering this question will provide a more detailed insight in the current state of PTSD service dog research and will help determine which forms of study are needed to answer the other two questions.



**Figure 1:** The three different questions posed for this thesis.

## Outline of the thesis

In order to answer the questions asked in this thesis a total of six studies have been conducted. The first study (**Chapter 2**) concerned the overarching question and investigated which scientific literature was already available regarding the use of Service dogs for individuals with PTSD. More specifically it was questioned what literature was available regarding military veterans with PTSD and a service dog, since they are one of the largest and the most studied subgroups of humans with PTSD.

**Chapter 3** of this thesis is dedicated to the validation of a Dutch translation of an originally English evaluation tool. This tool is called the Monash Dog Owner Relationship Score questionnaire (MDORS), which questions the value someone puts on the relationship with their dog. This value is important to the study of PTSD service dogs as it provides insight into how attached a person is to his or her service dog. Because the MDORS had not yet been validated in Dutch however, this attachment could not be determined in Dutch-speaking individuals, as was later done in **Chapter 4**.

**Chapter 4** of this thesis is dedicated to the welfare of military veterans and (ex) first aid responders who are supported by a PTSD service dog. To investigate whether or not service dog presence has a positive influence on veterans and first aid responders with PTSD, various parameters between those with PTSD and a service dog, those with PTSD and a pet dog, and those with PTSD without a service dog were studied. These parameters were salivary cortisol, overall activity, PTSD symptom frequency, sleep quality, and quality of life experience. Whether or not these variables were linked to one another was also questioned in order to see if they could be used as indicators of welfare changes.

**Chapters 5, 6 and 7** of this thesis are dedicated to PTSD service dog welfare. In **Chapter 5** we questioned whether service dogs show physiological signs of stress during a training session for active service dogs, and if so, whether they can recover from this stress. This question is important to the overall welfare of service dogs since training sessions teach them the basic behaviours they will be needing in their further working life. If these controlled situations therefore provoke a stress reaction in the animal, its overall welfare and how well it is prepared for its work can be questioned. Training sessions are additionally a standardised setup between animals which provides the opportunity to assess each animal in a similar manner. This is often difficult to do in a home environment due to the highly varying challenges each dog faces each day. It is for this reason that **Chapters 6 and 7** of this thesis are dedicated to overcoming the challenge of high variability in the home environment. More specifically **Chapter 6** questioned whether the average hair cortisol level of service dogs is different from



the average hair cortisol level of companion dogs of the same breed, while **Chapter 7** focussed on the disturbance of activity patterns.

In **Chapter 8** the results of this thesis will finally be discussed and linked back to the three original research questions.

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# Chapter 2

## **The study of service dogs for veterans with Post-Traumatic Stress Disorder: a scoping literature review**

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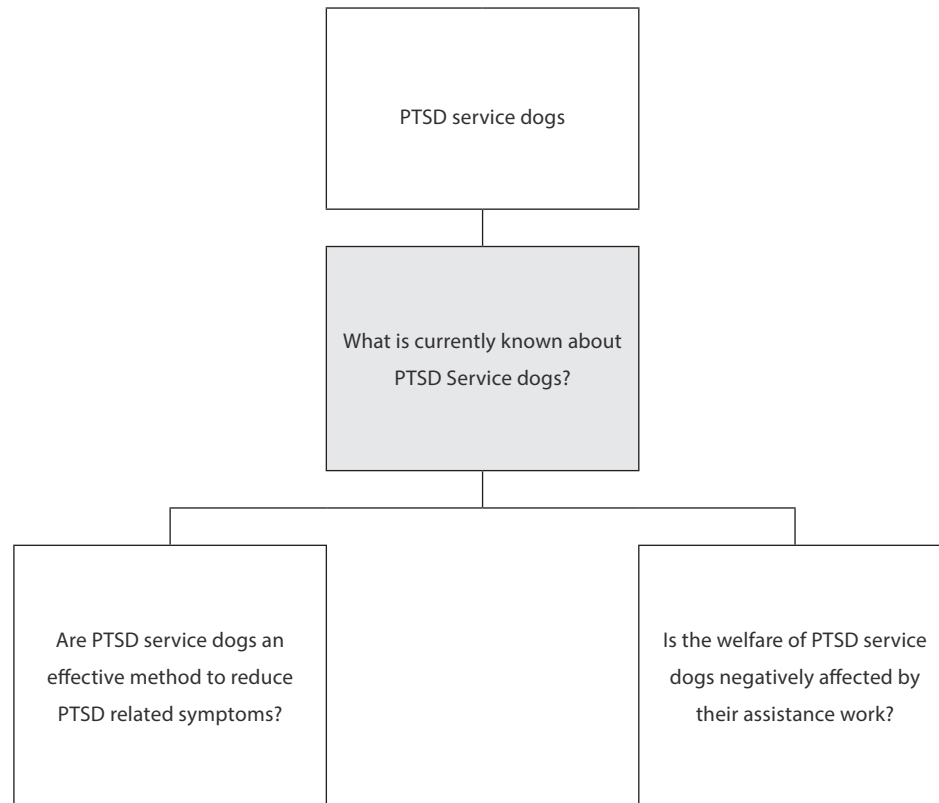
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## Abstract

The therapeutic application of human–animal interaction has gained interest recently. One form this interest takes is the use of service dogs as complementary treatment for veterans with Post-Traumatic Stress Disorder (PTSD). Many reports on the positive effect of PTSD Service Dogs (PSDs) on veterans exist, though most are indirect, anecdotal, or based on selfperceived welfare by veterans. They therefore only give a partial insight into PSD effect. To gain a more complete understanding of whether PSDs can be considered an effective complementary treatment for PTSD, a scoping literature review was performed on available studies of PSDs. The key search words were ‘dog’, ‘canine’, ‘veteran’, and ‘PTSD’. This yielded 126 articles, of which 19 matched the inclusion criteria (six empirical studies). Recurrent themes in included articles were identified for discussion of methodology and/or results. It was found that results from most included studies were either applicable to human–animal interaction in general or other types of service animals. They therefore did not represent PSDs specifically. Studies which did discuss PSDs specifically only studied welfare experience in veterans, but used different methodologies. This lead us to conclude there is currently no undisputed empirical evidence that PSDs are an effective complementary treatment for veterans with PTSD other than reports on positive welfare experience. Additionally, the lack of development standardization and knowledge regarding welfare of PSDs creates risks for both human and animal welfare. It is therefore recommended that a study on the effect of PSDs be expanded to include evaluation methods besides self-perceived welfare of assisted humans. Future studies could include evaluations regarding human stress response and functioning, ideally conducted according to validated scientific methodologies using objective measurement techniques to identify the added value and mechanisms of using PSDs to assist treatment of PTSD in humans.

## Keywords

Dog; PTSD; canine; veteran; military; intervention; review

## Introduction

In The Netherlands, the first reports of dogs employed by the military date back to the First World War. In 1913, dogs were introduced as beasts of burden to pull military carts with weaponry, ammunition, or other equipment; a role they already fulfilled in civilian life. Dogs thus became the third animal species used in the Dutch army, alongside messenger pigeons and horses (Rijnberk, 2012; Smits, 1976). This was not the only role dogs fulfilled during their service, as they also had incidental and unofficial duties. Dogs functioned as unofficial guard animals, alerting soldiers to oncoming intruders, vehicles, or other dangers. More interestingly, dogs were also reported to fulfil the role of emotional companion, social support, or troop mascot to those same soldiers, keeping military morale high under difficult and stressful circumstances in times of war (Lenselink, 1996).

By the end of the Second World War, it seemed that dogs would be phased out of the Dutch military services. This was because both the pigeon and horse had been retired from service and replaced by mechanical inventions like telephones and vehicles (Lenselink, 1996). The dog persisted among the military however, likely helped by the diversity of its application. This followed international development, which saw dogs increasingly used in various tasks within various international military forces.

### Post-Traumatic Stress Disorder

One such application was the role of the dog as a social or emotional companion. Developing beyond its original role as a troop mascot, the soothing and comforting aspects of human–dog interaction have gained interest in recent years. As a result, therapeutic applications and assisting treatment methods involving dogs are being developed for humans with various disabilities and disorders. One of these disorders is Post-Traumatic Stress Disorder (PTSD). PTSD is a trauma- and stressor-related disorder caused by the experience of one or multiple traumatic events (American Psychiatric Association [APA], 2013). Individuals with PTSD generally suffer from negative mood, periods of depression, periods of anxiety, flashes of anger, reckless behaviour, and sleeplessness (APA, 2013). They are additionally susceptible to drug, alcohol, or tobacco abuse, or to become suicidal (Glintborg & Hansen, 2017; Smith, Goldstein, & Grant, 2016). This leads individuals with PTSD to become disengaged from relationships with others, avoid public places, avoid strangers, and detach themselves from society as a whole (APA, 2013).

### The influence of dogs on PTSD

The use of dogs to help treat PTSD is a form of Animal Assisted Intervention (AAI). This means that interaction with an animal is considered as treatment augmentation within

part of a person's overall treatment plan (Kruger & Serpell, 2006). In veterans diagnosed with PTSD, interaction is often through the assignment of a PTSD Service Dog (PSD). A PSD is a specially bred and selected dog, trained to assist those with PTSD in their daily life (Krause-Parello, Sarni, & Padden, 2016). With its constant presence in the veteran's life, the PSD is a continuous form of support and/or treatment augmentation for traditional forms of treatment. The PSD might further form a barrier reduction for individuals who are hesitant to undergo conventional treatment methods, or for those who have proven unreceptive to said methods.

The potential benefit of the PSD to veterans with PTSD is supported by a number of studies investigating the effect of human–animal interactions on self perceived human welfare and quality of life. Positive interactions between humans and dogs, for example, have been proven to increase levels of oxytocin in both humans and dogs (Nagasawa et al., 2015). This has been found to cause a more positive mood, decreased negative emotions, and increased perceived welfare in humans (Beetz, Uvnäs-Moberg, Julius, & Kotrschal, 2012; Yount, Ritchie, St Laurent, Chumley, & Olmert, 2013). Moreover, companion animals act as social facilitators between humans, reducing the risk of social isolation (Banks & Banks, 2002; McNicholas & Collis, 2000; Wood, Giles-Corti, & Bulsara, 2005).

Another important feature of animal companionship is that the animal is largely dependent on the human for exercise, feeding, and grooming. This enables the human to express nurturing and protective behaviours. Activities related to animal care may therefore promote engagement with other individuals, responsibility, and self-efficacy (Tedeschi, Fine, & Helgeson, 2010). This in turn relates to behavioural activation, which has been shown to be an effective treatment for depression in humans (Jakupcak, Wagner, Paulson, Varra, & McFall, 2010; Kruger & Serpell, 2006). Because behavioural activation has also proven effective as treatment for PTSD (Jakupcak et al., 2010), the principles associated with behavioural activation may provide additional evidence of the positive influence human–animal interaction has on human welfare.

The interaction between veterans diagnosed with PTSD and their PSDs are consistent with the above. As stated, the interaction of humans with animals elicits positive emotions and feelings of affection, countering the emotional numbness and negative emotions individuals with PTSD might experience (Marr et al., 2000; O'Haire, 2013). Additionally, individuals with PTSD are often hyper aroused. PSDs may help reduce hyperarousal, because the presence of an animal is known to reduce anxiety (Barker, Pandurangi, & Best, 2003). A specific situation in which this might happen is when someone with PTSD is suffering a flashback of the event(s) that triggered the PTSD. While experiencing such flashbacks, the presence of a dog can help the person to focus on



the present, reminding them that the danger is no longer there (Yount et al., 2013) The specialized training of a service dog may further strengthen this association, as it can be trained to actively seek its handler's attention, strengthening the re-orienting effect.

Lastly, service dogs can be used by veterans with combat-sustained injuries to compensate for physical disabilities (Foreman & Crosson, 2012). Although not the primary function of a PSD, the assistance of a dog for small tasks may help to reduce costs for paid assistance, reduce embarrassment in public settings, and improve independence (Foreman & Crosson, 2012; Winkle, Crowe, & Hendrix, 2012). PSDs can therefore help improve the welfare of their handler by stimulating their engagement with their social and physical surroundings (Winkle et al., 2012).

In short, PTSD is a complex mental disorder, of which the cause and subsequent effect differ between individuals. It can be problematic to diagnose, and the exact number of affected individuals is unclear. Nonetheless, the consequences of PTSD can be severe, adversely affecting the health and welfare of those affected by it and those in their social support network. The provision of a PSD to people with PTSD has received anecdotal support as a new form of treatment augmentation. Veterans themselves have additionally reported the PSD to be a positive intervention. These reports only give a partial insight in PSD effect though, namely individual welfare experience, and do not provide a complete understanding of whether PSDs can be considered an effective complementary treatment for PTSD. They, for example, do not differentiate between PSDs and regular companion animals which, according to earlier described influence of human-animal interaction, can cause an increased experience of positive welfare. Current evidence can furthermore not account for potential report bias, as the presence or absence of a placebo effect is not known. Additional research seems therefore required to identify the effect a PSD has on a person with PTSD and whether the PSD can be regarded as a valid part of PTSD treatment. Before such research is performed, it would be wise to evaluate existing studies on PSD effectiveness and find out which aspects of human-animal interaction are described in them. In this scoping literature review it is therefore questioned which studies have already been performed regarding the effect PSDs have on veterans with PTSD, which aspects of human-animal interaction these studies discussed, and how their methodologies and results compare to one another. From this we hope to conclude whether an additional study of various aspects of the PSD-veteran relationship is needed.

## Methods

### Literature search

This scoping literature review assessed existing and ongoing studies regarding the use of PSDs published up to September 2017. Relevant articles were identified by a computerized search in the following databases: Scopus Search, PubMed, Web of Science, and Google Scholar. Retrieval and inclusion/exclusion of articles was performed by one researcher. No research protocol was used. The used query in the primary database (Scopus) was 'Dog OR Canine AND PTSD OR Veteran' in either the title, abstract, or keywords of an article. Queries in other databases matched these inclusion criteria. The full written spelling of Post-Traumatic Stress Disorder were not included in the final search terms because the abbreviation is more commonly used in text. Test queries furthermore showed that these terms yielded only articles which would be excluded under criterion 3 of the following inclusion criteria:

- (1) The article was written in English as a primary language;
- (2) The article originated from a peer-reviewed journal, or a proposal for such an article;
- (3) The article mentions all of the following concepts: veterans, dogs, and PTSD;
- (4) The article focused on the influence of dogs on veterans with PTSD as a primary subject, not as part of an overall theme (for example, different AAI methods).

Criterion 1 was included to exclude any article which might not be (fully) interpretable to the authors in its original language. Criterion 2 was included to distinguish between relevant scientific literature concerning PSDs and non-scientific literature like general discussions or narratives. Criterion 3 was included to distinguish between articles discussing the effect of human-animal interaction on human mental welfare, and articles which discussed other aspects of human-animal relationship. Criterion 4 was included in this review to distinguish between articles speaking specifically about PSDs and those who discussed other forms of AAI or AAI as a whole. The initial query in the Scopus Search database yielded 120 articles (published up to 29 September 2017), which conformed to the proposed query. Of these 120, two articles were immediately excluded due to being duplicates of another article in the query. A total of 105 articles were subsequently excluded because they did not meet all inclusion criteria. More specifically, all articles met criterion 1, 10 articles did not meet criterion 2, 88 articles did not meet criterion 3, and seven articles did not meet criterion 4. This left 13 articles from the 120 retrieved through the initial database. Six articles matching the inclusion criteria were additionally retrieved from secondary databases (PubMed, Web of Science,



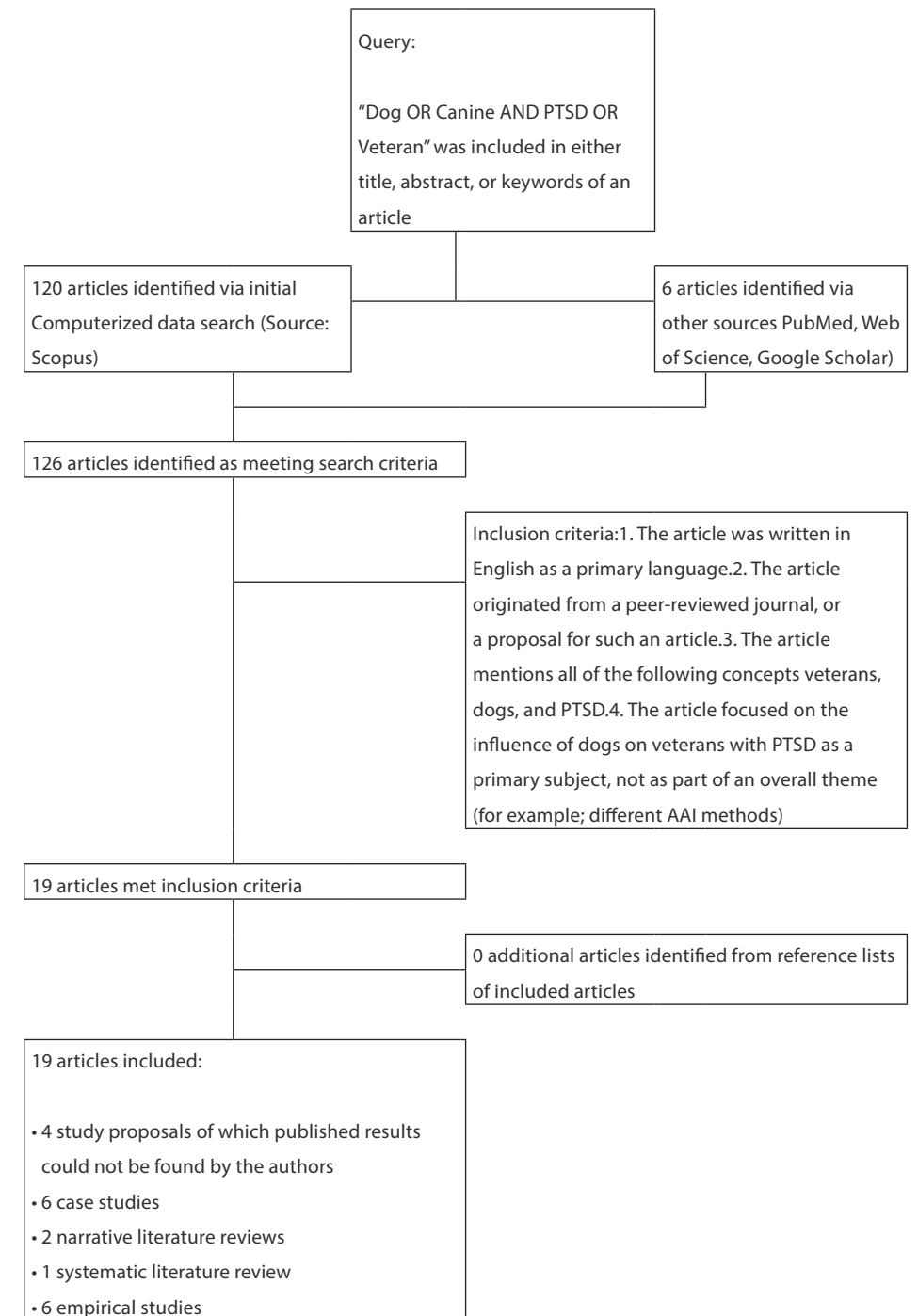


Google Scholar), resulting in a total of 19 articles included. These six additional articles included four study proposals, which were not catalogued by the primary database, and two articles which met all query criteria, yet for unknown reasons were absent from the primary database. No additional articles were identified from reference lists, leaving the final number of included articles at 19. An overview of the above process can be found in Figure 1.

Of the 19 included articles, six were case studies, two were narrative literature reviews, one was a systematic literature review, six were empirical studies, and four were study proposals of which published results could not be found by the authors of this review at the time of writing. Despite lacking clear results, these latter studies were included in the review, as they all proposed empirical studies regarding the influence of PSDs on military veterans. The authors therefore deemed the inclusion of these studies necessary for an inclusive discussion regarding developments in the study of PSDs. A complete list of all articles consulted during this review can be found in Appendix 1. Full text reading was subsequently performed to identify different themes and research questions in each article.

### Identified themes

In 2016, Krause-Parello et al. performed a literature review regarding PSDs for veterans. They included peer-reviewed literature on PSDs for veterans published up to October 2015. They identified the following overall themes: definition of a service dog, lack of consensus regarding PSD development, social/physiological benefits of a service dog, cost and availability barriers, and the welfare of service dogs. With the exception of service dog definition, these themes could also be identified in other reviewed papers. Several new themes were additionally identified in the literature published after October 2015. These themes were the expectations veterans have of a service dog (Crowe, Sánchez, Howard, Western, & Barger, 2017; Yarborough et al., 2017), reservations about service dogs (Finley, 2013; Glintborg & Hansen, 2017), the role of the service dog in the overall treatment plan (Furst, 2015; Glintborg & Hansen, 2017), and best practice regarding PSDs (Saunders et al., 2017). These themes are discussed below, with the exception of social/physiological benefits of a service dog as these have already been discussed.



**Figure 1:** A flow chart of the literature review. Included are search criteria, inclusion criteria, and number of included articles at each stage. An overview of the 19 included articles can be found in Appendix 1.

## Results

### Definition of a service dog

In their review from 2016, Krause-Parello et al. Gave the following definition of a service dog: 'Service dogs (SDs) are considered working dogs. These dogs are exhaustively trained to respond precisely to specific disabilities of their owners and are typically allowed entry into public facilities under the protection of the Americans with Disabilities Act' (Krause-Parello et al., 2016). By doing this, they combined several earlier statements about service dogs as presented by Taylor, Edwards, and Pooley (2013) into a single statement. This statement seems to be generally accepted in literature as the definition of a service dog, be it not directly quoted. This is possibly because it includes the most important aspects of a service dog, namely, its specialized training, commitment to a single handler, and its legal status. This definition also distinguishes between a service dog and other types of working dogs, such as therapy and emotional support dogs, and nonworking dogs, such as companion dogs. It does not outline the specific duties and tasks of a service dog, as these vary between dogs due to specific handler requirements.

### Reservations about service dogs

The presented definition of a service dog does not outline the specific qualifications and training criteria to which a dog must conform in order to be recognized as an official service dog. In their review on alternative treatment methods for PTSD, Wynn (2015) described this issue as a constraint in AAI as a whole and thus by extension in the use of service dogs. They noted that, although promising, the best practice for using PSDs to facilitate socialization, provide companionship, decrease trauma-related symptoms, and encourage independence had not been established (Wynn, 2015). This hampers the measurement of the effectiveness of these dogs and prevents animal-assisted interventions from achieving their full potential. This statement was taken up by Krause-Parello et al. (2016) in their review, which drew a connection to remarks by Finley (2013). In an earlier study, Finley (2013) stated that the exact cause and effect of service dogs as a complementary treatment for PTSD are not known. Although recognizing that there is anecdotal and self-report support for the effectiveness of PSDs on human welfare, Finley (2013) voiced concerns about the precise tasks of PSDs, as effectiveness for, and reasoning behind, specific tasks were not always known. This concern is shared in the recent literature by Glintborg and Hansen (2017), who noted that certain interventions by a PSD could potentially hamper treatment of PTSD rather than support it. As an example, Glintborg and Hansen (2017) mention the ability of some PSDs to physically block strangers who approach their handler by placing themselves directly in front or behind the handler. This behaviour may provide a sense of safety for the handler and help them to cope with stress experienced from an approaching stranger or being in a public place. It may therefore by extension increase the social interaction of the handler

and reduce isolation or detachment from society. Blocking could also be regarded as a negative effect. By blocking strangers from accessing the handler, the dog could indirectly reinforce the view of the handler that strangers pose a threat which needs to be kept at a distance. In this manner, the PSD would hamper the handler's treatment for PTSD or its symptoms as they are no longer confronted by what causes them stress or discomfort, but avoid it.

Relatively little is known about long-term interaction effects, with Vincent et al. (2017) reporting the longest follow-up of nine months. The precise relationship between the PSD and different aspects of the handler's welfare, especially in the long term, are therefore unknown. Definitive statements about the concerns of Finley (2013) and Glintborg and Hansen (2017) can therefore not be made at this point. Precise intervention methods and training furthermore differ between service dogs, creating differences between studies and observation groups. PSDs can nowadays be provided by multiple organizations in multiple countries, and are often trained to respond to the specific mannerisms of their handler. This results in a considerable variety between training methods and learned behaviours. Not every dog may perform the same behaviours/interventions for its handler, therefore not having the same effect on aspects of their welfare. This makes conclusive statements on effectiveness even more difficult, or at least not applicable to all PSDs.

This latter problem is in line with concerns voiced by Furst in 2015, who mentioned the growing number of organizations that provide PSDs for veterans in the US and how there was seemingly no governmental intervention, endorsement, funding, or quality control on them. They stated that the effectiveness of PSDs for veterans with PTSD is often justified through study of human-dog emotional interaction or the study of other forms of AAI. However, there was yet to be one standardized, scientifically recognized way to train PSDs or to pair a dog with a veteran with PTSD (Furst, 2015).

### Service dogs and animal welfare

The lack of empirical evidence for, and standardization in, the selection and training of PSDs constitute a potential threat to animal welfare. The primary task of a service dog is to increase the welfare of the person it is assigned to. While a service dog can potentially increase not only the physiological but also the mental and social welfare of its handler, by personal interaction or by facilitating interactions with others, it is not always clear to what extent the improved welfare of the handler comes at the expense of the dog's welfare. Dogs could be used for work which they are unsuited for, could be exposed to prolonged or unnecessary stress, animals could be unable to regulate the own (social) environment, and animals' physical degradation with age could go unnoticed (Serpell, Coppinger, Fine, & Peralta, 2006). It can furthermore be asked what is exactly meant by





both human and animal welfare, as there are various definitions of welfare. It is therefore not always clear what is meant by 'good' and 'poor' welfare, and how this difference should be measured. At present, no study seems to have specifically questioned the influence of service provision on the welfare of a PSD, or how good welfare should be defined in this specific group of animals. There is currently no single definition of welfare or welfare standard for PSDs, which makes it difficult to monitor their welfare.

### The role of the service dog in the treatment plan

Glintborg and Hansen (2017) questioned the role of a PSD in the overall PTSD treatment plan of its handler. In a single case study, they determined that there were multiple obstacles to the integration of PSDs into existing treatment plans. Main issues were a lack of communication and collaboration between healthcare professionals, combined with a perceived lack of knowledge of the function of the PSD. As an example, it was recalled that a healthcare provider had shown interest in the PSD, yet did not actively involve it in therapy sessions. Although this could have been inherent to the therapy given at the time, it could also have been a lack of knowledge on the part of the healthcare provider. The authors did not question which explanation was applicable though, leaving the mechanisms behind the above example ambiguous. Nonetheless, there is the perception that healthcare providers are lacking knowledge of the potential of PSDs. Whether this perception is correct remains to be established. How this perceived lack should be countered also remains unclear. Healthcare providers or their educators may be rightfully hesitant to accept available anecdotal and self-report evidence as definitive proof of the effectiveness of PSDs, out of fear of potentially harming patients with non-evidence-based treatment methods. This observation would be in line with concerns voiced by Owen, Finton, Gibbons, and DeLeon (2016), when they addressed nurse practitioners about the potential of PSDs in treating PTSD. They argued that although empirical evidence of the PSD effect was still lacking, PSDs and AAI are a promising field of PTSD treatment. They therefore urged nurse practitioners and health policy experts to see PSDs and AAI as a potential form of complementary treatment for PTSD and disorders arising from combat experience, especially considering the growing prevalence in the US.

### What to expect from a service dog

Among the reviewed literature, two studies specifically questioned the expectations and requests veterans might have of service dogs. Yarborough et al. (2017) questioned a total of 78 veterans with PTSD about their expectations of, and needs for, a PSD. Of the respondents, 24 already had a service dog while 54 were on a waiting list to receive one. An additional 22 veterans received a dog during the study, resulting in a final total of 46 veterans with a dog at the end of the study and 30 still waiting to receive one. The most important feature of a PSD, as reported by the veterans who had one, was its behaviours

towards its handler. Specifically appreciated were the dogs' attention-seeking behaviours such as licking or nudging the veterans. It was reported that these behaviours helped the veterans 'to remain focused on the present' (Yarborough et al., 2017) and thus helped them take their mind off negative thoughts, emotions, or memories they might be experiencing. This was combined with the ability of the dog to function as a physical barrier between the veteran and strangers, reducing the stress or arousal the veteran experienced from such encounters (Yarborough et al., 2017). Overall, the dog was thus considered as a calming catalyst of the veterans' mental/emotional state in potentially stressful situations, and therefore improved the veteran's experienced welfare.

The other study which questioned the needs and expectations veterans have of a service dog was Crowe et al. from 2017. In their study, they questioned nine veterans with PTSD about the most appreciated feature of their PSDs. The veterans appreciated that the dog was a facilitator of behaviour and experiences, helping its handler to reconnect with society, opening opportunities in daily life, facilitating social contact, and reclaiming life/sense of worth. Again, the overall theme herein was the function of the dog as a calming catalyst in stressful situations, and its ability to alert its handler to the development of stress or panic (Crowe et al., 2017). Because this conclusion is similar to that of Yarborough et al. (2017), this would seem to be the most appreciated feature of PSDs. This is consistent with the purpose for which a PSD is mostly provided, as they are not meant to act fully autonomously. Instead, PSDs are meant to facilitate insight into the handler's own behaviours and emotions to help them manage said emotions or behaviours. As found by Yarborough et al. (2017), it was also appreciated if the dog creates space for this reflection.

### Best practice for PSD study

The lack of empirical evidence regarding the effectiveness of PSDs seems to be caused by a lack of consensus on best practice or standardized methodology for the study type. Saunders et al. addressed this issue in 2017, as they spoke about recommended methodology and study constraints regarding PSDs. They referred to the same discussion currently taking place in literature regarding AAI in general, and mentioned recommendations to improve best practice. Kamioka et al. (2014) and Stern and Chur-Hansen (2013), for example, have made multiple recommendations to improve study design regarding AAI, such as careful description of methodology to improve replication. They also expressed concern about a trend to only use one group of animals, one data point, one measurement method, or one provider of animals in the study of AAI, an observation which seems applicable to the study of PSDs as well.

The use of only one source of information makes found results less relevant to the population of AAI or PSDs as a whole, and also reduces reproducibility of studies



between subject groups. Looking at the studies discussed in this review, however, the use of singular information sources might be a necessity in PSD study as developed PSDs are often incomparable between different providers. Using more than one would cause additional variation to appear, complicating the formation of methodology and result. Using only one information source still has its constraints though as, in addition to those mentioned above, it limits the number of PSDs and handlers which can be studied at one time. This was noted by Herzog in 2014 when they observed that studies on AAI generally had inadequate sample sizes to properly measure effect, a lack of randomization, and no control group among research subjects. Looking at current literature regarding PSDs, this statement holds true, as many studies on the effectiveness of PSDs show small sample sizes, a lack of control group, and no true randomization of research subjects. Some mention this lack as a constraint in their reporting, and Kloep, Hunter, and Kertz (2017) even names it as inherent to the research type. These factors are often absent because studies of PSDs necessarily depend on the availability of subjects with established PTSD, their willingness to participate, and the availability of service dogs. Some studies have attempted to account for this lack of standardization by using the natural variation within the available population to their benefit. This was done by comparing people waiting for a PSD (Yarborough et al., 2017) or people with an emotional support dog (Saunders et al., 2017) to people who had received a PSD. Others have opted to assume a baseline model (Vincent et al., 2017), in which change is measured within an individual rather than between treatment and control groups to reduce variation.

The above-mentioned methods still cannot account for all possible variation, however, as it cannot be excluded that factors such as habituation with measurement method, will to please the researchers, or placebo effect could have affected findings. Findings of positive PSD effects in the studies by Stern et al. (2013), Kloep et al. (2017), Vincent et al. (2017), and Yarborough et al. (2017) are furthermore solely based on self-perceived welfare of assisted humans which, though an important measurement tool, is poorly reproducible, poorly translatable to different study groups, and poorly comparable between different studies. Among the 19 studies included in this review, only six provided observational evidence of the effect of PSDs on the impact of PTSD between groups or within an individual overtime. Four of these studies (Kloep et al., 2017; Stern et al., 2013; Vincent et al., 2017; Yarborough et al., 2017) used multiple questionnaires among veterans to do so, one used interviews, and one used media response analysis. The four questionnaire-based studies made use of a total of 19 questionnaires (Table 1). Of these 19, only two were used more than once. These were the Beck Depression Index (BDI-II) and the PTSD checklist (PCL; Weathers, Litz, Herman, Huska, & Keane, 1993). The BDI-II was used in two studies and the PCL was used in all four. The PCL unfortunately has three different versions; civilian, military, and (event) specific. All three were used between the reviewed

studies. This complicated comparison of results, as similarity of answer models could not be assumed. Additionally, measurements were performed in different timeframes. Because of this, data similarity could not be assumed and comprehensive meta-analysis of the PCL scores reported by the four studies could not be performed. Finally, data pooling for various questionnaires measuring similar parameters was considered. This was also deemed not possible, due to the same reasons.

**Table 1.** The following are questionnaires used in either one or multiple of the six identified observational studies (Appendix 1).

Questionnaire	Study	Measures
PTSD Checklist, Specific (PCL-S)	Kloep et al., 2017	PTSD. Situation specific
PTSD Checklist, Military (PCL-M)	Vincent et al., 2017 Stern et al., 2013	PTSD. Military specific
PTSD Checklist, Civilian (PCL-C)	Yarborough et al., 2017	PTSD Civilian specific
Quick Inventory of Depressive Symptomatology (QIDS)	Kloep et al., 2017	Depression
Post deployment Social Support Scale (PSSS)	Kloep et al., 2017	Social support after deployment Quality Of Life Scale (QOLS) Kloep et al., 2017
Quality of life Dimensions of Anger Reactions Scale-5 (DAR-5)	Kloep et al., 2017	Anger
Pittsburgh Sleep Quality Index (PSQI)	Vincent et al., 2017	Sleep quality
Beck Depression Index (BDI-II)	Stern et al., 2013 Vincent et al., 2017	Depression
World Health Organization Quality Of Life (WHOQOLBREF)	Vincent et al., 2017	Quality of life (physical, psychological, social, environmental health)
Life Space Assessment (LSA)	Vincent et al., 2017	Mobility
Veterans Rand 12-item Health Survey (VR-12)	Yarborough et al., 2017	Physical and mental health
Deployment Risk and Resilience Inventory (DRRI)	Yarborough et al., 2017	PTSD. Military specific
Behaviour and Symptom Identification scale (BASIS-24)	Yarborough et al., 2017	Depression, social interaction, emotional state, psychosis, substance abuse
Wisconsin quality of life index	Yarborough et al., 2017	Quality of life measurement tool
Activity level	Yarborough et al., 2017	Activity
General social survey	Yarborough et al., 2017	General happiness index
Short form survey instrument (SF-36)	Stern et al., 2013	Patient health
Lexington attachment to pet scale	Stern et al., 2013	Attachment to pets

## Conclusion

This review demonstrated that there is relatively little empiric evidence available which supports the effectiveness of PSDs in the treatment of PTSD symptoms. Although it has been found that PSDs can positively influence perceived welfare and quality of life of those with PTSD (Kloep et al., 2017; Stern et al., 2013; Vincent et al., 2017; Yarborough et al., 2017), this evidence is mostly based on anecdotal reports and subject self report, making validity disputable. It does not explain to what extent the observed effect is influenced by the actual trained behaviour of the PSD, and to what extent by the inherent effects of human–animal interaction. Placebo effect is similarly unaccounted for, and it is possible that respondents gave socially desirable answers when studied. In addition to this, many studies only monitored the effect of PSDs on the symptoms of PTSD over a short time span, making long-term effects largely unknown. In conclusion, the current constraints and differences between the design and methodology of available studies hamper comparison, verification, and reproduction of results concerning the effectiveness of PSDs as a complementary treatment for PTSD.

As a consequence of limited evidence on working mechanisms, there is still discussion about what the specific tasks of PSDs are or should be, and to what extent PSDs benefit the welfare of individuals with PTSD. This is also caused by the lack of standardization in the development of PSDs, as there is no uniform methodology to do so. Although similarities exist, and a general definition seems to be maintained, different criteria are used between organizations to select and train potential PSDs. These differences lead to methodology currently being incomparable between providers and may affect the eventual effect PSDs have on individuals with PTSD.

This leads us to conclude that, despite considerable anecdotal and indirect evidence, there is currently a lack of empirical evidence for the effectiveness of PSDs for veterans with PTSD. Definitive placement and integration of PSDs in existing treatment plans is therefore quite problematic as the cause and effect relation currently observed in PSD–human interaction is insufficiently validated. Lastly, the potential consequences of service provision to the welfare of the PSD itself remain to be studied. It is therefore recommended that a study on the effect of PSDs be expanded to include evaluation methods besides self-perceived welfare of assisted humans. Future studies could include evaluations regarding human stress response and functioning, ideally conducted according to validated scientific methodologies using objective measurement techniques to identify the added value, and mechanisms, of using PSDs to assist treatment of PTSD in humans. It is finally desirable that the training of PSDs becomes more standardized, to provide future studies with more participants and to make study results relevant to a wider range of individuals.

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## Appendix 1. Literature overview

Authors	Year	Country	Study type	Purpose	N	Subject	Method	Interval
Crowe et al.	2017	US	Observational study	Gathering the opinions about service dogs of veterans with a history of Post-Traumatic Stress Disorder (PTSD) and/or traumatic brain injury	N = 9	Veterans with PTSD	Interview and focus group	-
Glinthborg & Hansen	2017	Denmark	Case study	How do medical professionals react to the inclusion of a service dog in a PTSD treatment programme	N = 1	Person with PTSD	Interviews	-
Kloep et al.	2017	US	Observational study	Investigate the effects of a new programme for people with PTSD	N = 7 N = 5	Veterans with PTSD	PCL-5, QIDS, PSSS, DAR-5, QOLS	1 month before treatment (baseline), at the start of treatment, each week during treatment (3x), 1 month after treatment, 6 months after treatment
Saunders et al.	2017	US	Study proposal	Difference between provision of service dogs and emotional support dogs to veterans with PTSD	N.A.	Veterans with PTSD Assigned a service or support dog.	WHO-DAS II, VR-12, physical component score, mental component score, PCL-5, PSQI, PHQ-9, DAR, WPAI;GHP, C-SSRS	18 months observation; Check-ups at 1 & 2 weeks, 1 & 2 months; Study appointment at 3, 9, 15 months; Home visit at 6, 12, 18 months
Scotland -Coogan et al.	2017	US	Study proposal	Investigate veterans experiences during a training programme with PTSD Service Dogs and programme effect	N.A.	Veterans with PTSD	-	-
Vincent et al.	2017	Canada	Observational study	Evaluate the effectiveness of PTSD Service Dogs for veterans with PTSD	N = 15	Veterans with PTSD, on a service dog waiting list	PSQI, PCL-M, BDI-II, WHOQOL BREF, LSA	6,3,0 months before receiving a service dog; 3 months after receiving a service dog
Yarborough et al.	2017	US	Observational study	Examining needs related to PTSD, service dogs, and feasibility of data collection	N = 54 N = 24 N = 22	Veterans with PTSD	VR-12, DRRI, BASIS-24, PCL-C, Activity meter, WQOLI, GSS	1 measurement
Krause Parello	2016	US	Systematic literature review	To examine the current knowledge of canine assistance for veterans diagnosed with PTSD to synthesize current empirical knowledge on the subject	N = 6	Peer reviewed subject specific articles published up to October 2015.	Review	-
Owen	2016	US	Narrative literature review	Describing recent developments in integrating specialty trained dogs in military veterans' health care	-	Integration of the PTSD Service Dog in existing PTSD treatment programmes	Narrative	-
Furst	2015	US	Case study	Discussing the way in which society treats military veterans with PTSD and how treatment could influence them	-	Role of society and healthcare in treating those with PTSD	Narrative	-
Weinmeyer	2015	US	Case study	Outline the difficulties surrounding the provision of PTSD Service Dogs to those with PTSD	-	Political struggle surrounding the provision of PTSD Service Dogs	Narrative	-
Gillett &Weidrick	2014	Canada	Study proposal	The use of canine-assisted interventions for veterans diagnosed with PTSD	N.A.	Military veterans with PTSD	Three levels of analysis: biological, physiological, social. Assessment per level (medical records, assessment tools for mental health, in depth interviews)	-
Yount et al.	2013	US	Review and case study	Discussing the potential of the PTSD Service Dog in reducing the negative influence of PTSD in military veterans	-	-	Narrative	-
Stern et al.	2013	US	Observational study	Investigate the comforting and supporting effect the presence of an animal (dog) on individuals with PTSD	N = 30	Military veterans with PTSD having benefitted from living with a dog (companion/pet dog)	PCL-M, BDI-II, SF-36, Dog relationship questionnaire, Lexington attachment to pets scale	1 measurement
Taylor et al.	2013	Australia	Observational study	Provide insights into the post-war dog-owner relationship experiences of contemporary veterans	N = 19 N = 81	Media accounts of veterans with PTSD and public comments	Triangulated three phase content analysis	-
Finley	2013	US	Narrative literature review	How do authorities on veteran affairs respond to new treatments for veterans with PTSD?	-	PTSD Service Dogs	Review	-





Authors	Year	Country	Study type	Purpose	N	Subject	Method	Interval
Krol	2012	US	Case study	The history, philosophy, and methodology behind America's Vet Dogs program	-	America's Vet Dogs program	Review	-
Yount et al.	2012	US	Case study	The history, philosophy, and methodology behind the Warrior Canine Connection (WCC)	-	Warrior Canine Connection	Review	-
Love & Esnayra	2009	US	Study proposal	-	N.A.	Soldiers returning to the Walter Reed Army Medical Center (WRAMC)	Behavioural assessments of general mental health and PTSD symptom manifestations, biological markers associated with anxiety/stress/depression	-



# Chapter 3

## The Translation and Validation of the Dutch Monash Dog–Owner Relationship Scale (MDORS)

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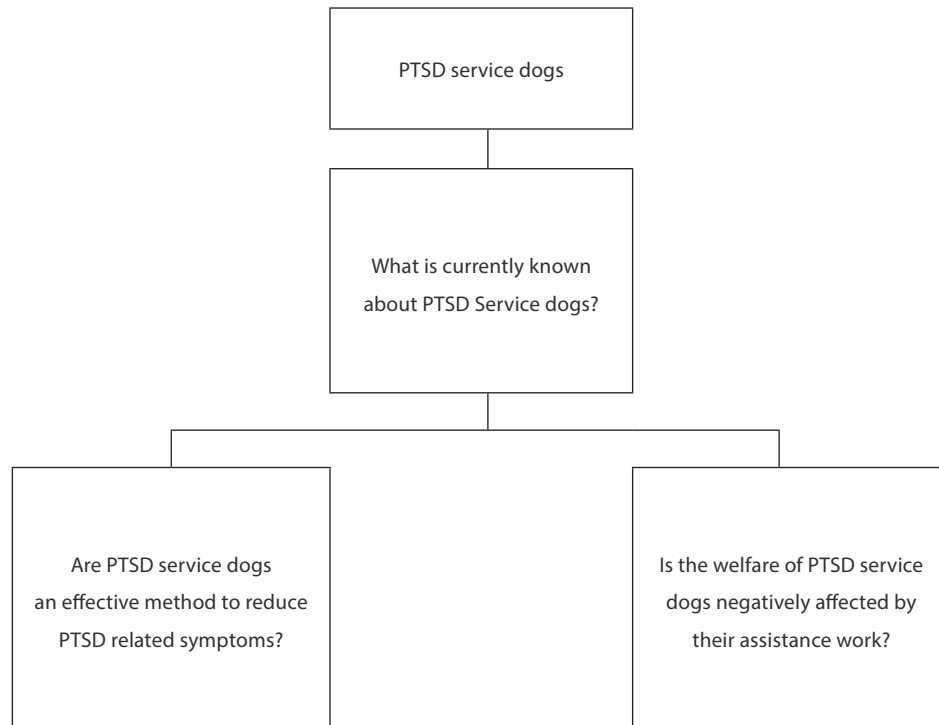
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## Simple Summary

There are several questionnaires that can evaluate how humans view the relationship they have with their dog. One of those questionnaires is the Monash Dog–Owner Relationship Scale. This questionnaire was originally written for people who speak English. Therefore, it is less useful and also less reliable for people who do not speak English. Since we want the questionnaire to be useful and reliable in more than one language, we wanted to create a reliable translation. The language that we chose for the translation was Dutch. During our translation and reliability study, we found that several of the English questions did not translate well to Dutch. Some words could not be directly translated, and some questions were not interpreted by Dutch-speaking dog owners in the same way that the English questions were interpreted. However, most of the questions were well understood. Therefore, we conclude that a Dutch translation of the Monash Dog–Owner Relationship Scale questionnaire can be used reliably to question Dutch-speaking dog owners after a few adjustments have been made and some questions removed.

## Abstract

The Monash Dog–Owner Relationship Scale (MDORS) is a questionnaire that is used to evaluate the perceived relationship between humans and their dog. This questionnaire was originally only formulated and validated in English, which limits its use among non-English speaking individuals. Although a translation could be made, the translation of questionnaires without additional validation often impairs the reliability of that questionnaire. Therefore, the aim of this study was to validate a translation of the MDORS that is suitable for use among native Dutch speakers. To achieve this, a Dutch translation of the MDORS was made and checked for spelling/grammar mistakes, readability, feasibility, and clarity. A test–retest comparison was subsequently performed on the translation together with a calculation of Cronbach’s alpha score and principal component analysis (PCA). Through the PCA, we found that the three-factor model of the original MDORS was also largely present in the Dutch translation. However, deviations were also found, as several questions did not achieve high PCA scores in their original factor. Therefore, we propose that these questions are excluded from the Dutch MDORS.

## Keywords

questionnaire; MDORS; dog; owner; human; relationship; translation; validation



## 1. Introduction

### 1.1 Describing Human–Animal Relationships

Over the last few decades, various methods have been proposed to objectively and quantitatively evaluate the relationship between humans and companion animals. Examples of such methods include the Pet Attitude Scale [1], the Pet Attachment Survey (PAS) [2], the Companion Animal Bonding Scale [3], the assessment of favorable attitudes toward pets [4], the Lexington Attachment to Pets Scale (LAPS) [5], and the Pet Relationship Scale [6]. Most of these methods are questionnaires that evaluate how a human values their relationship with either pet animals in general, or a specific pet animal. Exactly how these relationships are expressed or described differs between measurement methods and literary sources, as they use different concepts from human psychology to do so.

The most commonly used concept to quantify human–companion animal relationships seems to be ‘attachment’ [2,5]. Attachment is often used in human psychology to describe a parent–child relationship, and may be defined as a specific aspect of the relationship between parent and child with the purpose of making the child safe, secure, and protected [7]. Since it is originally defined in human–human relationships, it may thus be controversial to use the term ‘attachment’ to describe human–animal relationships. As noted by Ainsworth in 1989 [8], for example, it hadn’t been proven that humans could even be attached to animals, let alone if animals could be attached to either humans or other animals. Studies such as those by Garrity [9], Siegel [10], Johnson et al. [5], and Palmer and Custance [11] have nonetheless used attachment to describe human–animal relationships, while Topal et al. [12] and Prato-Previde et al. [13] tried to clarify the use of the term in their respective articles. Therefore, it remains questionable if humans can be attached to animals in the same way they are to humans, and if attachment is thus a proper way to quantify human–animal relationships.

### 1.2 The Social Exchange Theory

The discussion about whether humans could be attached to companion animals or not was picked up by Dwyer et al. in their article from 2006 [14]. In this article, they discussed human–animal relationships and how these relationships could be quantified. Dwyer et al. [14] noted that the main focus among the quantification of human–animal relationships lay in the expression of the positive effects that these relationships might have on humans [15]. Negative effects remained largely unquestioned, such as the restrictions that pet ownership may put on the social life of pet owners, or the emotional costs of losing a pet [16]. Even if studies questioned the negative effects of pet ownership, they did so without questioning the positive effects, and vice versa. This practice is contrary to the social exchange theory of relationships, which considers

any outcome of a relationship between two individuals to be the product of both the costs and benefits for an individual associated with the relationship. Furthermore, it is generally assumed that a relationship is only worthwhile or fulfilling for those involved if the costs and benefits of that relationship are balanced, or if the benefits outweigh the costs [17]. Since it considered both the costs and benefits of relationships, Dwyer et al. [14] proposed using the social exchange theory instead of attachment in the development of a new and more accurate quantification method for human–animal relationships.

### 1.3 The Monash Dog–Owner Relationship Scale (MDORS)

For their new quantification method, Dwyer et al. [14] chose to evaluate the relationship between humans and dogs. The dog was the first animal to be domesticated by humans. Therefore, it is generally assumed to have the closest relationship with humans out of all animals, which would consequently make their relationship with humans easiest to measure compared to human relationships with other animal species. Dwyer et al. [14] called this quantification the Monash Dog–Owner Relationship Scale. The MDORS was specifically developed to evaluate the relationship between a human and a dog from the human perspective, and to check the strength or impact of the human–animal relationship as experienced by the human. It is a 28-item self-reported questionnaire, which consists of questions divided over three different factors or clusters of related questions: Dog–Owner Interaction (Factor I), Perceived Emotional Closeness (Factor II), and Perceived Costs (Factor III). Answers to all questions can be given on a five-point Likert scale, and the validity of the complete questionnaire was provided by Dwyer et al. in their original publication [14].

### 1.4 Validation of Translation

Since its introduction, the MDORS has been used in multiple studies evaluating the relationship between humans and their canine companions. In some of these studies, the MDORS has been translated to other languages, so it would be applicable to a non-native English public. Examples of such translations include German [18], Swedish [19], Danish [20], and Spanish [21]. When translating the MDORS to German, Schoberl et al. [18] investigated how the MDORS behaved among a subject group for which it was not designed (speaking another language and having another culture). They did so by first translating the questionnaire to German in cooperation with a bilingual expert. Next, they presented the translated questionnaire to German-speaking dog owners and performed a principal component analysis (PCA) on the dataset collected from these subjects. Their efforts showed that the translated MDORS did not perform identically to the original English version, as the original three-factor model to group similar questions, as found and proposed by Dwyer et al. [14], did not appear in the German translation. Instead, Schöberl et al. [18] found a five-factor model, which they named:



'Dog as burden, dog as social supporter, dog as cuddling partner, separation anxiety, and dog as companion'.

Differences between an original and translated questionnaire are not an uncommon phenomena [18]. Many questionnaire translation processes have found that the translation of a questionnaire from one language to another is not only a translation of words, but also a translation of concepts. This is especially true if one is translating between different cultures and/or ethnicities [22–26]. In their translation of the Satisfaction with Daily Occupation questionnaire, Manee et al. [27] emphasized the importance of culture in translation as they spoke about the influences of cross-cultural adaptation in their translation process. Cross-cultural adaptation is a process that “looks at both language and cultural adaptation issues in the process of preparing a questionnaire for use in another setting” [28]. According to this concept, the translation of questionnaires to an audience different than the original is not based solely on textual translation, but requires the re-evaluation of individual questions or groups of questions regarding their distinguishing quality within the questionnaire. Due to cultural differences between populations or differences in textual meaning between languages, translations might lose or change their distinguishing quality and can therefore no longer reliably assess their intended variable. An example of such a loss in value upon translation can be found in the study of Handlin et al. [19] as they translated the MDORS for use among a Swedish population. During their study, Handlin et al. [19] noticed that three questions from their Swedish MDORS translation were interpreted differently by their subject group than intended in the original MDORS. Therefore, these questions no longer measured the concepts for which they were designed, and were eventually removed from the questionnaire to prevent any bias or errors in the scoring that it produced.

### 1.5 Translation Validation for the MDORS

The absence of validation for translated questionnaires is a serious threat to their reliability, accuracy, and comparability to the original. A questionnaire that is translated but not adjusted or re-validated in a new language may not measure the same constructs as its original counterpart, which would mean that it is technically useless in comparative research. Although it has been used in at least five different languages, to our knowledge, only the Swedish and German translations of the MDORS have been checked for deviations from their original counterpart. However, neither has been fully validated on its own, which still makes whether they measure the same constructs as the original or not questionable. Since we want to stress the importance of validating translated questionnaires, and because there is currently no validated MDORS translation available in Dutch, we aim to develop and validate a Dutch translation of the MDORS questionnaire. If a Dutch translation can be validated, the MDORS can in the future not

only be used to reliably evaluate the human–animal relationship between dogs and English-speaking individuals, but also between dogs and Dutch-speaking individuals.

## 2. Materials and Methods

### 2.1 Question Formulation

We used a multi-step process to test the validity and reliability of a Dutch translation of the MDORS questionnaire. This process consisted of the following steps: translation, expert opinion, subject opinion, and statistical analysis. For the translation step, a Dutch native speaker, who was also fluent in English at an academic level and who had worked with the original MDORS, translated the original English questionnaire to Dutch (version T1). They additionally compared their translation to a separate MDORS translation, which had been used in a previous study (version T2) [29]. A Dutch language expert subsequently checked the translations for grammar and spelling mistakes, or strange formulations. Any issues reported during translation or discrepancies between the two translation versions were resolved in this step, resulting in a single translation (version T12). The formulated questions were finally back-translated to English via an automated translation engine. This was done to check for deviations from the original questionnaire based on the factual meaning of each word in the questionnaire, rather than their interpretable meaning to individuals (Table 1).

### 2.2 Expert and Subject Opinion

After translation, a group of five dog behavior experts who spoke Dutch as their native language and English at an academic level, and were familiar with the original MDORS's concepts checked the Dutch MDORS for readability (personal opinion), feasibility (missing values <5%), clarity (personal opinion), and discrepancies from the original MDORS (only one of the experts had worked on translations before). The experts additionally judged whether they considered each individual question essential to the questionnaire. From the answer to this latter question, a 'Content Validity ratio' (CVR) [30] was calculated for each individual question. This was done via the following formula.

$$CVR = [(E - (N/2))/(N/2)].$$

In this formula, E stands for the number of experts in the panel that thought the question was essential to the questionnaire, while N stands for the total number of experts in the panel. Calculated scores could range between 1 (very essential) and –1 (absolutely not essential).



A group of test subjects additionally judged the questions for readability, feasibility, and clarity, in addition to filling out the questionnaire. These individuals were recruited by spreading a recruitment message on various social media platforms. A total of 501 individuals responded to the recruitment message and answered the questionnaire. This group had an average age of 39.62 years ( $\pm 13.63$ ), a 95% female to 5% male ratio, and lived distributed across the Netherlands.

### 2.3 Statistical Analysis

A sample of 88 subjects (of the original 501) were willing to fill out the questionnaire a second time to help test for test–retest reliability via a Pearson coefficient. The intermediate period between both inquiries was two weeks. This period was chosen based on earlier test–retest protocols for questionnaires by Brazier et al. [31].

The construct validity of the Dutch MDORS was tested with a principal component analysis (PCA) [32]. We calculated the PCA of the Dutch MDORS according to the three-factor model that was found by Dwyer et al. [14] (see Table 2 for question division). Through the use of PCA, clusters of related questions could be identified within the questionnaire. This was done by comparing the calculated PCA score of all the questions to one another for score height and orientation (positive or negative). Scores of individual questions had to be above 0.4 or below -0.4 (maximum score between -1 and 1) to consider a question relevant for a specific cluster. Furthermore, the percentage-explained variance of the total variance was calculated for each identified question cluster. The explained variance of a question cluster had to be above 5% for the questions within that cluster to be considered relevant to the overall outcome of the questionnaire.

A Cronbach's alpha score was finally calculated for each of the three factors originally found by Dwyer et al. [14] to determine if the internal consistency of the Dutch MDORS differed from the internal consistency found for the factors in the original MDORS [33]. The advisable cut-off point used for Cronbach's alpha was 0.7 or above for good internal consistency [34,35].

## 3. Results

### 3.1 Question Formulation

We encountered no major issues during the translation process of the English MDORS. Only five disputable points were identified. These points concerned questions number 3, 9, 19, 20, and 28. In question number 3, the translation of the words 'food treats' was difficult, as its literal translation 'voedseltraktaties' is not commonly used in the Dutch language to describe rewards for dogs. However, no other suitable Dutch translation

could be found without the risk of losing the original meaning of the words. Therefore, we chose to use the literal translation in the questionnaire. A similar problem was encountered with question number 9, as an adequate translation for the word 'groom' could not be found in Dutch. Therefore, we decided to describe the Dutch term instead of translating the word. The resulting replacement was: 'het verzorgen van de vacht van de hond' (to take care of your dog's coat). After receiving advice from a Dutch language expert, we did not use the word 'traumatisch' (traumatic) in question number 19. This word is not commonly used in daily Dutch language, which could cause the misinterpretation of questions in which it is used. Instead, the word 'moeilijk' (difficult) was used. In question number 20, the word 'chore' was difficult to translate directly to Dutch due to several translation options also being able to mean other words. The word 'karwei' was eventually chosen, although this was mistranslated to the word 'job' upon back-translation. This is not a common Dutch interpretation of the word, as job is usually translated as either 'baan' or 'werk'. Finally, in question number 28, the back-translations differed from the original English MDORS in context. This is due to the limitation of automated translation, because it can only provide literal translations and cannot fully capture contextual or cultural differences in languages. The product of the translation process can be found in Table 1.

### 3.2. Expert and Subject Opinion

The expert group considered all the questions proposed for the Dutch translation of the MDORS essential for the questionnaire (CVR = 1.0). The readability (0 issues reported), feasibility (missing values 0%), and clarity (0 issues reported) of all the questions was additionally deemed sufficient by both the expert and subject group.

### 3.3 Pearson Coefficient

To test for test–retest reliability, a Pearson coefficient was calculated over the MDORS scores of the 88 subjects who filled out the questionnaire twice. This was done by separately calculating the MDORS score each of the two times the participants filled out the questionnaire. Then, the scores of the first were compared to the scores of the second, which yielded a Pearson coefficient of 0.83.

### 3.4 PCA

Through the PCA (Table 2), we found a three-factor model among the Dutch MDORS, which resembled the model found by Dwyer et al. [14] in their original validation of the MDORS. The questions originally belonging to Factor I in the English MDORS were also found in a single question cluster in our translation, with the exception of questions 3 and 8. The questions of Factor I are further all oriented in the same direction.



The questions that study the emotional closeness of owners to their dog (Factor II) are also mostly found in a single question cluster. All but two (questions 18 and 19) had high (over 0.6) component scores, which were additionally oriented in the same direction.

The questions that study the perceived cost of dog ownership (Factor III) are also mainly found in a single question cluster. The only exception is question 25, though this is only due to its component score being just below the acceptable level of 0.4 (score 0.37). Similar to the other two question clusters, all the questions are again oriented in the same direction.

### 3.5 Cronbach's Alpha

We calculated Cronbach's alpha of the Dutch MDORS translation for each of the three factors described by Dwyer et al. [14] in the original MDORS. The found scores were 0.43 for Factor 1, 0.19 for Factor 2, and 0.19 for Factor 3 (compared to respectively 0.67, 0.84, and 0.84 in the original MDORS). According to the accepted interpretation of Cronbach's alpha [34,35], these scores indicated poor internal consistency for all of the factors of the questionnaire.

**Table 1.** The original English version of the Monash Dog-Owner Relationship Scale (MDORS) by Dwyer et al. [14] compared to the Dutch native speaker translation, and the automated back-translation. Deviations from the original MDORS are marked in **Bold** in the back-translation.

<b>Original English MDORS Version (Dwyer et al., 2006)</b>	<b>Dutch Translation</b>	<b>Literal Automated Back-Translation</b>
1. How often do you play games with your dog?	Hoe vaak speelt u met uw hond?	How often do you play with your dog?
2. How often do you take your dog to visit people?	Hoe vaak neemt u uw hond mee op visite?	How often do you take your dog <b>with you on a visit?</b>
3. How often do you give your dog food treats?	Hoe vaak geeft u uw hond voedsel traktaties?	How often do you give your dog food treats?
4. How often do you kiss your dog?	Hoe vaak geeft u uw hond een kusje?	How often do you <b>give your dog a kiss?</b>
5. How often do you take your dog in the car?	Hoe vaak neemt u uw hond mee in de auto?	How often do you take your dog in the car?
6. How often do you hug your dog?	Hoe vaak knuffelt u uw hond?	How often do you <b>cuddle</b> your dog?
7. How often do you buy your dog presents?	Hoe vaak koopt u "cadeautjes" voor uw hond?	How often do you buy " <b>presents</b> " for your dog?
8. How often do you have your dog with you while relaxing, i.e., watching TV?	Hoe vaak is uw hond bij u terwijl u ontspant, (bijv. TV kijken)?	How often is your dog with you while you are <b>relaxing (e.g., watching TV)?</b>
9. How often do you groom your dog?	Hoe vaak verzorgt u de vacht van uw hond?	How often do you <b>take care of your dog's coat?</b>
10. My dog helps me get through tough times.	Mijn hond helpt me door moeilijke tijden.	My dog helps <b>me through</b> difficult times.
11. My dog is there whenever I need to be comforted.	Mijn hond is er voor me wanneer ik getroost moet worden.	My dog is there <b>for me when I have</b> to be comforted.
12. I would like to have my dog near me all the time.	Ik zou mijn hond graag altijd bij me hebben.	<b>I would always like to have my dog with me.</b>
13. My dog provides me with constant companionship.	Mijn hond biedt me altijd gezelschap.	<b>My dog always offers me company.</b>
14. If everyone else left me, my dog would still be there for me.	Als iedereen me zou verlaten, zou mijn hond er nog voor me zijn.	If <b>everyone left</b> me, my dog would still be there for me.
15. My dog gives me a reason to get up in the morning.	Mijn hond geeft me een reden om 's ochtends op te staan.	My dog gives me a reason to get up in the morning.
16. I wish my dog and I never had to be apart.	Ik zou willen dat mijn hond en ik nooit uit elkaar hoefden te zijn	I wish my dog and I never had to be <b>separated.</b>
17. My dog is constantly attentive to me.	Mijn hond heeft altijd aandacht voor mij.	My dog <b>always has attention for me.</b>
18. How often do you tell your dog things you don't tell anyone else?	Hoe vaak vertelt u uw hond dingen die u aan niemand anders vertelt?	How often do you tell your dog things <b>that you tell no one</b> else?



Original English MDORS Version (Dwyer et al., 2006)	Dutch Translation	Literal Automated Back-Translation
19. How traumatic do you think it will be for you when your dog dies?	Hoe moeilijk zou het voor u zijn als uw hond overleed?	How difficult would it be for you if your dog died?
20. How often do you feel that looking after your dog is a chore?	Hoe vaak voelt het verzorgen van uw hond als een karwei?	How often does taking care of your dog feel like a job?
21. It is annoying that I sometimes have to change my plans because of my dog.	Het is vervelend dat ik soms mijn plannen moet veranderen vanwege mijn hond	It is annoying that sometimes I have to change my plans because of my dog.
22. It bothers me that my dog stops me doing things I enjoyed doing before I owned it.	Het is vervelend dat mijn hond me weerhoudt van dingen die ik deed voordat ik hem/haar had	It is annoying that my dog keeps me from doing things that I did before I had him/her.
23. There are major aspects of owning a dog I don't like.	Er zijn belangrijke aspecten aan het bezitten van een hond die ik niet leuk vind.	There are important aspects of owning a dog that I do not like.
24. How often does your dog stop you doing things you want to?	Hoe vaak weerhoudt uw hond u ervan dingen te doen die u wilt doen?	How often does your dog prevent you from doing things that you want to do?
25. My dog makes too much mess.	Mijn hond maakt te veel rommel.	My dog makes too much mess.
26. My dog costs too much money.	Mijn hond kost te veel geld.	My dog costs too much money.
27. How hard is it to look after your dog?	Hoe moeilijk is het om voor uw hond te zorgen?	How difficult is it to take care of your dog?
28. How often do you feel that having a dog is more trouble than it is worth?	Hoe vaak heeft u het gevoel dat het hebben van een hond meer kost dan het oplevert?	How often do you feel that having a dog costs more than it produces?

**Table 2.** The results of the principal component analysis (PCA) of the Dutch translation of the MDORS questionnaire (N = 501). The analysis was performed according to the three factors originally found by Dwyer et al. [14], which resulted in the production of three score clusters. Component scores above 0.4 or below -0.4 are marked in **bold**.

Factor Questions % of Variance	Cluster[1]	Cluster[2]	Cluster[3]
	19.87	<b>10.04</b>	<b>9.58</b>
1. How often do you play games with your dog?	0.07	0.06	<b>0.55</b>
2. How often do you take your dog to visit people?	-0.07	0.05	<b>0.41</b>
3. How often do you give your dog food treats?	0.02	-0.10	0.39
4. How often do you kiss your dog?	0.10	0.06	<b>0.55</b>
5. How often do you take your dog in the car?	-0.03	-0.08	<b>0.42</b>
6. How often do you hug your dog?	0.05	-0.06	<b>0.43</b>
7. How often do you buy your dog presents?	0.13	0.01	<b>0.56</b>
8. How often do you have your dog with you while relaxing, i.e., watching TV?	0.12	-0.03	0.36
9. How often do you groom your dog?	0.03	0.18	<b>0.45</b>
10. My dog helps me get through tough times.	<b>0.87</b>	0.01	0.14
11. My dog is there whenever I need to be comforted.	<b>0.86</b>	0.03	0.07
12. I would like to have my dog near me all the time.	<b>0.78</b>	0.09	0.26
13. My dog provides me with constant companionship.	<b>0.90</b>	0.00	0.01
14. If everyone else left me my dog would still be there for me.	<b>0.90</b>	0.00	0.01
15. My dog gives me a reason to get up in the morning.	<b>0.64</b>	0.01	0.26
16. I wish my dog and I never had to be apart.	<b>0.73</b>	0.11	0.28
17. My dog is constantly attentive to me.	<b>0.73</b>	0.15	0.00
18. How often do you tell your dog things you don't tell anyone else?	0.14	0.08	<b>0.55</b>
19. How traumatic do you think it will be for you when your dog dies?	-0.15	0.00	<b>-0.43</b>
20. How often do you feel that looking after your dog is a chore?	0.00	<b>0.60</b>	-0.02
21. It is annoying that I sometimes have to change my plans because of my dog.	0.23	<b>0.68</b>	0.06
22. It bothers me that my dog stops me doing things I enjoyed doing before I owned it.	0.28	<b>0.66</b>	0.00
23. There are major aspects of owning a dog I don't like.	0.33	<b>0.61</b>	0.07
24. How often does your dog stop you doing things you want to?	-0.06	<b>0.56</b>	-0.05
25. My dog makes too much mess.	-0.09	0.37	0.06
26. My dog costs too much money.	-0.11	<b>0.48</b>	0.08
27. How hard is it to look after your dog?	0.10	<b>0.48</b>	0.00
28. How often do you feel that having a dog is more trouble than it is worth?	0.00	<b>0.41</b>	-0.09



## 4. Discussion

### 4.1 Statistical Considerations

The conception of the Dutch MDORS was not without some statistical or design issues. A first issue was that some concepts or sentences could not be literally translated to the Dutch language. Therefore, the adjustment of some questions was necessary to make the MDORS applicable to a Dutch population. Cronbach's alpha for all three factors was additionally calculated to be below 0.7 (0.43, 0.19, and 0.19), which would suggest poor internal consistency. Although we do not have a definite explanation for the low Cronbach's alpha scores that were found for the Dutch MDORS, we do know that it was not caused by low response numbers, as is sometimes encountered in questionnaires (N = 501) [36]. Therefore, the most likely reason for the change in alpha that we can devise from the literature on the topic is that the Cronbach's alpha score might be low in our translation due to several items measuring heterogeneous constructs or related questions that have lost their explanatory value in translation due to cultural differences between dog owners. This theory is supported by the results found in the PCA and the relatively high (0.83) Pearson coefficient, which measures internal consistency independent of inter-item relatedness [36]. The Cronbach's alpha score might additionally be low due to the low number of items in the test (28). Fewer items can lead to an alpha score that is artificially low because it cannot accurately estimate the items' relation to the measured construct [36]. However, this is a less likely explanation, as the alpha scores of the original MDORS were high, and also appear to have been calculated over a total of 28 items.

Finally, it should be noted that female subjects were overrepresented in this study's subject group (95% female versus 5% male). This is a known phenomenon in voluntary questionnaires [19,21,37–40]. A possible way to equalize the male–female ratio among subjects would be to actively ask men to participate in the questionnaire. However, this practice could lead to differences in subject motivation, or may introduce a selection bias because the researcher has to actively choose and approach subjects. Therefore, we decided that it wasn't desirable to actively attempt to equalize the male–female ratio among respondents during this study. However, this leads to the possibility that the results of this study are not representative for male dog owners.

**4.2. Similarity between the Original and Translated MDORS** Besides some statistical considerations, the Dutch MDORS translation seems to fit the results that were found by Dwyer et al. [14] for the original English version of the questionnaire. The three factors or question clusters found by Dwyer et al. [14] can also clearly be identified in our Dutch translation. These factors are: Dog–Owner Interaction (Factor I), Perceived Emotional Closeness (Factor II), and Perceived Costs (Factor III). Still, some questions did not seem to fit the original MDORS model, as the PCA showed them to score below the cut-off point of 0.4. In Factor I, this

concerned questions 3 and 8. In Factor II, this concerned questions 18 and 19, while in Factor III, it concerned question 25.

Although it is not entirely clear why these questions did not relate fully to the other questions in their original factor, some explanations can be proposed. In Factor I, it should be noted that questions 3 and 8 scored only slightly below the cut-off point (0.39 and 0.36, respectively). Some other questions of Factor I additionally only scored slightly above the cut-off point (between 0.40–0.45). Therefore, it could be possible that instead of only questions 3 and 8, all the questions belonging to Factor I together are not that related to the rest of the MDORS, and some are only included because of the placement of the cut-off point. This is supported by the percentage of explained variation in the questionnaire associated with Factor I, as it is only 9.58% of the total variation.

Regarding Factor II, it appears that question 18 is associated more with the questions placed in Factor I than its original Factor II. This might be because of the concept measured by the question, as it asks owners how often they share secrets with their dog that they do not share with other people. The use of the term often implies frequency, which is perhaps associated more with Factor I as it measures frequency of interaction, rather than Factor II, which measures emotional attachment. Question 19 is also more closely associated with the questions of Factor I than Factor II, although the reasoning behind this association is similarly uncertain. Similar to question 18, the association might be due to the concept addressed by the question, as it asks owners how difficult it would be for them if their dog died. The death of their dog would prevent owners from performing any interactive behaviors with it; therefore it is more closely associated to questions of interaction frequency.

Finally, regarding Factor III, it appears that question 25 scores just below the cut-off point (0.4) for any association with this factor. This might be due to the possibility of an open interpretation of this question. The possibility for the open interpretation of this question lies in the use of the word messy, as the word's exact interpretation may differ between individuals. The downside of open interpretation in MDORS questions has already been studied by Handlin et al. [19] in their Swedish MDORS translation. In their translation, they found that questions 15 and 23 could be interpreted differently in Swedish than intended by the original authors of the MDORS. After consideration, they eliminated these questions from the Swedish MDORS, because a change in interpretation would influence the scoring system that can be applied to the MDORS.

### 4.2 The Impact of Phenotype

Besides the exclusion of questions based on our statistical results, we would also like to address two non-statistical points of discussion detected in the original MDORS. The first



point is the possibility of bias in the MDORS. In their work from 1996, Zasloff et al. [41] stated that the quantification methods of human–animal relationships may be biased due to the way in which their questions are formulated. They specifically addressed interspecies bias, as some interaction behaviors that are used to measure the strength of human–animal relationships may be observed more in one species than in another due to species-specific behavior. Therefore, the assessment of a human–animal relationship based on these interaction elements could create the impression that relationships with an animal that can perform the behavior are stronger than with an animal that cannot perform the behavior. However, this may not be true, as different animal species, or even individual animals, have different ways of expressing themselves.

In their original MDORS, Dwyer et al. [14] aimed to avoid the issue of species bias by designing their questionnaire to be applicable only to dogs. However, since they chose the dog we question if Dwyer et al. [14] did not inadvertently encounter another type of bias in their questionnaire: phenotypical bias. Due to the high phenotypical variation among dogs, some phenotypes may look even less related than two different animal species. Although behavior patterns generally do not differ strongly between dogs, that they look very different from one another may influence the way they interact with humans in a similar manner as species-specific behavior. Good examples of this possibility are questions 2 and 9 of the original MDORS. Question 2 asks how often people take their dog with them when they visit other people, while question 9 asks how often people groom their dog. These questions may not be answered based solely on the basis of the dog–owner relationship, as they may be affected by the size and breed of the dog. For example, short-haired dogs require less grooming than long-haired dogs, while small dogs are easier to carry everywhere than large ones. However, this does not necessarily mean that owners of short-haired or large dogs interact less with their dog or that they do not have a close emotional relationship with their animal. Therefore, we advise that all questions that are related to the transport or grooming of dogs are removed from all versions of the MDORS to prevent a bias of phenotype on the evaluation of human–animal relationships via the questionnaire.

In fact, we advise that no question belonging to Factor I should be counted toward the overall MDORS given how much discussion is possible regarding some of these questions. For example, Handlin et al. [19] also found in their study that not all dog owners were able to answer question 5 of Factor I (How often do you take your dog in the car?), since not all owners owned a car. Instead, we propose that the questions of Factor I are instead used as an indicator of how likely the outcomes of factors II and III are to be true for the owner who filled out the questionnaire, as they do indicate how often dogs and owners are in direct contact with one another.

### 4.3 Are Costs and Benefits Balanced in the MDORS?

The second point that we would like to discuss regarding both the original and Dutch MDORS is the use of the social exchange theory. In their original publication, Dwyer et al. [14] stated that the MDORS was based on social exchange theory [17]. This is apparent in the inclusion of both positive and negative aspects of the human–dog relationship in the MDORS. However, we question if the positive and negative aspects of the human–dog relationship are measured equally in the MDORS. According to social exchange theory, it is generally assumed that a relationship is only worthwhile or fulfilling for those involved if the costs and benefits of that relationship are balanced, or if the benefits outweigh the costs. Despite it being based on this concept, it remains to be seen if the balance between costs and benefits can indeed be measured by the MDORS. Within the MDORS, only one positive aspect (emotional attachment) of the human–animal relationship is measured, while several negative aspects are measured (pain of loss, financial impact, impact on daily life). Therefore, one could argue that the measured positive and negative aspects are not in balance, because several potential positive aspects of dog ownership go unquestioned. Examples include the connection between some dog breeds and human social status [42], the higher chance of social interaction while being with a dog [43], or the dog providing meaning and structure to the life of their owner. Therefore, it would be advisable to investigate if the addition of more questions regarding the emotional benefits of dog ownership could be a meaningful addition to the existing questions of the MDORS.

## 5. Conclusions

In conclusion, we found that a translated MDORS can be used to assess dog owner relationships as perceived by the owner among a population of Dutch native-speaking dog owners. However, we advise that questions 18, 19, and 25 of the original MDORS are not used in the Dutch version based on their low PCA scores. Questions 2, 5, and 9 should additionally be removed from Factor I, although the argument to do so is based on logical reasoning rather than statistical analysis. Based on logical reasoning, it would further be advisable to remove the remaining questions of Factor I entirely from the MDORS scale calculation. Questions regarding the positive effects of human–animal relationships may be added to the scoring system instead in order to balance the number of questioned costs and benefits of human–animal interaction, although the further study of these questions is required. The questionnaire resulting from all of these proposed changes can be found in Appendix A Table A1.

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## Appendix A

**Table A1.** The questions that were retained in the Dutch MDORS.

	Minstens 1 Keer Per Dag	2 tot 3 Keer per Week	1 Keer per Week	Minstens 1 Keer per Maand	(Bijna) Nooit
Hoe vaak speelt u met uw hond?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Hoe vaak geeft u uw hond voedsel traktaties?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Hoe vaak geeft u uw hond een kusje?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Hoe vaak knuffelt u uw hond?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Hoe vaak koopt u "cadeautjes" voor uw hond?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Hoe vaak is uw hond bij u terwijl u ontspant, (bijvoorbeeld tijdens televisie kijken)?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	<b>Heel erg mee oneens</b>	<b>Mee oneens</b>	<b>Neutraal</b>	<b>Mee eens</b>	<b>Heel erg mee eens</b>
Mijn hond helpt me door moeilijke tijden.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Mijn hond is er voor me wanneer ik getroost moet worden.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Ik zou mijn hond graag altijd bij me hebben.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Mijn hond biedt me altijd gezelschap.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Als iedereen me zou verlaten, zou mijn hond er nog voor me zijn.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Mijn hond geeft me een reden om 's ochtends op te staan.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Ik zou willen dat mijn hond en ik nooit uit elkaar hoefden te zijn.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Mijn hond heeft altijd aandacht voor mij.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Het is vervelend dat ik soms mijn plannen moet veranderen vanwege mijn hond	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Het is vervelend dat mijn hond me weerhoudt vanden dingen die ik deed voordat ik hem/haar had.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Er zijn belangrijke aspecten aan het bezitten van een hond die ik niet leuk vind	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Mijn hond kost te veel geld.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>



	Minstens 1 keer per dag	2 tot 3 keer per week	1 keer per week	Minstens 1 keer per maand	(Bijna) nooit
Hoe vaak heeft u het gevoel dat het hebben van een hond meer kost dan het oplevert?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Hoe vaak voelt het verzorgen van de hond als een karwei?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Hoe vaak weerhoudt uw hond u ervan dingen te doendie u wilt doen?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	<b>Heel erg moeilijk</b>	<b>Een beetje moeilijk</b>	<b>Neutraal</b>	<b>Niet moeilijk</b>	<b>Helemaal niet moeilijk</b>
Hoe moeilijk is het om voor uw hond te zorgen?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

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# Chapter 4

## **The impact of service dogs on military veterans and (ex)first aid responders with Post-Traumatic Stress Disorder**

To be submitted to *Frontiers in Psychiatry*

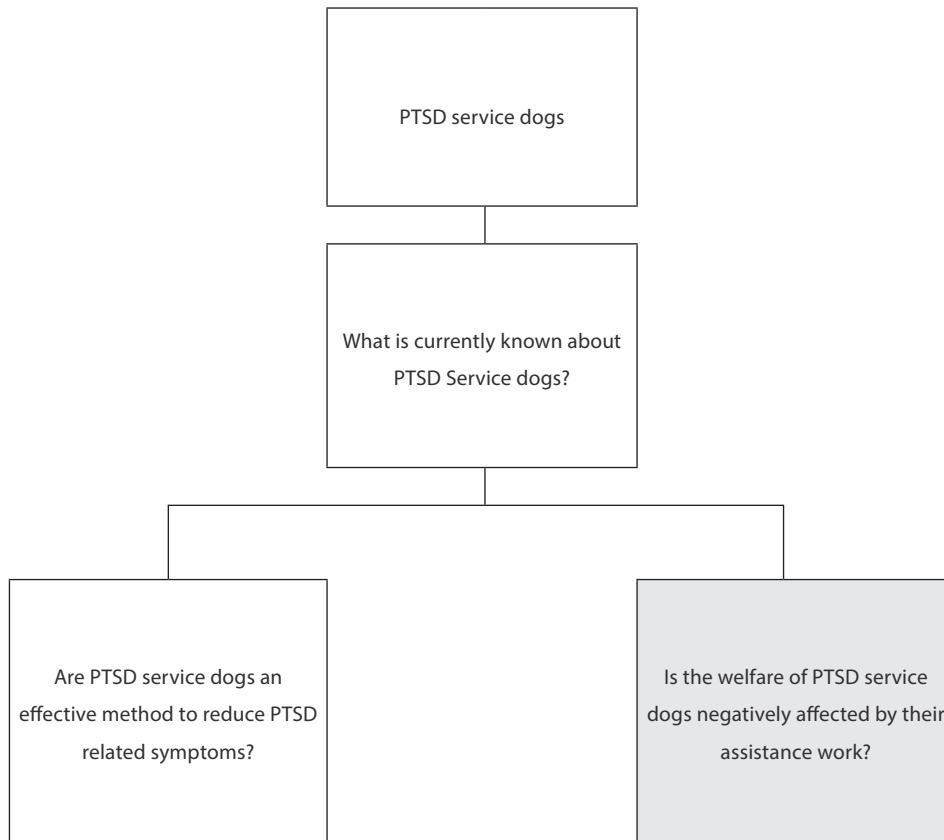
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## Abstract

Due to its novelty and lack of empirical study it remained unclear if a service dog truly mitigates the burden of PTSD symptoms. To cross sectionally investigate the effect of service dogs on veterans and first aid responders with PTSD, we compared subjective and objective parameters in 65 individuals divided over four groups. These groups were: veterans and first aid responders with PTSD and a service dog (n=20), with PTSD and a companion dog (n=10), with PTSD without a dog (n=12) and a control group without PTSD (n=23). We found that veterans and first aid responders with PTSD who had a service dog showed less PTSD related symptoms, better sleep quality, and better wellbeing experience, than those with a companion dog. Those with a service dog additionally experienced fewer PTSD related symptoms than those without a service dog and tended to walk more than individuals in the control group. No differences were found in cortisol levels between groups though and changes in both salivary cortisol and activity were not linked to improved welfare experience. Though the use of objective measurement methods thus warrants more research, our study showed that the subjective experience of wellbeing, sleep quality and PTSD related symptoms is improved by the presence of a service dog.

## Key words

service dog, PTSD, veteran, dog, Post-traumatic stress disorder



## Introduction

PTSD is an anxiety disorder, that manifests in a general negative mood, periods of depression, periods of anxiety, flashes of anger, reckless behaviour, sleeplessness, and general increased arousal causing impairment or distress (American Psychiatric Association (APA), 2013). A novel way in which the symptoms of PTSD can be lessened is through the provision of a PTSD service dog. Service dogs are specialised assistance animals, which have learned to respond to various verbal and non-verbal communication cues of their handler. As a response they will act as both a social support and behavioural mirror, and help their handler in coping with the consequences of their PTSD. Service dogs are further known to work as a social facilitator via their learned behaviours (Crowe et al., 2017) and their presence as a companion animal (Lane et al., 1998; Banks & Banks, 2002; Wood et al., 2005). This function is related to the principles of Behavioural Activation (BA), which has been shown to be an effective treatment for depression (Kruger & Serpell, 2006; Jakupcak et al. 2010). Because there is also empirical support for BA as a treatment for PTSD (Jakupcak et al., 2010), the principles of BA may provide evidence for PTSD service dog effect. The most compelling evidence of the effectiveness of service dogs to date however, seems to be in the form of self-report by those who are supported by a service dog (Stern et al., 2013; Kloep et al., 2017; Vincent et al., 2017; Yarborough et al., 2017) In these reports handlers state that their service dog helps them reclaim control of their life and obtain a sense of worth by promoting responsibility and self-efficacy through the care the service dog needs (Tedeschi et al., 2010). Service dogs are further stated to help handlers reconnect with society, improve individual quality of life, and therefore help their handlers reach opportunities in life they previously deemed unreachable (Crowe et al., 2017).

All these effects seem to speak in high favour of the provision of service dogs to individuals with PTSD. In our literature study from 2018 we however concluded that the presented evidence of service dog effectiveness at that time was insufficient to definitively attribute any improved wellbeing in individuals with PTSD to service dog presence (van Houtert et al., 2018). This attribution was difficult because, as stated above, the influence of service dogs is mostly measured via self-report measurements. Although very valuable in the determination of individual wellbeing, these measurements do not indicate physiological changes that might be influenced by both PTSD and presence of a PTSD service dog. We further determined that many studies on service dogs were conducted among small sample sizes, did not have control groups, and had vastly varying measurement methodologies, which made them difficult to compare to one another (van Houtert et al., 2018). All this led to the conclusion that further study regarding the effect of service dogs on individuals with PTSD needed to address the above uncertainties by not only introducing standardisation in methodology, but also

by introducing the use of quantifiable measurements to complement and frame the subjective experience of service dogs by individuals with PTSD.

One study which has since addressed some of the uncertainties in service dog research is that of Rodriguez et al from 2018. In their study they compared the morning awakening cortisol response in 45 veterans with a service dog with that of 28 individuals on a waiting list to receive one. By doing so, they found that individuals with a service dog had a higher morning awakening cortisol level than those on the waiting list. Morning awakening cortisol is a measure related to the human circadian cortisol rhythm. In this rhythm a basal release of the hormone is regulated throughout the day by the suprachiasmatic nucleus in the hypothalamus (Krieger et al., 1975; Chan & Debono, 2010). In individuals with PTSD this basal release of cortisol is known to deviate from that of non-PTSD individuals. Though differences in the overall circadian average are disputable (Meewisse et al., 2007), evening peak and early morning levels of cortisol were found to be lower in individuals with PTSD (Yehuda et al., 1996; Pierce & Prichard, 2016; Als et al., 2017). The results of Rodriguez et al (2018) therefore suggest that the difference in presence or absence of a service dog between their two subject groups influenced the manner in which PTSD affected the subjects' cortisol response, and brought the service dog group closer to what could be expected of non-PTSD afflicted individuals. If this conclusion is correct, they have provided one of the first measurements that can be used to objectively quantify the influence of service dog presence on an individual with PTSD and have therefore created interest in the use of other PTSD symptom related measurement techniques in service dog research.

One of these other measurement techniques is through the observation of changes in behavioural patterns and overall functioning of individuals with PTSD (Lessard et al., 2020). Although PTSD can express differently between individuals, it generally alters observable behaviour and functioning in an individual compared to non-PTSD individuals. Especially overall activity and activity intensity are known to decrease in those with PTSD since they are less inclined to leave their house or safe environment. The degree in which an individual undertakes activities and is active in his or her daily life is therefore an indicator of how he or she is affected by PTSD. Combined with a record of service dog presence, an individual's activity level or changes therein can thus be used to evaluate the effect of the service dog on PTSD related symptoms (Lessard et al., 2020)

All in all, there are various measurements with which the effect of PTSD on human physiology and psychology can be quantified. The main objective of this study was therefore to identify the influence of a service dog on the various measurements discussed above. To do so we asked several questions regarding these measurements. The first question was whether the presence or absence of a service dog is measurable



in the 24 hour activity pattern of individuals with PTSD? Our second question concerned cortisol levels and whether or not the presence or absence of a service dog is measurable in the morning and evening cortisol of individuals with PTSD. Our third question finally was whether or not the morning waking cortisol and 24 hour activity pattern of those with PTSD were positively correlated to wellbeing experience as reported. If these questions could be answered, they could provide insight in the effects that provision of a service dog might have on individuals with PTSD.

## Material & Methods

### Subjects

Four groups were identified for this study (Total n=65). The first group (n=20) consisted of military veterans or (ex)first aid responders (ambulance workers, firefighters, police officers) who were currently matched with a service dog from the service dog provider Stichting Hulphond Nederland. We chose to only work with individuals who had received a service dogs from a single provider as to eliminate the influence of different training, education, selection, and support strategies on the performance of service dogs as an extra variable in this study. It was further chosen to only work with veterans or (ex)first aid responders with PTSD, as the origin, development, and support offered for PTSD is similar between individuals in this group.

The second group (n=12) consisted of military veterans or (ex)first aid responders with PTSD who were currently waiting to be matched with a service dog from the abovementioned service dog provider. Individuals in the second group were additionally not in the possession of a companion dog, as those who already had a companion dog (besides waiting for a trained service dog) were considered a separate third group (n=10). This division between groups two and three was made to see if the presence of a companion dog had a positive influence on veterans/(ex)first aid responders with PTSD, and if so, to see if this influence was different from the influence of a service dog. The fourth and final group of participants (n=23) consisted of military veterans without PTSD and functioned as a control group for groups one, two and three. Details of each group can be found in Table 1.

Contact with potential participants to the study was sought via various channels. All individuals of group one were contacted via the above mentioned service dog provider. This was also done for a number of individuals belonging to groups two and three who were on a waiting list to receive a service dog from that same service dog provider. The remaining participants in groups two, three, and four were finally found via a mixture of personal connections, and communication channels targeted at veterans.

**Table 1:** Details on the participants of the four subject groups in this study. The first group consisted of veterans/(ex) first-aid responders with PTSD and a service dog (n=20), the second group consisted of veterans/(ex) first-aid responders with PTSD but without any dog (companion or service dog) (n=12), the third group consisted of veterans/(ex) first-aid responders with PTSD and a companion dog (n=10), and the fourth group consisted of veterans without PTSD (n=23).

\* the percentages of veterans and first aid responders do not add up because some participants were part of both groups (e.g. veterans who joined the police force after their deployment)

Group	Male %	Female %	Age Years	Veteran* %	First aid responder* %	PTSD %	Service dog %
1	90	10	52	84	47	100	100
2	75	25	20	80	58	100	0
3	100	0	47	67	60	100	0
4	91	9	51	100	26	0	0

### Experimental design

All participants were instructed to perform several measurements at home. These measurements were: collecting 10 salivary samples at set timepoints over the course of two days, wearing an accelerometer for a period of 36 hours, and filling out a maximum of five questionnaires. Individuals who had a service dog finally also collected 10 salivary swabs from their dog, made sure it wore an activity measuring collar and filled out an additional questionnaire. These dog based measurements were used for a study on service dog welfare. The results and full design of this study will be published separately.

To ensure the instructions for home measurements were clear, a researcher visited each participant in their home and explained every measurement before handing over the necessary equipment to perform them. This same researcher collected the used equipment after a period of at least a week, and answered any questions the participants might ask before, during, and after their participation to the study.

### Questionnaires

The five questionnaires used during this study were filled out by all subjects in all groups as long as the questionnaire was applicable to their situation. This means that questionnaires regarding dogs were not filled out by subjects without a dog. The five questionnaires were:

- An intake questionnaire used to register general information on each subject like age, sex, whether they were a veteran or (ex) first aid responder, whether or not they were diagnosed with PTSD, and if so whether they were assisted by a service dog or not.





- The PTSD Check List - version DSM 5 (PCL-5). The PCL-5 is a 20 item questionnaire concerning the prevalence or severity of trauma associated symptoms in individuals. Each answer can be given on a 5-point scale which indicates increasing prevalence or severity. If points for all answers are combined a score between zero and 80 points should be achieved (Weathers et al., 2013), with a cut-off point at 31-33 points for PTSD diagnosis (Bovin et al., 2016) Analysis of this questionnaire was performed via its included instructions which resulted in four component scores and a final score for each questionnaire.
- The Pittsburg Sleep Quality Index (PSQI) questionnaire. The PSQI is a 21 item self-report questionnaire which questions the frequency of disruptive nocturnal behaviours (DNB). It is made up of seven components; subjective sleep quality, sleep latency, habitual sleep efficiency, sleep duration, sleep disturbance, use of sleep medication and daytime functioning (Buysse et al., 1988; Germain et al., 2005). Analysis of this questionnaire was performed via its included instructions which resulted in a final score.
- The 36-Item Short Form Survey Instrument (SF36) questionnaire. The SF36 is a 36-item self-reflective wellbeing measurement tool with multiple choice answer format. Shiner et al. (2011) found the SF36 to reproduce reliable results when filled out by a subject group of military veterans with PTSD. It was later also applied by Stern et al. (2013) to evaluate experienced quality of life by military veterans in relation to service dog intervention. Analysis of this questionnaire was performed by first mirroring negative question scores before adding all answer scores into a final score.
- A Dutch translation of the Monasch Dog Owner Relationship Score (MDORS) (Dwyer et al., 2006; van Houtert et al., 2019). The Dutch translation of the MDORS has 16 items divided over 2 factors; perceived emotional closeness and perceived costs of dog ownership. Answers can be given on a five-point multiple choice format which produces a score between 16 and 80 points. Analysis of this questionnaire was performed by first mirroring the score of negative questions before adding all answer scores into a final score. The MDORS questionnaire was only filled out by the participants that either had a service dog or a pet dog.

### Salivary cortisol

To study deviations in normal morning and evening peripheral cortisol level between subject groups, salivary cortisol level was measured on 10 occasions divided over two days. On the first day, the first sample was taken in the morning directly after waking up. The next sample was taken 15 minutes later, the third 30 minutes after waking up, and the fourth 60 minutes after waking up. The fifth and final sample was taken right before

going to sleep, after which the whole procedure was repeated the next morning and evening.

Sample collection by participants occurred in their individual home environment through passive drooling into a new collection tube at each time point. Participants were instructed not to eat, smoke, or consume any other fluid than clear water 30 minutes before each measurement, as this might influence sample quality (Pierce&Prichard, 2017). After collection, a sample was marked with its order-number and stored at -20 C until retrieval by the researcher. Retrieved samples were then transported to the general storage facility at Utrecht University, where they were again stored at -20 C.

Extraction of cortisol from samples was performed by spinning the samples at 3000 rpm for 5 minutes. This resulted in a clear supernatant of low viscosity. Visual inspection was performed at this stage for any signs of contamination (discoloration). No samples were rejected because of this. Cortisol concentrations were finally measured using a commercially available chemiluminescence immunoassay with high sensitivity (IBL International, Hamburg, Germany). The average intra-assay coefficient was 5%

From the 10 cortisol samples spread over five timepoints and two days an average was finally calculated for each timepoint. This resulted in a total of five datapoints per participant, one for each timepoint. If a participant missed a measurement on either one of the days the final datapoint was based on a single measurement instead.

### Activity measurements

Overall activity in all human subjects was monitored via the Empatica E4. Participants wore the E4 for a continuous period of at least 36 hours. During those 36 hours the device had to be worn at all time, both while awake and while sleeping, unless there was a high chance of damage to the devices (showering, swimming, working heavy tools). All registered data were stored on the device's internal storage capacity until extraction via Empatica's specialised E4 software. Data analysis was performed via the EDA explorer scripts of Taylor et al. (2015). This entailed that each dataset was run through a step detection script which returned the estimated total number of steps, mean step time during movement and percentage of time spent inactive during the first 24 hours.

### Statistical analysis

Statistical analysis was performed in R version 4.0.3 with R studios (R core team, 2018). A total of 12 numeric variables were analysed for differences between four participant groups. The variables were: salivary cortisol levels at five different timepoints, the number of steps taken in a 24 hour time period, the mean time spent walking in a 24 hour time period, the percentage of time an individual was inactive in a 24 hour time



period, an individual's PCL5 questionnaire score, an individual's PSQI questionnaire score, an individual's SF36 questionnaire score, and an individual's MDORS questionnaire score. For all these variables normality was judged by plotting a histogram and observing if the resulting figure neared normal distribution. From these histograms it became apparent that normality could not be assumed for any of the variables. A choice was therefore made for statistical analysis via non-parametric methods. This analysis was started with a Levene's test of homogeneity of variances for each variable. None of these tests were significant which meant that equal variances could be assumed. To check if pairs of two participant groups differed from one another, a series of Mann-Whitney tests was performed per variable ( $\alpha=0.05$ ). This resulted in six Mann-Whitney tests per variable according to the following schedule: group 1-2, 1-3, 1-4, 2-3, 2-4, 3-4. A series of Spearman correlations ( $\alpha=0.05$ ) was finally used to evaluate possible correlations between the four questionnaire scores (PCL5, PSQI, SF36, MDORS) and the other eight variables.

### Ethical Statement

Ethical review and approval for this study was obtained from the medical ethical comity of the Utrecht Medical Centre, Utrecht, The Netherlands under number NL64117.041.18. Each participant further gave informed consent before participation to the study.

## Results

### Dataset description

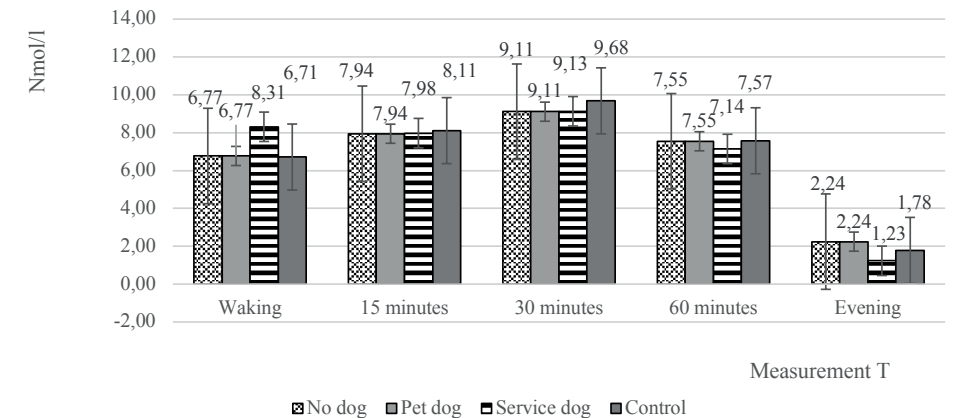
All but a few datasets were fully complete. This resulted in a reduced n for several measurements compared to the total participant number. Regarding salivary cortisol, a total of 60 out of 65 participants had at least one sample at all five timepoints. A further three had a sample for at least four timepoints, one had a sample for three timepoints, and one missed samples for all timepoints. The main reason for these missing samples was insufficient saliva volume.

Activity measurements were successful for 47 out of 65 participants. The most common reason for activity measurement to fail was due to (premature) battery failure of the measurement equipment.

The full set of questionnaires was finally retrieved for 55 out of 65 participants. The intake questionnaire missed one or more items for three participants, the PCL5 questionnaire missed one or more items for one participant, the PSQI missed one or more items for 10 participants, and the SF36 questionnaire missed one or more items for two participants.

### Salivary cortisol differences between groups

The salivary cortisol levels at all five timepoints were compared between participant groups using a series of Mann-Whitney tests between group pairs. A trend was observed ( $p=0.09$ ) in which the evening cortisol of participants with PTSD and a companion dog (Figure 1) was higher than that of participants with PTSD but without a dog. No trends or significant differences were found between any of the other groups.



**Figure 1:** The salivary cortisol levels for the four different subject groups during five different measurement points. The four groups are: individuals with PTSD and a service dog, individuals with PTSD and a companion dog, individuals with PTSD without a dog, Individuals without PTSD. The five measurement moments are: Just after waking up ( $n=19,10,11,21$ ), 15 minutes after waking up ( $n=20,10,12,22$ ), 30 minutes after waking up ( $n=20,10,12,22$ ), 60 minutes after waking up ( $n=17,10,12,22$ ), just before going to bed in the evening ( $n=19,10,12,22$ ).

### Activity differences between groups

The number of steps taken, mean time walking and percentage of stillness were compared between participant groups using a series of Mann-Whitney tests between group pairs. These tests showed that the total number of steps taken appeared higher for participants with PTSD and a service dog (Figure 2) than for individuals without PTSD ( $p=0.05$ ). No other differences between groups were found.

### Questionnaire differences between groups

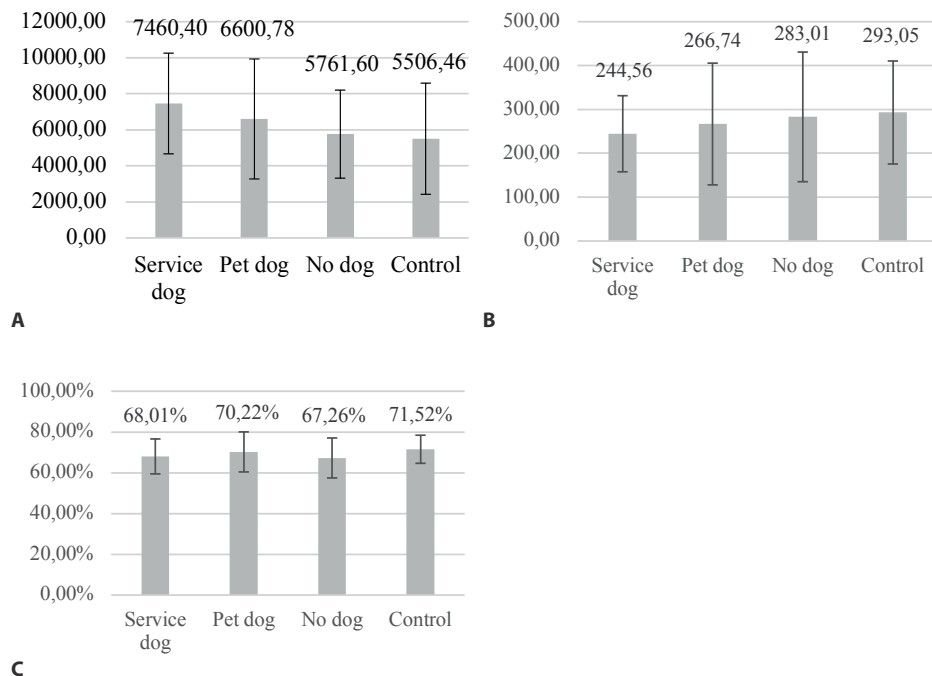
The questionnaire scores of the PCL5, PSQI, and SF36 were compared between participant groups using a series of Mann-Whitney tests between group pairs. Regarding the PCL5 questionnaire, it was found that participants without PTSD had significantly lower PCL 5 scores (Figure 3a) than participants with PTSD and a service dog ( $p=0.00$ ), participants with PTSD and a companion dog ( $p=0.00$ ), and Participants with PTSD without a dog ( $p=0.00$ ). It was additionally found that individuals with PTSD who were



supported by a service dog had significantly lower PCL5 scores than those with a companion dog ( $p=0.00$ ) or without a dog ( $p=0.01$ ).

Regarding the PSQI it was found that participants without PTSD had significantly lower PSQI scores (Figure 3b) than participants with PTSD and a service dog ( $p=0.00$ ), participants with PTSD and a companion dog ( $p=0.00$ ), and participants with PTSD without a dog ( $p=0.00$ ). It was additionally found that individuals with PTSD who were supported by a service dog had significantly lower PSQI scores than those with a companion dog ( $p=0.01$ ).

Regarding the SF36 it was found that participants without PTSD had significantly lower SF36 scores (Figure 3c) than participants with PTSD and a service dog ( $p=0.00$ ), participants with PTSD and a companion dog ( $p=0.00$ ), and without a dog ( $p=0.00$ ). It was additionally found that individuals with PTSD who were supported by a service dog had significantly lower SF36 scores than those with a companion dog ( $p=0.04$ ).

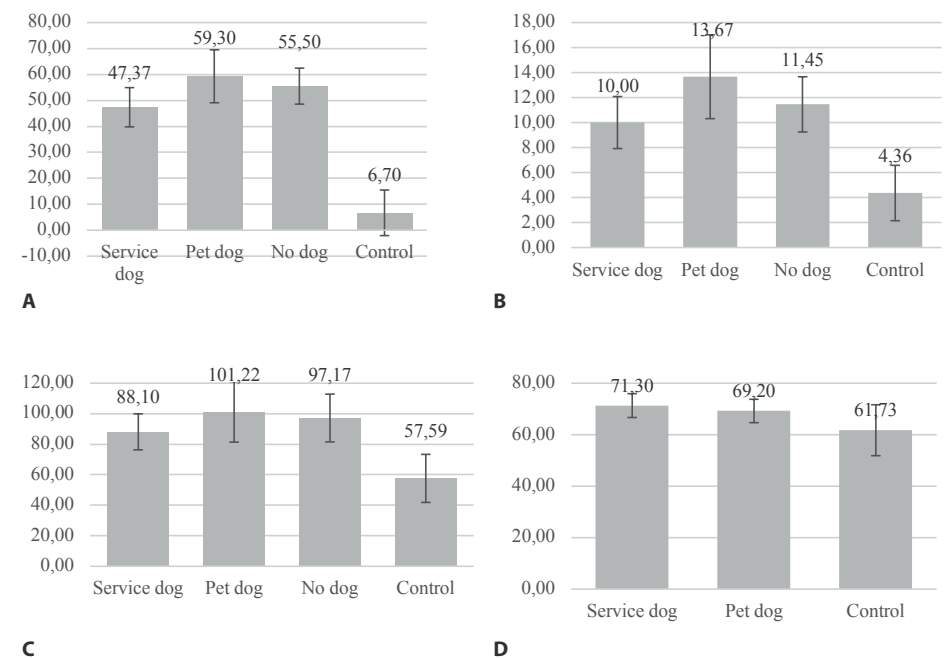


**Figure 2 A,B,C:** The number amount of steps taken during 24 hours (a), mean step time (b), and percentage stillness (c) per participant group. The four groups are: individuals with PTSD and a service dog ( $n=15$ ), individuals with PTSD and a companion dog ( $n=9$ ), individuals with PTSD without a dog ( $n=10$ ), Individuals without PTSD ( $n=13$ ).

Regarding the MDORS it was finally found that participants without PTSD had significantly lower MDORS scores (Figure 3d) than participants with PTSD and a service dog ( $p= 0.00$ ), and participants with PTSD and a companion dog ( $p=0.03$ ).

### Relations between questionnaire scores and other variables

To see if there was a relation between the PCL5, PSQI or SF36 or MDORS questionnaire scores of participants and either their activity or salivary cortisol measurements, a series of spearman correlations were calculated. These tests showed that the correlation between cortisol level taken right before and individual went to bed and their PSQI score showed a trend ( $p=0.07$ ,  $\rho= -0.24$ ). All other correlations were non-significant.



**Figure 3 A,B,C,D:** The average scores for the PCL5 (a), PSQI (b), SF36 (c), and MDORS (d) questionnaires per participant group. The four groups are: individuals with PTSD and a service dog ( $n=19,13,20,20$ ), individuals with PTSD and a companion dog ( $n=10,9,9,10$ ), individuals with PTSD without a dog ( $n=11,12,12$ ), Individuals without PTSD ( $n=23,22,22,11$ ).

## Discussion

### Subjective measurements of service dog influence

In this novel study we found that individuals with PTSD and a service dog had the lowest level of PTSD related symptoms among all individuals with PTSD observed during this study. This is in line with earlier studies by Stern et al. (2013), Kloep et al. (2017), Vincent et al. (2017), and Yarborough et al. (2017), who all found that individuals with PTSD and a service dog judged their own wellbeing to be better than that of those with PTSD without a service dog. Our study thus demonstrates that service dogs can have a positive effect on the wellbeing of individuals with PTSD. Because individuals with a pet dog showed more PTSD related symptoms than individuals with a trained service dog, our study furthermore shows that this effect is most likely not an inherent effect of dog presence but instead a result of service dog training and/or guidance by the organisation that provided the service dog. Because those with a service dog additionally experienced better quality of life and sleep quality than those with a pet dog, the results of our study seem to speak in favour of trained service dogs as an aid to those with PTSD. Further study on this topic is still needed though to evaluate if this conclusion is true for all service dogs or only those trained by a select number of organisations who follow similar protocols.

### Objective measurements of biological parameters

Because subjective measurements of wellbeing cannot fully account for placebo effects and bias, our study combined them with several objective measurements of biological parameters. These parameters were salivary cortisol levels and overall activity level. Neither of these measurements showed differences between participant groups though.

Two earlier studies have attempted to measure service dog effect on individuals with PTSD via objective measurement. These studies were Rodriguez et al. (2018) and Lessard et al. (2020). Rodriguez et al. (2018) studied the influence of service dogs on morning salivary levels while Lessard et al. (2020) studied the effect of service dogs on activity levels in those with PTSD. Both studies found an effect of service dogs on these respective measurements which is in contrast to our results. This could be due to the manner in which these parameters were evaluated though. Lessard et al. (2020) for example studied activity within individuals while we studied activity between individuals. It is therefore possible that the effect of service dogs on activity levels is small or differs between individuals which makes it easier to measure within than between individuals.

Another possibility for the differences in found results could have been a difference in study populations. In some populations PTSD is known to lower morning cortisol levels (Yehuda et al., 1996; Meewisse et al., 2007; Pierce & Prichard, 2016; Als et al., 2017). This

was true for the population observed in the study by Rodriguez et al. (2018), which made it possible for them to observe an elevating effect of service dog presence on salivary cortisol levels. No lowering of salivary cortisol levels in those with PTSD was observed in our study though, which made it impossible to measure an effect of service dogs on this parameter.

An explanation for why a non-lowered group was observed might be sought in which individuals with PTSD agreed to participate in our study. Out of all approached individuals with PTSD without a service dog, about half of the agreed to participate. The other half stated that they did not feel well enough to participate, and that they wanted to focus on their own recovery instead. Because of these statements it is possible that only individuals with PTSD in relative good welfare participated. The cortisol of these individuals might therefore not have been lowered, which might explain why they did not differ from the control group and the individuals with a service dog in this aspect.

### Correlation between subjective and objective measurements

In addition an absence of difference between groups, salivary cortisol and activity level as measured in this study also failed to show a correlation with subjective measurements of welfare. Of course it is possible that this was due to the absence of difference within the objective parameters, though it is also possible that the effects of PTSD on wellbeing and bodily function are truly separate (Rodrigue et al., 2018). The PTSD service dog itself might for example influence different consequences of PTSD via different routes. The activity level of an individual with PTSD, might not solely be influenced by the severity of PTSD symptoms and the service dog's reduction thereof. Measurements of activity level might instead be independently influenced by a dog's intrinsic need for exercise. This possibility is supported by data found in this study which showed that both those with a service dog and a companion dog walked more than those who did not have a dog. Though this difference was not significant, the absence of a correlation with measurements of wellbeing in this study suggests that dog presence does increase activity in its own right independent of changes in wellbeing.

Another reason why a correlation between objective and subjective measurements of PTSD might be absent is due to the order in which these variables are affected by a service dog's presence. Salivary cortisol levels for example may not be directly influenced by service dog presence but indirectly by a service dog's influence on sense of wellbeing. Good wellbeing over longer periods of time may subsequently normalise cortisol levels which can then be measured after a certain amount of time has passed. A study which demonstrates this effect is one by Hsiao et al. from 2016. They found that the effects of mindfulness on morning cortisol levels in breast cancer survivors and their partners continued to increase up to 14 months after the start of the intervention. Similarly



the effects of a service dog might be found early on in subjective measurements of wellbeing and later develop into effects on physiological measurements like salivary cortisol. To measure a correlation between these subjective experience of wellbeing and physiological changes however, repeated measurements over longer periods of time would be necessary. This was not done within this study, which might explain a lack of found differences in this variable.

## Conclusion

Taken together our results showed that the presence of a service dog improved the reported quality of life, improved the reported sleep quality, and lowered the level of reported PTSD symptoms in those with PTSD. Because these results are in line with earlier studies by Stern et al. (2013), Kloep et al. (2017), Vincent et al. (2017), and Yarborough et al. (2017), they speak in favour of service dogs as an aid to those with PTSD. Because subjective measurements might suffer from bias though, we also studied two objective measurement of PTSD service dog effect. No effects of service dog presence were found on these measurements and they also did not correlate to measurements of wellbeing (Rodriguez et al., 2018; Lessard et al., 2020). The possibility of bias and placebo that would undermine the positive results of service dog effect as presented in this study is therefore difficult to counter via objective measurement. Other methods to do so might be considered for future research, though it can also be questioned if bias and placebo are present at all. Several studies have repeatedly shown a positive influence of service dog presence on those with PTSD. This effect was additionally greater than that of pet dog presence as shown by our results. It can therefore be questioned how big the influence of bias and/or placebo would truly be on our results since similar results have been found across populations. Though the possibility of this influence seems to be small, it is advisable that in future a meta-analysis or similar study is performed on these parameters, to establish a definitive answer to this question.

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**Institutional Review Board Statement:** Ethical review and approval for this study was performed by the medical ethical comity of the Utrecht Medical Centre, Utrecht, The Netherlands under number NL64117.041.18

**Informed Consent Statement:** Informed consent was obtained from all participants to this study prior to participation.

**Data Availability Statement:** The data presented in this study are available on request from the corresponding author.

**Conflicts of Interest:** This validation study was performed at Utrecht University as part of a larger research to the influence of PTSD service dogs on veterans with PTSD in the Netherlands. The overall project is performed with the support of Stichting Hulphond Nederland, and the Dutch Ministry of Defence, with financial support of the Karel Doorman Fund, the Utrecht University Fund, Royal Canin, the Triodos Foundation, the K.F. Hein foundation, and stichting Vrienden Diergeneeskunde. None of these stakeholders were part of the conception of this study. Therefore, the authors report that there were no conflicting interests involved in the conception of this study, and that they did not gain any direct commercial, financial, or political benefit from this publication.



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# Chapter 5

## **Do Service Dogs for Veterans with PTSD Mount a Cortisol Response in Response to Training?**

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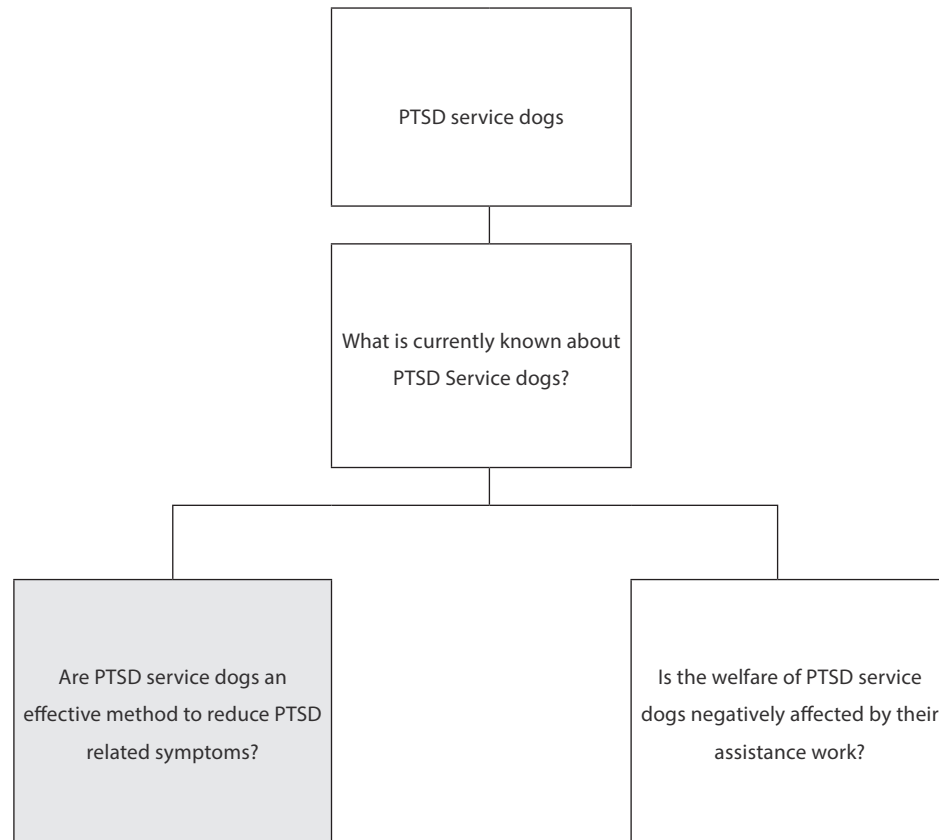
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## Simple Summary

A growing number of people are supported by specialized service dogs. These dogs are highly trained to improve human welfare, yet not much is known about their own welfare. One of the ways in which welfare can be measured is through the expression of stress via the hormone cortisol. In this study, we investigated the level of cortisol in saliva, a measure for physiological stress, in 19 service dogs. We measured cortisol in the dogs' saliva 15 min after arrival at a training ground, before partaking in a training session for service dogs, after participation in the training session, and after a 45-min free play period. We found no elevated levels of cortisol after the training session. Instead, we found that cortisol had lowered when compared to before the training. Additionally, we found that cortisol was highest 15 min after arriving at the training round and after 45 min of free play. This led to the conclusion that dogs in our study did not seem to have a stress response in response to participation in the training.

## Abstract

Only a few studies have investigated the welfare of animals participating in animal-assisted interventions (AAIs). Most of these studies focus on dogs in therapeutic settings. There are, however, also dogs—service dogs—that are employed to continuously support a single human. Because the welfare of these service dogs is important for the sustainability of their role, the aim of this study was to investigate their stress response to service dog training sessions. To do this, we took repeated salivary cortisol samples from dogs who participated in a training session ( $n = 19$ ). Samples were taken just after arrival at the training ground, before training, after training, and after a period of free play. Our results showed that mean cortisol levels in all samples were relatively low (between  $1.55 \pm 1.10$  and  $2.73 \pm 1.47$  nmol/L) compared to similar studies. Analysis further showed that samples taken before and after participation in the training's session did not differ from one another. Mean cortisol levels in both situations were additionally lower than those upon arrival at the training site and after a period of free play. This led to the conclusion that the dogs in our study did not seem to experience training as stressful.

## Keywords

AAI; PTSD; service dogs; welfare



## 1. Introduction

The relationship between humans and dogs knows a long history. Dogs have assisted humans in a growing array of tasks. These tasks include tracking specific scents [1,2] guarding objects, people, or locations [3], cattle herding, pulling carts, scrap cleaning (and through this, pest and disease control), providing companionship, and providing warmth [4]. As of the 20th century, there has additionally been a growing interest in the development and deployment of specialized dogs to improve individual human health. Perhaps the best known of these dogs is the uide dog for humans with a visual disability. Other examples include dogs for those with a hearing impairment [5], dogs that detect low blood sugar [6], dogs that detect symptoms of epileptic seizure [7], dogs that assist with a physical disability [8], dogs that assist with autism spectrum disorder (ASD) [9,10], and dogs that assist those with a post-traumatic stress disorder (PTSD) [11,12].

Dogs intentionally deployed for the welfare of humans are collectively known as either service dogs or assistance dogs (region-dependent). Their deployment is further considered a form of animal-assisted intervention (AAI), which entails that an animal is used in a (therapeutic) intervention for the improvement of human welfare and/or health. Since the goal of AAI is aiding humans, studies on the topic have mainly focused on the effects that the animals have on the humans they are aiding. Only a few studies and publications have discussed the effect of AAI on animal welfare [13–16] and even fewer have studied animal welfare in AAI via experimental design.

Most studies that have focused on animal welfare in AAI concentrated on the deployment of dogs in therapeutic settings. They did so primarily through a combination of behavioral assessment through structured observation and the analysis of cortisol samples. The use of heart rate and body temperature is, however, also seen [14,16–22]. Although it is disputed whether there is a relation between behavioral observations and cortisol measurements in dogs [23–27], both measures have individually been found to be indicative of animal welfare status. Behavioral observation, for example, has been established as a tool to assess arousal or stress in dogs [28,29]. Dogs that are subjected to stressors such as social or spatial restriction are known to perform specific behaviors more often than relaxed dogs. Examples of such behaviors include yawning without other signs of drowsiness, paw lifting, body shaking without a waterlogged fur, and walking around erratically [30,31]. The performance of these behaviors has further been linked to a state of either conflict, confusion, or fear in dogs [32], which can, in turn, be used to determine if an individual dog is either physically or mentally able to cope with the situation it is currently in.

Changes in the concentration of the steroid hormone cortisol have additionally been associated with physiological signs of stress in dogs and other mammals [28,33–35], though it deserves mention that heightened cortisol is also a possible sign of positive arousal. Although cortisol can be found in various bodily fluids [36–38], one of the less invasive, yet accurate, ways in which to detect it is through a salivary swab [39,40]. Because of this reduced invasiveness, salivary cortisol has become a widely used method to determine both acute [23] and chronic stress [24,30] in dogs. It has additionally given insight into dogs' recovery process from acute stressors, as demonstrated by Beerda et al. in their study from 1998 [23]. In their study, they found that salivary cortisol in dogs showed a 13- to 20-nmol/L elevation compared to the basal level (mean 6 nmol/L) after the dogs had been exposed to an acute stressor (opening umbrella, sudden shock). The time it took for this peak to appear was between 0 and 30 min following the stressor, which is in line with the time it takes salivary cortisol to reflect plasma cortisol [41].

Beerda et al. [23] additionally found that peak values of salivary cortisol had dropped by half in most dogs 30 min post-stressor and returned to baseline levels after 45–60 min post-stressor. These findings indicate that the observed dogs had a capacity to recover from their encountered stressor and return to baseline values if given time to do so. This capacity to recover from stressors is particularly important for dogs in AAI as they are exposed to potential stressors on a regular basis [13]. Dogs that are used for AAI are, therefore, often pre-selected for their capacity to recover from stressors via a series of temperament tests and behavioral observations. They are additionally specifically trained from a young age to familiarize them with the work they will perform in later life. In theory, therefore, only animals that are both mentally and physically capable of assistance work are employed. To test if this assumption is true, studies such as those by Glenk et al. [14,18] and Clark et al. [16] have evaluated the effect of assistance work on dog welfare in AAI. This was mostly done during therapeutic sessions in which dogs performed assistance work for several individuals one, two, or three times a week. In their studies, Glenk et al. [14,18] and Clark et al. [16] reported no indications of (severe) stress in the dogs after they had assisted in a therapy session, which can be interpreted as meaning that selected and trained dogs are capable of coping with the stressors of assistance work. That is not to say that this conclusion holds true for all dogs in AAI though, as settings and workloads tend to differ between subtypes of AAI. There are, for example, also dogs who assist a single human 24/7 as opposed to several humans during a therapeutic session two to three times a week. This subtype is often referred to as a service dog and has a more unpredictable and more frequent workload than the dogs observed in earlier studies. These dogs too, however, are pre-selected and trained for their work, which should mean they are mentally and physically capable of the work they are asked to perform in a similar manner as dogs used during therapy sessions.



To test if service dogs are capable of handling the tasks they are asked to do during their working life, we wanted to know if they showed physiological signs of stress during their work. Because a service dog's work is highly variable, however, we instead chose to evaluate dogs during a standardized situation which is similar for each dog. As such, we questioned whether service dogs show physiological signs of stress during a training session for active service dogs (as indicated by heightened salivary cortisol), and if so, whether they can recover from this stress within a time span of 45–60 min. If the dogs do not show a salivary increase after training, it can be argued that they did not experience the training as stressful. If they do show elevation after training yet show a return to baseline values after a recovery period, it can be argued that the dogs are capable of coping with the stressors they experienced during training. Both answers could help to evaluate whether service dogs are properly prepared for the work that is asked from them through their selection and training, or if these procedures need to be reevaluated for future generations of service dogs.

## 2. Materials and Methods

### 2.1. Subjects

For this study, 19 service dogs were observed. All dogs were trained and licensed service dogs of the Dutch service dog provider "Stichting Hulphond Nederland" and deployed to assist a single military veteran or (ex-)first aid responder with post-traumatic stress disorder (PTSD) (referred to as handler). They had additionally been living with their assigned handler full-time for at least a year and were used to working with them in daily tasks. Among the dogs, 16 were purebred Labrador Retrievers, one a Standard Poodle, one an Airedale Terrier, and one a mix between a Malinois and Labrador Retriever. The male/female ratio was 17/2 (all spayed/neutered), while the age of all dogs was between two and eight years (average  $3.9 \pm 0.7$ ), as these are the regular working years of a service dog (between training and retirement). To participate in this study, all dogs finally needed to be in good clinical health (as judged by a veterinarian) and were obliged to have had regular (at least four times a year) behavioral monitoring by an animal trainer from the service dog provider during the past year.

### 2.2. Experimental Design

Measurements for this study were taken during one of two collective training days at a service dog training facility of "Stichting Hulphond Nederland". These training days were part of the service dogs' ongoing training and primarily serve to help to reinforce trained behaviors on a periodical basis after they have been matched with a handler. They additionally serve as an opportunity to assess the development of the relationship

between the dog and the handler. Due to the varying ages of the dogs participating in this study, some dogs were familiar with this form of training while others were not.

Although PTSD service dogs usually work in their own home environment, a collective training session was chosen as a measurement moment to standardize conditions between dogs. During training, dogs had to perform a novel navigation task (such as following a specific path between obstacles). They could only complete this task by communicating with their handler since the dogs did not know the desired route between or around presented obstacles. With this method, the training simulated elements of the service dogs' work in a controlled environment, namely helping their handler navigate a distracting and often unfamiliar environment while maintaining focus on the handler.

During the collective training, four saliva samples were collected from each dog ( $n = 19$ ). This was done by placing a SalivaBio children swab (Salimetrics, 5001.06 and 5001.05) [42,43] in saliva pooling areas (mouth corners or under the tongue) in the mouth of the dog. In this manner, the swabs could passively absorb saliva for 60 s, while the dog was gently held around the muzzle. To prevent contamination of the samples, the dogs were not given any treats for at least 10 min prior to sampling. After sampling, the dogs were given a treat, however, to reward good behavior. The complete process of sampling was less than four minutes [40] for each sample so as to prevent the procedure from influencing the sample.

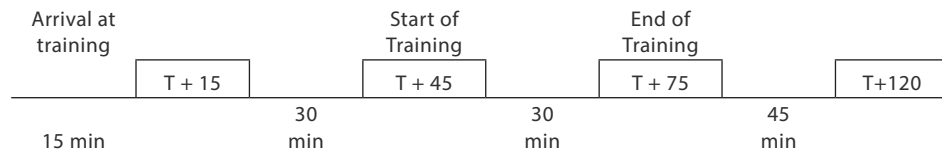
Out of the four samples, the first sample was collected 15 min after dogs had arrived at the training ground ( $T + 15$ ). This was done to measure anticipation stress in the dogs caused by the arrival at the training ground. The dogs were then given 30 min to adapt to their new environment before the second sample was collected at the start of the training exercise ( $T + 45$ ). During this 30-min gap, the dogs were either interacting with other dogs, walking with their handler, or resting while their handler received instructions for the training.

The third sample was taken, again, 30 min after the dogs had finished their training exercise ( $T + 75$ ). They were subsequently given 45 min of free time after training, at the end of which the fourth sample was collected ( $T + 120$ ) (see, also, Figure 1). During these 45 min, dogs were free to either play with other dogs present, play with their handlers, go for a walk with their handlers, or rest.

All samples were subsequently stored at  $-20\text{ }^{\circ}\text{C}$  until saliva extraction. Extraction was performed by spinning the samples at 3000 rpm for 5 min. This resulted in a clear supernatant of low viscosity. A visual inspection was additionally performed at this



stage for any signs of contamination (discoloration). No samples were rejected because of this. Cortisol concentrations were finally measured using a commercially available chemiluminescence immunoassay with high sensitivity (IBL International, Hamburg, Germany). The average intra-assay coefficient was 4%.



**Figure 1.** An overview of the different sample moments of this study relative to the arrival of the dogs at the training ground.

### 2.3. Statistical Analysis

Statistical analysis of salivary cortisol levels between all four samples taken during the collective training day was performed in R via Skillings–Mack test for non-parametric paired data with missing data points. Additional analysis of all possible sample pairs was performed via Wilcoxon signed rank test for paired non-parametric data. A Holm–Bonferroni correction was additionally performed on these tests to correct for multiple testing. Mauchly’s and Levene’s tests were finally performed to test for sphericity and equal variance of the dataset, respectively.

### 2.4. Ethical Statement

Ethical advice regarding this study was sought with the university’s resident animal experiment advisory board. Because no invasive measurements were taken, however, the full protocol of this study did not require judgement by the ethical committee.

## 3. Results

### 3.1. Missing Values

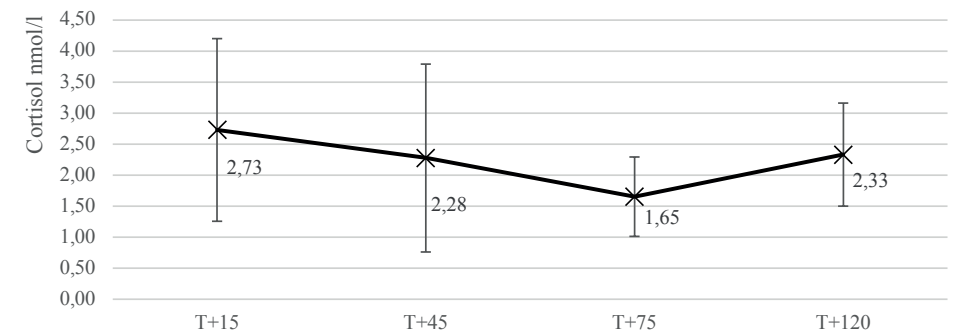
Out of the samples collected during the collective training days, the volume of retrieved saliva was sufficient for analysis in 67% of samples. Out of the total 19 dogs, nine had four sufficient samples, six dogs had three sufficient samples, two dogs had two sufficient samples, one dog had one sufficient sample, and one dog had zero sufficient samples. These missing values bring the total amount of successful samples at each time point to  $n = 13$  at T + 15,  $n = 16$  at T + 45,  $n = 16$  at T + 75, and  $n = 14$  at T + 120.

### 3.2. Cortisol Levels

The average salivary cortisol level of the dogs at the start of the collective training day (T + 15;  $n = 13$ ) was 2.73 nmol/L ( $\pm 1.47$ ). At the start of training (T + 45,  $n = 16$ ), this level was 2.28 nmol/L ( $\pm 1.51$ ). It was 1.65 nmol/mL ( $\pm 0.64$ ) at the end of training (T + 75,  $n = 16$ ), and finally, 2.33 nmol/L ( $\pm 0.83$ ,  $n = 14$ ) 45 min after the training session had ended (T + 120; Figure 2).

### 3.3. Statistical Analysis

The Skillings–Mack test statistic was 33.05 ( $p = 0.01$ ,  $\alpha = 0.05$ ), which indicates that the four measurement points of this study differed from one another. To identify which specific data points caused this result, an additional analysis was performed via Wilcoxon signed rank test between all data points in combination with a Holm–Bonferroni correction. The Wilcoxon signed rank tests indicated the data points T + 15/T + 75 and T + 75/T + 120 to be significantly different (Figure 3). The Holm–Bonferroni correction, however, did not yield significant differences between combinations. This combination of results indicates that T + 15/T + 75 and T + 75/T + 120 might be significantly different, though a Type I error cannot be excluded. All other data point combinations did not differ significantly from one another in both tests. Mauchly’s and Levene’s tests were finally performed to test for sphericity ( $p = 0.49$ ) and equal variance ( $p = 0.10$ ) of the dataset, respectively.



**Figure 2.** The various mean levels of salivary cortisol ( $\pm$ SD) at the four different sample points for the collective training session ( $n = 13$  at T + 15,  $n = 16$  at T + 45,  $n = 16$  at T + 75, and  $n = 14$  at T + 120). The training session took place between T + 45 and T + 75.

	T+15	T+45	T+75	T+120
T+15				
T+45	0.20			
T+75	<b>0.01</b>	0.06		
T+120	0.13	0.94	<b>0.02</b>	

**Figure 3.** The results of the Wilcoxon signed rank test matrix between all measurement points of this study (N = 19). The two measurement moments with a significant ( $\alpha = 0.05$ ) difference are in **bold**. A Holm-Bonferroni correction showed that these two points are susceptible to Type I error, however.

## 4. Discussion

In this study, we questioned whether service dogs would show physiological signs of stress during a service dog training session and, if so, whether they recover from this stress within a time span of 45–60 min. Our results did not show any indication of acute stress experienced due to participation in the training, as salivary cortisol levels before and after training did not differ significantly from each other. This is in line with earlier findings by Glenk et al. [14,18] and Clark et al. [16] in therapy dogs, as they also did not find a significant effect of assistance work on the level of salivary cortisol in assistance dogs.

The cortisol levels retrieved during this study (mean cortisol T + 15 = 2.73, T + 45 = 2.28, T + 75 = 1.65, T + 120 = 2.33 nmol/L) were slightly lower than those found during earlier studies. A meta-analysis by Cobb et al. [44], for example, found an overall mean basal salivary cortisol level of 0.45 ug/dL or 12.42 nmol/L between various dog studies. This, however, included studies with various dog breeds in different situations such as shelter dogs, companion dogs, guide dogs, and laboratory animals. Because of this diversity in breeds and settings, the values calculated by Cobb et al. [44] are potentially not representative of specific subsets (breeds or disciplines) of dogs. A study by Koyama et al. in 2003 [45] in Beagles, for example, found lower values for 24-h salivary cortisol variability of dogs. They found resting cortisol to be fluctuating between 2 and 8 nmol/L, with the interesting remark that no distinct circadian cortisol rhythm seemed to be present in dogs, as it is in most other mammals. A study by Beerda et al. [23] found results in agreement with Koyama et al. [45], as they reported basal cortisol levels to be 6 nmol/L in their dogs (mainly Beagles) in an experimental setting. Because of the above, it could be that the dogs in this study (mainly Labrador Retrievers) had a natural disposition for low cortisol due to their genetic background. A study by Batt et al. [46], however, found salivary cortisol values in guide dogs in training (also mainly Labrador Retrievers) which exceeded the results found in our study and those by Beerda et al. [23] and Koyama et al. [46] (2.07–2.17 ug/dL = 57.11–59.87 nmol/L).

Because of the above, it is more likely that the lower cortisol values in this study were caused by the setting in which it was performed. Within this study, a total of four measurement points were used surrounding a single intervention (the training session). Out of these measurement points, those preceding the intervention were higher than the one following it (significant for T + 15/T + 75). As stated before, this observation is in line with earlier findings by Glenk et al. [14,18] and Clark et al. [16] in therapy dogs, as they did not find an increasing effect of assistance work on the level of salivary cortisol in assistance dogs after participation in a therapy session. It is, additionally, contrary to results found by van der Borg et al. [47], who found that salivary cortisol did increase relative to pre-intervention levels when dogs were exposed to a stressful situation. They additionally found that cortisol levels lowered again after a 30-min resting period, which is, in turn, in line with the results of Beerda et al. [23].

Because van der Borg et al. [47] noted a possibility for salivary cortisol to increase in a setup comparable to our study, it can be assumed that the lowering of cortisol seen in our study after the start of training is indicative of lowering physiological stress. It can, therefore, be argued that the dogs in our study either did not show signs of physiological stress in response to the training they took part in or that they were able to recover before their salivary cortisol was re-measured (30-min gap). Given that it takes roughly 45–60 min for salivary cortisol in dogs to fully return back to basal levels after encountering a stressor [23,29], the former explanation seems more plausible than the latter.

The possibility of lowered physiological stress in dogs after training is, finally, supported by their salivary cortisol levels shortly after arrival at the training ground and after 45 min of free play. These levels were elevated compared to pre- and post-training levels, which indicates that the dogs experienced more physiological stress or arousal at these time points than during training. This, in turn, also suggests against the possibility of long-term stress-induced Hypothalamic–pituitary–adrenal (HPA) axis downregulation in dogs [48], since this generally reduces cortisol reactivity. In the case of arrival at the training ground, the elevation might have been caused because the dogs encountered unfamiliar surroundings and conspecifics, which might have acted as a stressor or a stimulator. Meeting other dogs could have additionally increased activity in the dogs, which, by itself, is known to increase cortisol levels in animals [49,50]. This last effect would additionally explain the elevation seen after free play, as the dogs were allowed to play with one another on the training field. It might further explain the greater variation in salivary cortisol levels seen at both time points, as not all dogs were equally engaged in play behavior.

All in all, our results, therefore, indicate that the dogs in this study did not experience the training as physiologically stressful. Out of all the time points, the dogs in our study showed the lowest cortisol response with the least variation among them right after they had partaken in training. Combined with the fact that this data point differed significantly from measurements taken right after arrival at the training ground (when dogs might have also experienced stressors), we interpret that the dogs in our study did not experience the training as stressful. As there appeared to be no stress to recover from, it is difficult to draw additional conclusions about the dogs' capacity to recover from stressors. Given that the dogs did show elevated cortisol immediately after arrival at the training ground, however, which lowered after an acclimatization period (not significant), it could be interpreted that this capacity is present. A note of caution needs to be added that only from nine dogs were samples at all time points available, underlining the need to confirm these results in a larger number of service dogs. We finally conclude that the service dogs in our study did not appear to experience training as physiologically stressful, but instead seemed to be able to cope with the work that was required from them.

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**Institutional Review Board Statement:** Ethical review and approval were waived for this study, because its protocol did not involve invasive measurements in animals.

**Informed Consent Statement:** Not applicable.

**Data Availability Statement:** The data presented in this study are available on request from the corresponding author.

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# Chapter 6

## **Hair Cortisol in Service Dogs for Veterans with Post-traumatic Stress Disorder compared to companion dogs (*Canis Familiaris*)**

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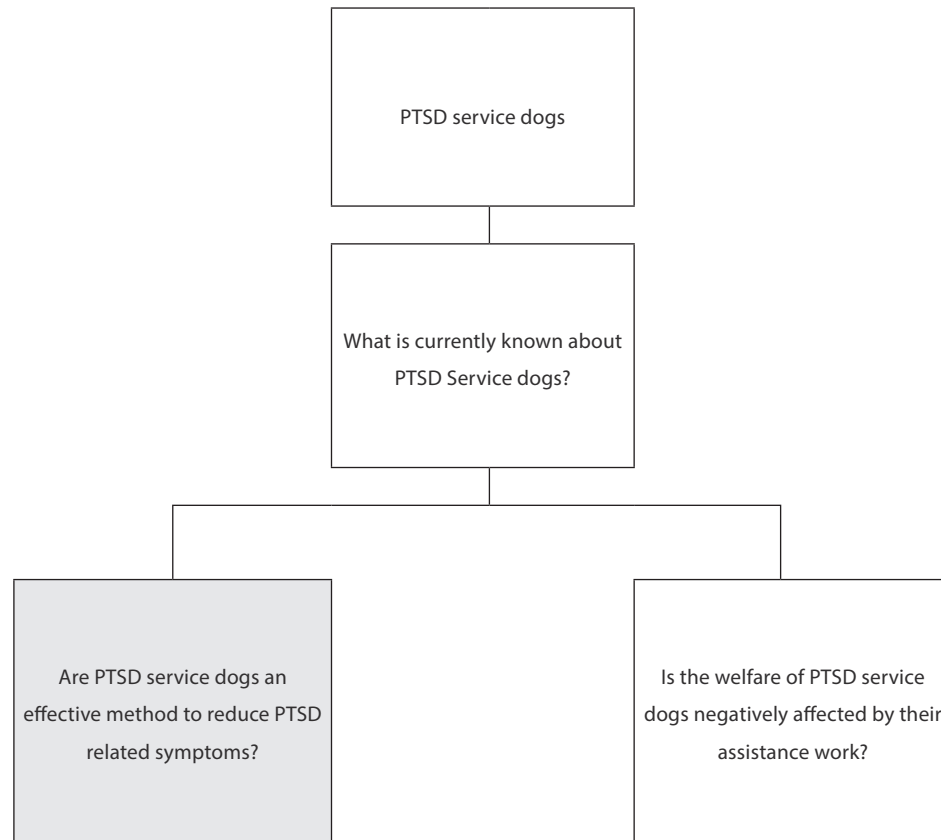
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## Abstract

Service dogs are trained to assist a single human handler. This continued availability potentially exposes service dogs to stressors that might in turn affect animal welfare. To investigate if service dogs are indeed exposed to more frequent stressors than companion dogs we questioned whether hair cortisol levels could be informative to assess differences between both groups. The difference in hair cortisol was studied by cutting a tuft of hair from the neck of 19 companion and 11 service dogs. Cortisol levels in these samples were subsequently analysed via immunoassay and compared via a simple linear regression model. The influence of coat colour, season, sex, other dogs, pets, or mental health dragonesses in the household was also checked via a simple-linear regression model and a multiple linear regression. Results showed that cortisol values did not differ between service and companion dogs, Furthermore, none of the additional variables had an influence on cortisol levels. This lead to the conclusion that the service dogs in this study did not have higher hair cortisol levels than companion dogs and that chronic stress levels therefore did not appear different between both groups. Further study should be conducted as to why no difference did occur between groups and if this difference is persistent over time given that we only studied a period of up to two months' worth of hair cortisol.

### Key words:

service dog, PTSD, cortisol, hair



## Introduction

The use of service dogs is a form of Animal Assisted Intervention (AAI) in which a single specifically trained dog is deployed to continuously support the welfare of a single human handler. This handler often receives this support because he or she has a mental or physical illness or disability for which he or she requires personalised assistance to be on standby. Because this deployment potentially entails a 24/7 workload, service dogs are at risk of reduced welfare due to disturbed resting and sleeping patterns. They are additionally not in charge of their own daily schedule or social contacts and may come into contact with stressed or angry humans due to their handlers' illness or disability (Serpell et al., 2006). Because all these factors are known sources of stress in dogs (Hubrecht et al., 1995; Iannuzzi & Rowan, 1991), service dogs are at risk of being exposed to stressors for extended periods of time, which can develop into the experience of chronic stress. This experience of prolonged or chronic stress not only negatively influences individual animal welfare, but can also directly influence the capacity in which a service dog is able to perform its assistance. It is therefore in the best interest of both handler and dog to keep service dogs in good welfare and to protect them from experiencing possible chronic stress.

To date, few studies have been performed specifically on the welfare and stress experience of service dogs. The welfare of related dog types within AAI has however been studied. A noteworthy example are therapy dogs. Several studies have questioned whether therapy dogs experience stress from assisting humans in a therapeutic setting (Clark et al., 2019; Clark et al., 2020; Glenk et al., 2013; Glenk et al., 2014; King et al., 2011; Melco et al., 2020; Palestini et al., 2016; Riemer et al., 2016). The most common methods used to evaluate this question are a combination of behavioural assessment through structured observation and the analysis of salivary cortisol samples. From these measurements, hardly any significant differences in salivary cortisol were reported between measurements taken before and after dogs participated in a therapy session, which indicated there was no influence of assistance work on physiological stress (Clark et al., 2020; Glenk et al., 2013; Glenk et al., 2014; van Houtert et al., 2021). Behavioural observations further aligned with these observations by showing low frequencies of stress related behaviour in dogs during assistance work. The heart rate of some dogs was even lower after than before participation in a therapy session, indicating reduced stress and/or excitement (Clark et al., 2020).

These results suggested that dogs are capable of handling assistance work for short periods of time, though the maximum frequency of work they could perform without experiencing negative effects to their welfare remains unclear. This question was therefore asked in a study by Clark et al. (2019). In their study they observed that salivary

cortisol levels were lower in dogs who assisted in multiple therapeutic sessions a week as opposed to once a week, or less than once a week. Older dogs further seemed to have lower cortisol responses than younger dogs participating in their study. Combined these results suggest that dogs have a capacity to grow accustomed to their working environment when they encounter it more frequently, and as a result mount a lower cortisol response to working situations compared to less experienced dogs. This conclusion is further supported by results of Roth et al. (2016) who observed little difference between the hair cortisol levels of companion and working (police/military) dogs over the course of three different seasons. Whether these results would also hold true for therapy or even service dogs however, remains to be seen as the longitudinal effect of assistance work in both these types of dogs has yet to be studied.

One of the ways in which the longitudinal effect of assistance work in service dogs could be explored is by following the example of Roth et al. (2016) and compare the level of hair cortisol in service dogs with that of companion dogs. Hair cortisol is a fairly new analysis method to determine physiological stress in an individual human or animal over extended periods of time. Like other free molecular structures, cortisol is built into hair by the follicles from which the hair originates. Although the exact mechanisms of this process are not yet fully understood, it is generally assumed that cortisol is incorporated during the hair's active growth phase by passively diffusing out of the surrounding plasma (Cone, 1996; Henderson, 1993; Meyer & Novak, 2012). Through this method, the concentration of cortisol incorporated in the hair is dependent on the concentrations in the plasma at the moment of incorporation. Over time hair cortisol therefore generates a registration of plasma cortisol levels, which can be retrieved through chemical analysis. There are several factors which should be taken under consideration in this process though, as not all hair cortisol can be interpreted in the same way. It is for example important to realise that hair follicles reside several millimetres below the skin surface. It therefore takes a varied period of time before the new segment of hair arrives at the skin surface and its cortisol contents can be measured (Udo, 1978; Harkey, 1993). This period depends mainly on the growth rate of the hair, which in turn may be affected by lifestyle, social interaction, month or season, sex, age, hair colour, species, and the body region it is taken from (Bennet & Hayssen, 2010; Dettenborn et al., 2012; Mesarcova et al., 2017; Roth et al., 2016; Terwissen et al., 2013). Hair cortisol has nonetheless been successfully linked to changes in diurnal salivary (D'Anna-Hernandez et al., 2011; Papafotiou et al., 2017; Vanaelst et al., 2012), and 24-hour urinary cortisol (Russell et al., 2012) within an individual, which makes it a valuable tool for assessing longitudinal physiological stress experience on an individual level.

The aim of this study was to investigate whether the average hair cortisol level of service dogs is different from the average hair cortisol level of companion dogs of the



same breed. Insight into this difference or the absence thereof can help determine if current service dogs experience more chronic stress than companion dogs due to their workload. This knowledge could inform service dog trainers whether intervention is required in either the current living situation of service dogs or in the manner they are prepared for their work (LaFollette et al., 2019).

## Material and Methods

### Subjects

This study compared two groups of animals. The first group consisted of 11 service dogs for individuals with a Post-traumatic stress disorder (PTSD). The second consisted of 19 companion dogs. Both groups consisted of Labrador retriever dogs or mixed breeds which were predominantly Labrador retriever.

All PTSD service dogs had already been selected for favourable behaviour prior to being deployed as a service dog. This behaviour included human oriented attention seeking behaviour, the ability to ignore distractions, and an even temperament. Dogs were additionally trained for at least two years in required trained behaviours, and matched to an individual with PTSD for at least half a year prior to participation in this study. For all service dogs, this process of selection, training and matching was overseen by the Dutch service dog training organisation 'Stichting Hulphond Nederland', via which recruitment of service dogs was also performed. This recruitment was done as follows. Individuals with a service dog were contacted by the organisation for their willingness to participate in the study. If they were willing to participate, the organisation would bring them into contact with a researcher who would make an appointment to explain the steps necessary to participate. Only after having been provided with this information both verbally, participation became possible to ensure informed consent of all owners/handlers before their dog participated.

All companion dogs were privately owned dogs who were volunteered by their owners for participation. Recruitment for this group was performed via social media platforms or through personal communication. Like with the service dog group, owners could only volunteer their dog for participation after receiving verbal instructions by a researcher. Again this was to ensure informed consent of all owners/handlers before their dog participated in the study. Further details on both groups can be found in Table 1.

**Table 1:** Age (n=11, n=16), sex (n=11, n=16) and coat colour (n=11, n=19) of both the service dogs and companion dogs that participated in this study. Some percentages do not add up to 100% due to rounding. Additionally the n of the companion dog group differs between variables due to missing data.

	Age		Sex		Coat colour		
	$\mu$	$\pm Sd$	Male	Female	Black	Blond	Brown
	years	years	%	%	%	%	%
Service dogs	3.27	2.05	82	18	45	18	36
Companion dogs	5.38	3.56	31	69	32	26	42
All dogs	4.52	3.17	52	48	37	23	40

### Measurements

A tuft of 2-centimetre-long hair was collected from each dog for cortisol analysis. Samples were retrieved from the base of the back of the neck of each dog by their owner (Meinders, 2017). Collection of samples was done by cutting the hair as close to the skin as possible without damaging the skin. This method was chosen because the use of sheering tools can cause stress in dogs who are not familiar with the sound. The desired weight of the hair sample (when trimmed down to two centimetres from the root) was 40 mg or more (a tuft of roughly 2 fingers wide). Collected hair samples were initially wrapped in aluminium foil to protect them from sunlight and stored at room temperature in a dark environment. Subsequent extraction of cortisol was performed based on the protocol by Davenport et al. (2006). In summary this meant that samples were washed twice with isopropanol to remove any external corticosteroids that could interfere with analysis. Samples were subsequently dried and reduced to powder. 30mg (+- 5 mg) of this hair powder was dissolved in 1.5ml methanol to extract steroid hormones. After 24 hours the remaining powder pallet was removed from the methanol. The methanol itself was then evaporated to leave only the steroid residue behind. Analysis of this steroid residue for cortisol was finally performed via a Salimetrics High Sensitivity Salivary Cortisol Enzyme Immunoassay (Salimetrics, 1-3002). The average intra-assay variation was 2.4%.

Specific details on each dog's sex, and age, and living conditions were additionally recorded through a questionnaire filled out by their owner or handler. This included information on the number of hours each dog walked per day, the presence of other dogs in the household, the presence of other pets besides dogs in the household, and the occurrence of (mental health diagnoses in humans (both adults and children) of the household the dog lived in. Specifics regarding a dog's coat colour and the month in which the sample was collected were registered by a researcher upon receiving the hair sample and questionnaire from the dog owner (Table 1, 2, and 3).

**Table 2:** Hours walked (per day), percentage of households with other dogs or other pets present, and absence or presence of humans with psychological deviations (number of deviations present per household). of the service (n=11) and companion dog (n=19) groups.

	Hours walked $\mu \pm Sd$	Other dogs present %	Other pets present %	Mental health diagnoses $\mu \pm Sd$
Service dogs	2.36 $\pm$ 1.12	45	55	2.27 $\pm$ 1.42
Companion dogs	1.62 $\pm$ 0.83	53	58	0.32 $\pm$ 0.58
All dogs	1.89 $\pm$ 1.00	50	57	1.03 $\pm$ 1.35

**Table 3:** The Month in which the hair of service and companion dogs was collected (n=11, n=19).

	Jan	Mar	Apr	May	Jun	Sep	Okt	Dec
Service dogs	2	0	1	0	2	1	3	2
Companion dogs	0	9	4	3	3	0	0	0
All dogs	2	9	5	3	5	1	3	2

## Statistical analysis

Statistical analysis was performed in R version 4.0.3 with R studios (R core team, 2018). A total of eight variables were analysed for their difference between two participant groups. These variables were PTSD service dog/companion dog, coat type (light = blond, dark = brown/black), month of sample collection, dog sex, dog age, the presence of other dogs in the household, the presence of other pets besides dogs in the household, and the presence of mental health diagnoses in humans living in the household. Normality of collected data were judged via a QQ plot and equality of variances was judged via Bartlett test of homogeneity of variances. Analysis of the dataset itself was subsequently performed via a student's T-tests, simple/multiple linear regression between sets of two variables. Simple linear regressions were applied to the variables: PTSD service dog/companion dog, dog sex, dog age, coat type, the presence of other dogs in the household, the presence of other pets besides dogs in the household, and the presence of mental health diagnoses in humans living in the household. Categorical variables were first transformed to dummy variables to make analysis via linear regression possible. This was also true for the variable 'month of sample collection' which was analysed via multiple regression.

## Ethical Statement

Ethical advice regarding this study was sought from Utrecht University's resident advisory board for animal experiments. Because no invasive measurements were taken however, the full protocol of this study did not require judgement by the ethical committee for animal experiments.

## Results

### Linear regression

The mean hair cortisol found in service dogs was 9.69 pg/mg hair ( $\pm$  2.77) while that of companion dogs was 8.65 pg/mg ( $\pm$ 3.09). To check if these means differed from one another, a simple linear regression (hair cortisol =  $\beta_1 * \text{PSD/companion dog status} + \beta_0$ ) was calculated to predict hair cortisol level based on PSD/companion dog status. With this calculation a non-significant regression equation was found ( $p = 0.37$ ,  $\beta_1=1.04$ ), with an  $R^2$  of 0.03.

Additional analyses via linear regression were performed to check if sex, age, month of collection, coat type, hours walked daily, presence of other dogs, presence of other animals, and/or presence mental health diagnoses in the household had an influence on the hair cortisol samples retrieved during this study. None of these variables showed a significant relationship to the retrieved levels of hair cortisol (Table 4)

### Dataset description

The retrieved sample weight was below 40 mg in 7 out of 30 hair samples. This required the use of adjusted dilution volumes during analysis for samples with low weight. Because of this correction no hair cortisol values were missing from the dataset. Some descriptive information of samples was missing though, since the age and sex of three companion dogs was not registered.

When comparing characteristics in both groups of dogs via student's t-test, there was no significant difference between the, coat type (black/brown or blond;  $p=0.63$ ), presence of other dogs ( $p=0.72$ ), or presence of other animals in the household ( $p=0.92$ ). A difference was present however between the sex ratios of both groups ( $p=0.01$ ), the months in which the hair was retrieved ( $p < 0.01$ ), the hours walked daily ( $p=0.05$ ), and in the presence of mental health diagnoses in humans of the household ( $p < 0.01$ ). Regarding the sex ratios, the service dog group contained a higher percentage of male (82% vs 31%) and a lower percentage of female (18% vs 69%) dogs when compared to the companion dog group. Regarding months, samples in service dogs were taken predominantly in winter months while samples in companion dogs were taken predominantly in spring or summer months. Regarding hours walked daily, results showed that service dogs walked more hours with an average of 2.36 vs 1.62 in companion dogs. Regarding the presence of mental health diagnoses results showed that service dog households had more diagnoses than those of companion dogs, with 2.27 versus 0.32 reported diagnoses per household (see also Table 2). Regarding the average age of the dogs in both groups, no significant difference were found though a trend could be observed ( $p=0.09$ ; service dogs =3.27 years, companion dogs = 5.38 years). This was likely caused by the presence





of some older dogs in the companion dog group who skewed the age distribution of this group, while the service dogs were more of similar age.

Analysis of equal variance was performed via Bartlett test of homogeneity of variances in R ( $p=0.66$ ).

**Table 4:** The p value, r<sup>2</sup>, Beta, and intercept values of simple linear regressions between various independent variables and the hair cortisol concentration in the various dogs within this study.

Independent variable compared to hair cortisol	p	R <sup>2</sup>	$\beta_1$	$\beta_0$
PSD/companion dog status	0.37	0.03	1.04	8.65
Sex	0.40	0.03	-1.03	9.59
Age	0.58	0.01	-0.11	9.56
Month of collection	0.17	0.05		9.28
			March	-0.38
			April	0.37
			May	-1.72
			June	0.01
			September	1.63
			October	-0.95
			December	-0.30
Coat colour	0.47	0.02	-0.96	9.77
Hours walked daily	0.83	0.00	0.11	8.81
Presence of other dogs	0.95	0.00	0.07	8.99
Presence of other pets	0.10	0.09	1.81	8.07
Mental health diagnoses	0.16	0.01	-0.17	9.37

## Discussion

This study investigated if the average hair cortisol level of service dogs differed from that of companion dogs of the same breed. Our results showed no difference in hair cortisol based on this division. This observation leads to the conclusion that service dogs do not appear to experience more physiological stress over time than companion dogs do. Nonetheless it is possible that found cortisol levels were influenced by variables other than the division between service dogs and companion dogs. Because of this possibility the influence of several variables on the results found was checked.

### Influence of dog specific variables

A variable which possibly influences the level of retrieved hair cortisol independent of the experience of physiological stress, is a dog's coat type. A study by Bennet and

Hayssen (2010) for example found dark hair or dark portions of hair to contain less cortisol than light portions of hair in German Shepherd dogs. This is contrary to results found in our study as this study did not find an influence of coat type on the overall retrieved level of hair cortisol in Labrador retriever dogs. A possible explanation for this difference in results is that the difference between light and dark coloured hairs found by Bennet and Hayssen (2010) was not entirely based on coat type but rather on an underlying confounding factor like breed or coat type (Mesarcova et al., 2017). This theory is supported by results found by Nicolson and Meredith (2015) and Rosen (2016), who also found no differences in hair cortisol based on coat type in several dog breeds other than German Shepherds (Border collies, Jack Russell terrier, Labrador retriever, Cavalier King Charles spaniel, Shih Tzu and Springer spaniel).

Age is a second variable that can potentially influence the level of hair cortisol in an animal independent of physiological stress. Although the mean age of service dogs and companion dogs did not differ significantly from one another in our study, the average age of companion dogs tended to be higher than that of service dogs. This difference could therefore have influenced found cortisol levels in retrieved hair, since since some assume that cortisol levels in dogs' coats increase with age (Mesarcova et al., 2017). According to Mesarcova et al. (2017) however, this difference has not yet been confirmed. Indications additionally exist that progressing age lowers instead of raises cortisol levels in dogs. In their study Clark et al. (2019) for example found that older therapy dogs had lower salivary cortisol levels in response to therapy work than younger conspecifics. Given that, like hair cortisol (Cone, 1996; Henderson, 1993; Meyer & Novak, 2012), salivary cortisol is linked to free cortisol levels in the blood of an individual (Aardal & Holm, 1995; Beerda et al., 1996), this makes it unlikely that hair cortisol levels would rise while salivary cortisol decreased with age. This does not rule out the possibility of hair cortisol rising with age necessarily however, since the lowering of cortisol seen in dogs during the study of Clark et al (2019) might have been influenced by the experience dogs had with the situation they were put in (therapy session). Regardless, this study did not find any influence of age on hair cortisol levels retrieved during our study, which is in line with findings of Mesarcova et al. (2017).

A third and final dog specific variable which could have influenced the level of hair cortisol found in our study, is sex. Although it is possible that differences in hair cortisol level based on sex or spay/neuter exist in mammals, such a difference has not yet been found in dogs (Bennet & Hayssen, 2010; Mesarcova et al., 2017; Svendsen & Sondergaard, 2014). Results from our study are in line with these findings, as this study did not find a relationship between sex and hair cortisol despite there being a significant difference in the sex ratio of the PSD and companion dog groups (82% vs 31% male).

### **Influence of living conditions**

Besides dog specific variables there are also several variables regarding a dog's living conditions which might influence the accumulation of hair cortisol. This study therefore checked for the influence of several potentially stress increasing or stress reducing variables. Regarding stress reduction, this study checked for the influence of the total hours a dog walked per day and the presence of other dogs in the household. This was done because both social and spatial restriction are known to negatively affect welfare in dogs (Beerda et al., 1999). Walking more and having free contact with conspecifics could therefore theoretically reduce the experience of chronic stress in dogs and by extension the total amount of cortisol found in hair. Although the service dogs in our study walked more hours per day than the companion dogs, no relation between these variables and hair cortisol was found. Possibly this is due to the environment in which dogs walked. In humans it has been found that walking in a forest or natural area reduces cortisol levels, while walking in an urban area does not (Kobayashi et al., 2019). Because service dogs frequently accompany their handlers to stores, in public transport and in other urban areas when going for walks it is therefore possible that no effect of walking on cortisol levels is present due to the walking environment. It is further possible that walking increased instead of decreased the level of found cortisol in service dogs since cortisol is known in some mammals to increase with increased activity (de Groot et al., 2000; de Jong et al., 2000) therefore cancelling out any reduction effects.

Additionally no relationship between the presence of other dogs in a household and retrieved hair cortisol levels was found. Though it is possible that the presence of another dog helps to prevent stress from social isolation in dogs, it is also possible that it simultaneously increases cortisol levels. Since the presence of another dog increases the opportunity to show play behaviour, cortisol could be elevated in dogs who live with a conspecific. It is additionally possible for cortisol to increase in the presence of another dog if the interactions between both animals are hostile or competitive. Since no difference was found between living with and without a conspecific though, neither of the three theories can be excluded or proven in our study.

Regarding stress induction this study further checked for the influence of pets other than dogs in the household and the presence of psychological deviations in humans of the household. As expected the presence of psychological deviations in humans of the household was significantly higher for service dogs than for companion dogs. Mostly this was due to the presence of PTSD in service dog owners/handlers, though issues in other individuals like children were also reported. This had no detectable effect on hair cortisol levels in the service dogs however. A trend was further observed, in which dogs who lived with other pets tended to have higher hair cortisol levels than those who lived alone or only with other dogs. The pets most frequently reported were cats,

which might lead to heightened stress in dogs if both species cannot peacefully live side by side in a restricted environment or have to compete for human attention. The presence of some rodents (guinea pigs, gerbils, hamsters) or rabbits was additionally reported which might also cause stress elevation in dogs due not to being allowed to perform prey directed behaviour. The presence of livestock (horses, sheep, chickens) was reported for some dogs, though these animals did not live in the same environment as the dogs (indoor vs outdoor housing) and might therefore have had limited influence on stress experience.

### **Influence of environmental variables**

Besides dog specific variables and living conditions there was an environmental variable which might have influenced retrieved levels of hair cortisol during this study. This variable is the month in which hair was collected for each dog. In our study most service dogs were sampled in the autumn or winter months while most companion dogs were sampled in spring months (based on animal availability). A study by Roth et al. (2016) found a seasonal effect on hair cortisol in dogs, with cortisol being higher in January than it was in either September and May. This study did not find an effect of season on hair cortisol, which is in line with the results of a study by Thun et al. (1990) who also did not find this effect on plasma cortisol levels in dogs. An explanation for the results found by Roth et al. (2016) could therefore be that hair cortisol levels in dogs in autumn and winter months are affected by external factors like the onset of cold weather or the shortening of photoperiod in the months leading up to January. Since the study by Roth et al. (2016) was conducted in Sweden while the study by Thun et al. (1990) and this study were conducted in the milder climates of Switzerland and the Netherlands respectively, an influence of climate and length of daylight in winter months on coat development in dogs cannot be excluded.

### **Limitations and future research**

Because of the all above we can assume that the results found in this study were not influenced by the discussed factors. Nonetheless the results presented in this study know several limitations. The most prominent of these limitations are the limited sample size of this study and that we only observed hair cortisol over two months. Differences between groups of dogs may be bigger if measurements are taken in larger sample sizes and over longer periods of time, which may lead to different conclusions than the ones drawn in this study. Future research should therefore focus on larger studies over longer periods of time to determine whether or not the results of this study are relevant to a wide group of service dogs. Additionally it can be questioned if symptom severity of those afflicted with mental health diagnoses in humans might have influenced results. In our study only the presence or absence of mental health diagnoses in humans was used as a potential stressor for (service) dogs. Severity could vary between individual



humans though which in turn could affect dogs differently. It is therefore recommended that more study is performed to the influence of different mental health diagnoses in humans on dog welfare. Finally it could be discussed whether hair cortisol is a good medium to measure differences in experienced stress between dogs. No clear baseline for hair cortisol in stress free dogs is currently known, which left us with the option of comparative research between groups. We chose to compare service dogs with companion dogs because these dogs resemble the most common form of housing and care in dogs. Nonetheless it cannot be excluded that companion dogs experience chronic stress due to the way they are kept by humans. Future research to the presence of stress in both companion and service dogs should therefore consider how to account for this knowledge gap by for example combining the measurement of hair cortisol with other measurements like heartrate monitoring and behavioural observations.

## Conclusion

In conclusion there was no difference in hair cortisol between the group of service dogs and the group of companion dogs observed during this study. Additionally, no significant influence of several other variables was found on this result. This lack of difference in cortisol levels suggests that the service dogs who participated in this study did not experience more physiological stress over time than the companion dogs. An explanation for this favourable result can be the high quality of the training program of the service dogs who participated in this study. These dogs underwent an extensive 2 year training with a specialised service dog organisation, were selected for suitable behaviours, were matched with a suitable handler, and were monitored on a half year basis post placement with their handler. Whether or not the conclusion of this study therefore holds true for dogs trained by other organisations and other types of dogs in AAI (like dogs for autism, physical disabilities, diabetes) deserves further study.

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**Conflicts of Interest:** This study was performed at Utrecht University as part of a larger project on the influence of PTSD service dogs on veterans with PTSD in the Netherlands. The overall project is performed with the support of Stichting Hulphond Nederland, and the Dutch Ministry of Defence, with financial support of the Karel Doorman Fund, the Utrecht University Fund, Royal Canin, the Triodos Foundation, the K.F. Hein foundation, and Stichting Vrienden Diergeneeskunde. None of these stakeholders were part of the conception of this study. Therefore, the authors report that there were no conflicting interests involved in the conception of this study, and that they did not gain any direct commercial, financial, or political benefit from this publication.

**Institutional Review Board Statement:** Ethical review and approval were waived for this study, because its protocol did not involve invasive measurements in animals.

**Informed Consent Statement:** Not applicable

**Data Availability Statement:** The data presented in this study are available on request from the corresponding author.



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# Chapter 7

## **The difference in daily activity and morning cortisol between service dogs for Post-traumatic stress disorder and pet dogs**

Submitted to: *Frontiers in Veterinary Sciences*

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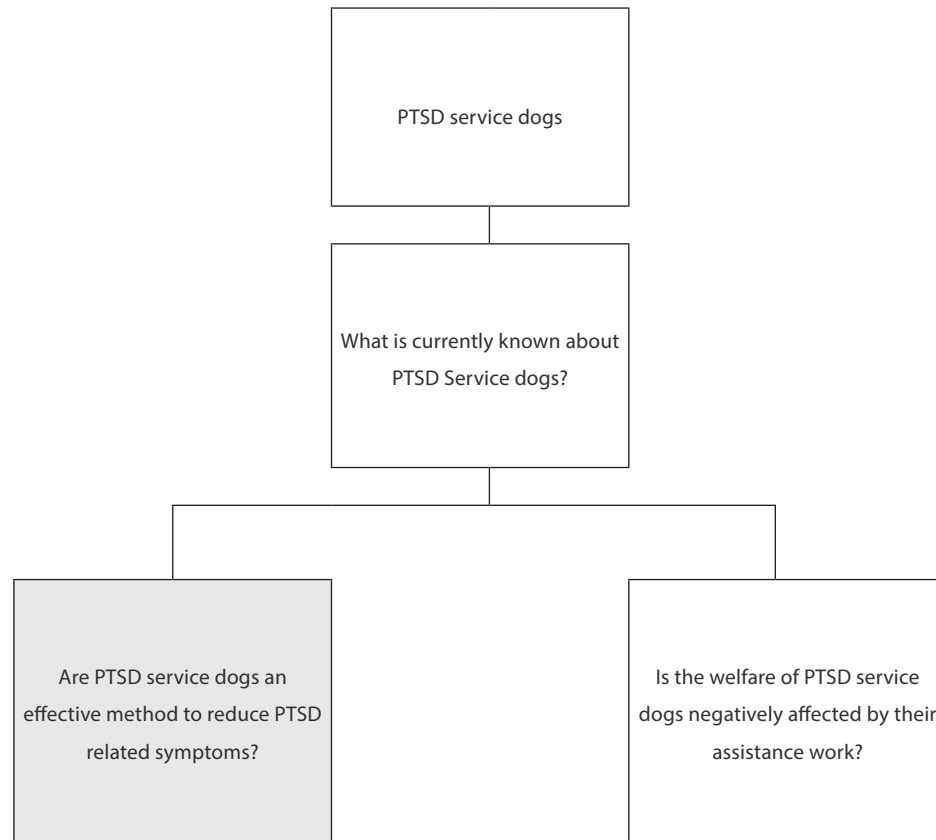
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## Abstract

Service dogs for Post-traumatic stress disorder (PTSD) are trained to assist an individual with PTSD. Because a service dog can be asked to provide assistance at any time of day or night their activity and resting pattern of may be disturbed. Because of this welfare risk we questioned whether or not the activity pattern, resting pattern, and cortisol levels in the morning and evening differs between service and pet dogs. To investigate this, 20 PTSD service dogs and 23 pet dogs wore an activity meter for at least 24 hours. They additionally provided 10 salivary samples and owners/handlers filled out a questionnaire regarding their dog. Our results showed that the activity level of service dogs did not differ significantly from pet dogs. A significant difference was found in salivary cortisol levels, which were higher in the evening for pet dogs. These results suggest that pet dogs experience either more physiological stress than service dogs do at this timepoint, or are more active. Because there is a possibility that some dogs were taken for a walk at these timepoints the latter seems more likely than the former. Nonetheless we found no evidence for increased stress levels in service dogs compared to pet dogs, based on activity levels and cortisol data. This indicates that service dog welfare does not seem to be impaired by their daily duties. Further studies are needed to study long-term effects of work as a service dog, for instance on oxidative stress and aging.

## Key words

service dog, Animal assisted intervention, activity, cortisol, dog



## Introduction

Service dogs for individuals with a Post-Traumatic Stress Disorder (PTSD) are an expanding form of Animal Assisted Intervention (AAI). PTSD is a trauma- and stressor-related disorder caused by the experience of one or multiple traumatic events during one's life (American Psychiatric Association [APA], 2013). These events are relived in the form of flashbacks and nightmares, which results in anxiety, a negative worldview, periods of depression, restlessness, flashes of anger, insomnia, and reckless behaviour (APA, 2013). In an attempt to avoid flashbacks or nightmares, individuals with PTSD often limit their exposure to visual cues, sounds, people, and places which remind them of the traumatic event. This however leads to reduced social interactions and isolation from society (APA, 2013). Service dogs can be trained to assist with these symptoms by pointing out negative behaviours, and signs of stress in their handler. They can additionally facilitate social interaction with other humans, accompany their handler in stressful situations (social support), and assist their handler in small tasks via learned behaviour. Taking care of a service dog may finally promote engagement with other individuals, responsibility, self-efficacy in the handler. These are all examples of behavioural activation, which has been known to help treat depression and PTSD (Kruger & Serpell, 2006; Jakupcak, et al., 2010; Tedeschi et al., 2010).

Because of the above, a theoretical basis for the positive effect of PTSD service dogs on human welfare seems to exist. Combined with positive feedback from humans supported by a service dog, this generally leads to the conclusion that PTSD service dogs have a positive effect on human wellbeing. Whether or not this is true however is subject to ongoing research (van Houtert et al., 2018; Rodriguez et al., 2018; Lessard et al., 2020). Another question which remains unanswered is whether or not the work of a PTSD service dog affects the welfare of the service dog itself. This question is of importance however, since the welfare status of PTSD service dogs influences the sustainability of their work and may impact the acceptability of this practice.

To date, only a limited number of studies have questioned assistance animal welfare (Glenk et al., 2013; Glenk et al., 2014; Clark et al., 2019; Clark et al., 2020). Among these, even fewer focussed on welfare in PTSD service dogs specifically (van Houtert et al., 2021). Among the studies who did focus on assistance animal welfare, the main focus has been on the steroid hormone cortisol in different matrices and different settings. Two studies by Glenk et al (2013, 2014) for example focussed on salivary cortisol levels in therapy dogs during therapy sessions with humans. During these studies it was found that therapy dogs did not show elevated salivary cortisol responses in response to participation to therapy sessions. This indicated that the dogs did not experience the sessions as either physiologically stressful or exciting. These results are in line with

results found in our study from 2021 which focussed on salivary cortisol during a training session for PTSD service dogs (van Houtert et al., 2021). In this study it was found that, like in the studies by Glenk et al. (2013, 2014), the dogs did not show elevated cortisol responses in response to training. Combined with the results from Glenk et al. (2013, 2014) this suggests that the tasks that were asked from the dogs in either of the three studies were not perceived as either physiologically stressful or exciting and that therefore no signs of acute stress were detectable via salivary cortisol.

Because no physiological signs of stress were found in the above studies, it could be assumed that PTSD service dogs did not experience poorer welfare when compared to pet dogs. Whether or not this assumption is true however remains to be seen, since cortisol levels are not the only indicator of stress in dogs. Another manner in which the welfare of dogs can be evaluated is through deviations in resting and activity patterns. Service dogs are at risk of disturbed activity and resting patterns which can accumulate to stress or health problems over time. Because of this possibility it is important to understand the general activity and resting patterns in dogs and the extent to which human disturbance in the form of assistance requests is possible.

A study by de Andrade Silva et al. (2018) in free roaming domestic dogs showed that these dogs were most active in the morning and the early afternoon. This is in line with findings by Tobler & Sigg (1986) in laboratory housed dogs who found that dogs were most active after light onset and had a resting period during afternoon hours. Nishino et al. (1997) finally agrees with the above activity pattern as they also found that healthy dogs were more active during light as opposed to dark hours. This pattern of daylight activity in dogs therefore seems robust and is different than that of their wolf ancestors, who seem to prefer a bimodal pattern with activity during dawn and dusk (Eggerman et al., 2009; Theuerkauf et al., 2003).

Because the activity pattern of dogs appears different from wolves it is possible that humans have influenced the preferred active hours of dogs via selection during the domestication process. It is however also possible that dogs have learned to adapt to human activity and therefore have variable activity patterns based on human presence. Evidence of this latter theory has been shown in various studies like those mentioned above by Tobler & Sigg (1986) and Nishino (1997). Although the dogs in these studies did indeed show a stable morning activity peak, this was only true for week or working days. The observed dogs showed different or more even activity patterns during weekend days, which is likely due to the absence of laboratory personnel during the weekend. A study by Beck (1973) additionally found that feral dogs show a more wolf like behaviour with peak activity during 500-800 am and 700-1000 pm. Although this bimodal pattern was observed during summer months, which means it might have been



correlated to heath avoidance, it was in line with the studies of Berman & Dunbar (1983), Hirata et al. (1986), Perry & Giles (1971), Scott & Causey (1973), Causey & Cude (1980), Boitani & Racana (1984), and Daniels & Bekoff (1989) in several other feral or rural dog populations. Because of these shared observations it is likely that feral dogs naturally maintain an activity pattern that is more in line with their wolf ancestor and less in line with their domestic conspecifics. Combined with the observations by Tobbler & Sigg (1986) and Nishino (1997) it is therefore plausible that domestic dogs have learned to adapt to human behaviour and are more active during daylight hours in response to human activity around them.

Because human activity appears capable of altering dog activity and resting patterns, it is possible that PTSD service dogs are affected by the work they are asked to perform despite the lack of influence on cortisol levels found in earlier studies. Primarily we therefore questioned whether the activity pattern of PTSD service dogs differed from that of pet dogs. We hypothesised that PTSD service dogs would show a less distinct activity peak than pet dogs do, that they would have fewer resting periods overall and that they would have an increase in activity during night hours due to their work as a service dog. Secondly we questioned whether or not the salivary cortisol levels of PTSD service dogs during the early morning and late evening would differ from those of pet dogs. We hypothesised that since activity can influence salivary cortisol levels (de Groot et al., 2000; de Jong et al., 2000), these levels will be elevated in PTSD service dogs to follow their elevated activity when compared to pet dogs. This knowledge can help us understand whether or not their overall welfare is at risk. If welfare is at risk additional questions can be asked whether or not training, selection and coaching of service dogs and their handlers is adequate or needs to be improved.

## Material & Methods

### Subjects

This study was conducted involving two groups of dogs; PTSD service dogs and pet dogs. The PTSD service dog group consisted of 20 dogs who were each placed with a veteran or (ex) first aid responder with PTSD for at least six months. They were additionally all trained by Dutch service dog provider 'Stichting Hulphond Nederland' and underwent a selection procedure and two years of training before being certified. All but one service dog were Labrador retrievers or of mixed breed with predominantly Labrador retriever genes, while one dog was a Standard Poodle. The average age of the dogs was  $3.9 \pm 2.14$  years while 80% dogs were male and 20% female. All dogs were spayed or neutered as is common practise among service dogs.

The pet dog group consisted of 23 dogs who lived within their owner's home. They were recruited via social media or by personal connections. All dogs were Labrador retrievers or of mixed breed with predominantly Labrador retriever genes. The average age of the dogs was  $5.02 \pm 3.73$  years while 35% dogs were male and 65% female. The spay/neuter status of dogs was finally not registered.

### Experimental setup

This study was part of a dual study to both military veterans with PTSD and their PTSD service dogs. All of the following measurements in dogs were therefore taken while their handler participated in a study with similar measurements themselves.

Dogs were monitored in their own home environment with minimal interruption or change in daily routine. To measure general activity in this setting all dogs wore an Actigraph gtx link mounted on their collar for a period of at least 36 consecutive hours. The gtx link had to be worn at all times except for moments when there was an unavoidable high risk of damage to the device (when the dog came into contact with water or engaged in rough play behaviour).

To additionally study morning and evening peripheral cortisol level in both subject groups, each dog's salivary cortisol level was measured on 10 occasions divided over two days. On the first day, the first sample was taken in the morning directly after their owner woke up. The next sample was taken 15 minutes later, the third 30 minutes after waking, and the fourth 60 minutes after waking. The fifth and final sample was taken right before the dog owner went to sleep, after which the whole procedure was repeated the next morning and evening. These timepoints were chosen because they were times of day at which stressors should be at a minimum for dogs. Activities that take place in the early morning and late evening (like receiving food and going for a walk) have a high chance of falling into routine behaviours which makes them predictable. This predictability potentially makes these activities less stressful which allows for the opportunity to measure cortisol near baseline levels without adjustments to a dog's living conditions. One small adjustment was made though, since dogs were not allowed to eat in the 15 minutes preceding each sample.

The age, sex and several other aspects of each dog were finally recorded via a questionnaire filled out by each dog's owner/handler (See Appendix 1). This questionnaire was a Quality of Life questionnaire for service dogs (SD-QoL) based on the dog QoL questionnaire presented by Ortolani and Ohl (2014). Several adjustments were made to the existing questionnaire to provide better fit for this target group. Questions related to dog-training were removed, as training is largely standardised among service dogs. They were replaced with questions regarding work load, because these questions

are more relevant to the welfare experience of service dogs. The questionnaire was further shortened from the original 107 questions to 50 (not including sub questions), and reformulated slightly to address a different target audience.

### Measurements

Gathered activity data was stored on the devices' internal storage capacity and extracted via Actigraph's specialised software. This extraction was done in intervals of 60 seconds. A maximum of 36 hours of activity data was extracted per dog in this manner. The first epoch of each dataset was the first one in which the gtx link had registered activity other than zero on either the x,y,or z axis. This criteria was added because it was noted that not all dog owners/handlers had put the device around the neck of their animal before the programmed start of measurement (7.00 am). From the total dataset three timeframes were subsequently isolated. These frames were 9.00 am to 12.00 am, 12.00 am to 12.00 pm, and 12.00 pm to 5.00 am. For each timeframe the y-axis/vertical output was finally categorised in three levels of activity intensity according to the categories identified by Yam et al. (2011) and described by Morrison et al. (2013). These categories were sedentary (0-562 points), moderate (563-2911 points), vigorous (>2912 points).

Saliva was collected by each dog's handler or owner by placing a SalivaBio children swap (Salimetrics, 5001.06 & 5001.05; Maclean et al., 2017; Maclean et al., 2018) in the saliva pooling areas (cheeks, under the tongue) of the dog's mouth for 60 seconds. Handlers were allowed to gently hold the muzzle of the dog, if necessary, to steady the animal for sampling. Use of force during sampling was not allowed however as this could stress the animal unnecessarily. Handlers subsequently stored samples in their refrigerator at -20 Celsius before they were collected by a researcher.

Extraction of cortisol from samples was performed by spinning the samples at 3000 rpm for 5 minutes. This resulted in a clear supernatant of low viscosity. Visual inspection was performed at this stage for any signs of contamination (discoloration). No samples were rejected because of this. Cortisol concentrations were finally measured using commercially available chemiluminescence immunoassay with high sensitivity (IBL International, Hamburg, Germany). The average intra-assay coefficient was 5.23.

From the 10 cortisol samples spread over five timepoints and two days an average was finally calculated for each timepoint. This resulted in a total of five datapoints per subject, one for each timepoint. If a subject missed a measurement on either one of the days the final datapoint was based on a single measurement instead.

### Statistical analysis

Data analysis was performed in R version 4.0.3 with R studios (R core team, 2018). A total of 14 numeric variables were judged between two groups. These variables were: three levels of activity between 900 am and 1200 am, three levels of activity between 1200 am and 1200 pm, three levels of activity between 1200 pm and 500 am, salivary cortisol directly after the owner/handler woke up, salivary cortisol 15 minutes after the owner/handler woke up, salivary cortisol 30 minutes after the owner/handler woke up, salivary cortisol 60 minutes after the owner/handler woke up, and salivary cortisol in the evening before the owner/handler went to bed. A series of categorical variables was additionally judged between the two groups. These concerned answers to the SD-Qol questionnaire (see also appendix 1)

The normality of all activity levels was judged via histogram. The distribution of these variables was judged to not be normal. Because of this Levene's test as opposed to Bartlett's test for equal variances was used. In this manner all variances for accelerometric and salivary cortisol variables were judged. These were judged to be equal, since Levene's test was not significant. Analysis of the numeric dataset was therefore performed via a series of Mann-Whitney tests per variable ( $\alpha=0.05$ ). A series of Chi-square tests ( $\alpha=0.05$ ) was additionally used to compare SD-Qol questionnaire answers. A series of Spearman correlations ( $\alpha=0.05$ ) was finally used to evaluate possible relationships between cortisol levels and percentages of activity.

### Ethical Statement

Ethical advice regarding this study was sought with Utrecht University's resident animal experiment advisory board. Because no invasive measurements were taken the full protocol of this study did not require judgement by the ethical committee.

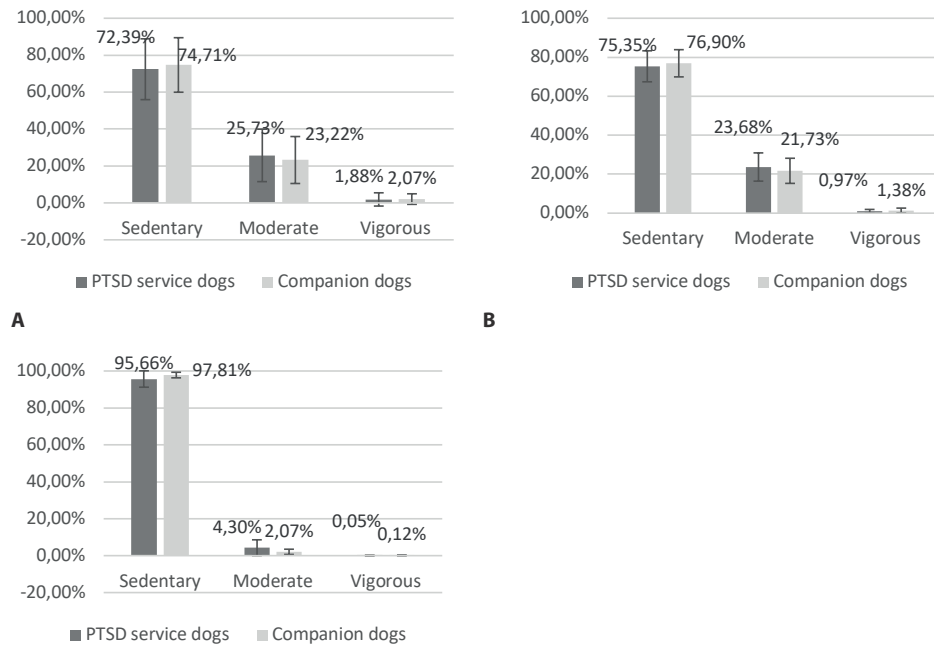
## Results

### Dataset description

The questionnaire for each dog was filled out by their respective owner/handler. This resulted in a total of 20 service dog questionnaires and 23 pet dog questionnaires. Saliva collection for cortisol analysis was successful at varying rate. Due to insufficient saliva volume only 10 out of 20 dogs had at least one successful saliva sample at the timepoint 'right after their owner woke up'. For the other timepoints this number was, 11, 14, 11, and 15. Among the pet dogs 14 out of the 23 participating dogs had a successful salivary sample at timepoint 'right after their owner woke up'. For the other timepoints this number was, 16, 17, 14, and 14.



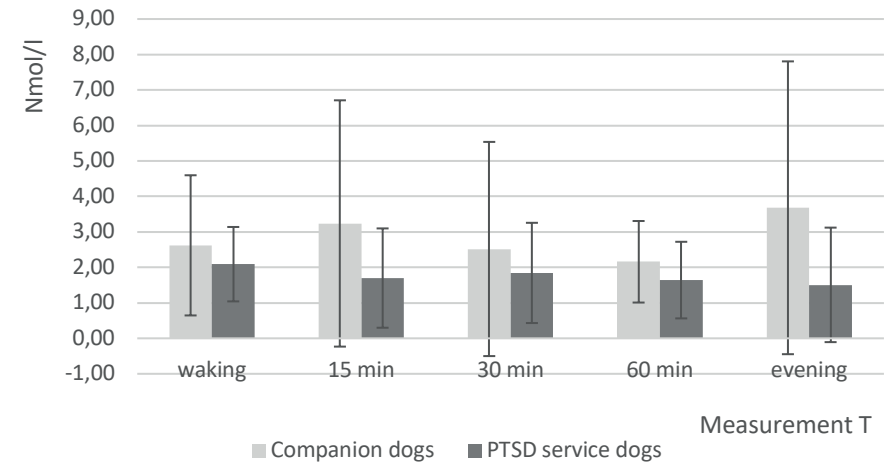
Regarding actigraphy seven out of 20 service dog and 12 out of 23 pet dog datasets were missing in the timeslot 9.00 am to 12.00 am. In the timeframe 12.00 am to 12.00 pm a total of five out of 20 service dog and seven out of 23 pet dog datasets were missing. In the timeframe 12.00 pm to 5.00 am a total of six out of 20 service dog and nine out of 23 pet dog datasets were finally missing.



**Figure 1: A.** The percentages Sedentary, moderate, and vigorous activity performed by PTSD service dogs (n=13) and pet dogs (n=11) as categorised from accelerometric data between 900 am -1200 am. **B.** The percentages Sedentary, moderate, and vigorous activity performed by PTSD service dogs (n=15) and pet dogs (n=14) as categorised from accelerometric data between 1200 am – 1200- pm. **C.** The percentages Sedentary, moderate, and vigorous activity performed by PTSD service dogs (n=14) and pet dogs (n=14) as categorised from accelerometric data between 1200 pm – 500 am.

### Accelerometry data

A Mann-Whitney tests was used to compare the percentages sedentary, moderate, and vigorous activity between the accelerometric data of PTSD service dogs and pet dogs who participated in this study. No significant differences between the two groups of dogs were found in the separate timeframes of 900 am to 1200 am, 1200 am to 1200pm, and 1200 pm to 500 am (Figure 1).



**Figure 2:** The levels of salivary cortisol in service dogs (N= 10,11,14,11,13) and pet dogs (n=14,16,17,14,14) as measured at various timepoints throughout the day. The first timepoint is right after the owner/handler woke up, the second 15 minutes after the first sample, the third 30 minutes after the third sample, the fourth 60 minutes after the first sample, and the fifth and final timepoint is right before the owner/handler went to sleep in the evening.

### Salivary cortisol

Among the salivary cortisol measurements, the measurements taken in the evening right before the owner/handler went to bed were significantly different between PTSD service dogs and pet dogs ( $p=0.01$ ). Salivary cortisol levels measured in service dogs had an average of  $1.51 \pm 1.61$  nmol/l which was lower than the average in pet dogs ( $3.68 \pm 4.13$  nmol/l; see also Figure 2).

Salivary cortisol levels measured 15 minutes after the owner/handler woke up further neared significant difference between PTSD service dogs and pet dogs ( $p=0.06$ ). Salivary cortisol levels measured in service dogs averaged on  $1.70 \pm 1.40$  nmol/l which was lower than the average in pet dogs ( $3.24 \pm 3.47$  nmol/l).

### Relation between activity and salivary cortisol

Via a series of spearman correlations we checked if the level of activity that dogs performed was related to the levels of cortisol retrieved during this study. We found that cortisol levels as measured after the owner/handler woke up correlated significantly to the percentages of sedentary ( $p=0.02$ ,  $\rho=0.69$ , see Table 1) and vigorous ( $p=0.03$ ,  $\rho=-0.64$ ) activity in the 24 hour timeframe. This was additionally true for the cortisol level 15 minutes after the owner/ handler woke up, which correlated significantly to the percentage of sedentary ( $p=0.02$ ,  $\rho=-0.64$ ) and vigorous ( $p=0.01$ ,  $\rho=-0.65$ ) activity in the 24 hour timeframe, and to the sedentary( $p=0.03$ ,  $\rho=0.50$ ) and moderate ( $p=0.05$ ,

rho= -0.46) activity in the day (1200am – 1200 pm) timeframe. The cortisol levels at 60 minutes after the owner woke up correlated significantly to the percentage of vigorous (p=0.03, rho= -0.68) in the 24 hour timeframe. The cortisol level in the evening just before the owner/handler went to bed finally correlated significantly to the percentage sedentary activity (p=0.04, rho= 0.57) in the 24 hour timeframe, the percentage sedentary (p=0.03, rho=0.53) and moderate activity (p=0.02, rho= -0.57)

### Differences in questionnaire answers

Via a Chi-squared test we checked if service dog handlers and pet dog owners answered questions of the SD-QoL differently. Questions for which this was true can be found in Table 1.

**Table 1:** a series of Spearman's correlations were used to compare cortisol levels at five timepoints with three levels of activity in four timeframes in service dogs and pet dogs. The five timepoints for cortisol were: just after the owner/handler woke up, 15 minutes after the owner/handler woke up, 30 minutes after the owner/handler woke up, 60 minutes after the owner/handler woke up and just before the owner/handler went to sleep. The four activity timeframes were 24 hours, morning (900-1200 am), day (1200 am -1200 pm), and night (1200 pm – 500 am).

	Waking Cortisol		+ 15 minutes		+ 30 minutes		+ 60 minutes		Evening cortisol	
	p	rho	p	rho	p	rho	p	rho	p	rho
24 hour sedentary activity	0.02	0.69	0.02	0.64	0.64	0.12	0.15	0.47	0.04	0.57
24 hour moderate activity	0.07	-0.55	0.09	-0.46	0.91	-0.03	0.52	-0.22	0.11	-0.47
24 hour vigorous activity	0.03	-0.64	0.01	-0.65	0.34	-0.24	0.03	-0.68	0.73	-0.11
Morning sedentary activity	0.96	-0.02	0.56	0.16	0.97	-0.01	0.37	0.27	0.34	0.27
Morning moderate activity	0.78	0.09	0.62	-0.13	0.92	0.03	0.40	-0.25	0.30	-0.30
Morning vigorous activity	0.42	-0.25	0.43	-0.21	0.35	-0.25	0.11	-0.47	0.62	-0.15
Day sedentary activity	0.13	0.38	0.03	0.50	0.89	0.03	0.17	0.36	0.03	0.53
Day moderate activity	0.23	-0.31	0.05	-0.46	0.99	-0.00	0.19	-0.34	0.02	-0.57
Day vigorous activity	0.18	-0.34	0.07	-0.42	0.74	-0.08	0.15	-0.38	0.94	0.02
Night sedentary activity	0.08	0.45	0.63	0.12	0.61	0.12	0.50	-0.18	0.88	-0.04
Night moderate activity	0.09	-0.44	0.64	-0.12	0.65	-0.11	0.50	0.18	0.97	0.01
Night vigorous activity	0.91	-0.03	0.82	0.06	0.42	0.18	0.30	0.28	0.20	0.33

**Table 2:** The questions from the SD-QoL which showed a significant difference between service dog handlers and pet dog owners. Average answer options per group are given in the last two columns and English translations of questions are present in *italics*. If no units are mentioned with an answer average the noted number refers to a Likert scale answer. For the entire questionnaire see Appendix 1.

Question	X2	df	n	p	Service dog	Pet dog
9. Hoe vaak is uw hond het afgelopen jaar bij de dierenarts geweest? (voor algemene controle) <i>How often did your dog visit the vet during the past year? ( for general checkup)</i>	7.13	1	43	0.01	80% yes	35% yes
10. Is uw hond voor zover u weet gezond? <i>Is your dog , to your knowledge, in good health?</i>	4.08	1	43	0.04	0.95% yes	0.65% yes
22. Speelt binnen uw gezin een van de volgende situaties? (andere mogelijk stressvolle situaties) <i>Is the following situation applicable to your family?( other potentially stressful situations)</i>	6.20	1	43	0.01	40% yes	4% yes
27. Hoe vaak wandelt uw hond gemiddeld per dag? <i>How often does your dog go for a walk daily?</i>	7.95	1	43	0.02	3.15	2.74
29e. Mijn hond loopt los tijdens het wandelen <i>My dog is of the lead during walks.</i>	11.75	1	43	0.02	3.20	3.78
29i. Mijn hond draagt een tuigje/harnas tijdens het wandelen <i>My dog wears a harness during walks.</i>	24.15	1	43	0.00	4.30	1.83
30. Wat zijn, volgens u, de taken die uw hond voor u vervult? (Mij begeleiden) <i>Which tasks does your dog perform for you? (Guide me)</i>	18.71	1	43	0.00	65% yes	5% yes
30. Wat zijn, volgens u, de taken die uw hond voor u vervult?(Zintuig vervangen) <i>Which tasks does your dog perform for you? (replaces one or more of my senses)</i>	9.83	1	43	0.00	15% yes	0% yes
37. Waar slaapt uw hond 's nachts vaak? (overig) <i>Where does your dog often sleep at night? (other)</i>	5.29	1	43	0.02	50% yes	13% yes
38a. Hoe lang is uw hond meestal dagelijks zonder u? <i>How long each day is your dog not in your presence?</i>	20.94	1	43	0.00	1.40 uur	2.26 uur
38b. Hoe lang is uw hond meestal dagelijks zonder mensen (alleen thuis)? <i>How long each day is your dog without human company?</i>	20.21	1	43	0.00	1.10 uur	2.13 uur
39a. Hoe vaak spreekt u buitenshuis af? <i>How often do you have an appointment outside your home?</i>	9.07	1	43	0.01	2.80	3.43
39b. Hoe vaak neemt u uw hond mee op bezoek bij anderen? <i>How often do you bring your dog to appointments with others?</i>	18.88	1	43	0.00	4.55	2.96



Question	X2	df	n	p	Service dog	Pet dog
40a. Mijn hond mag contact hebben met andere personen dan mijzelf. My dog is allowed to make contact with humans other than me.	32.57	1	43	0.00	2.70	4.57
40b. Mijn hond benadert zelf andere personen dan mijzelf. My dog approaches humans other than me on its own.	19.88	1	43	0.00	2.70	4.13
40c. Mijn hond vermijdt andere personen dan mijzelf. My dog avoids humans other than me.	11.04	1	43	0.01	2.65	1.83
40d. Mijn hond negeert andere personen dan mijzelf. My dog ignores humans other than me?	17.83	1	43	0.00	3.35	1.87
41b. Mijn hond speelt met gezinsleden. My dog plays with family members.	9.17	1	43	0.03	3.90	4.48
41d. Mijn hond speelt met vreemde personen. My dog plays with strangers.	14.66	1	43	0.00	1.14	2.27

## Discussion

### Differences in activity

During this study we hypothesised that PTSD service dogs show a less distinct activity peak during morning hours than pet dogs do, show less resting periods overall and have an increase in activity during night hours due to the work they are required to perform. Overall the activity pattern of the PTSD service dogs in our study was not significantly different from that of pet dogs. This result is especially interesting regarding the night-time (1200 pm-500 am) timeframe, in which disturbance of sleep was expected in service dogs. A possible explanation of why this disturbance was not found might be sought in the sleeping pattern of dogs. Dogs are known to have around 23 sleep-wake episodes during an eight hour sleep period, which each last for about 16 minutes sleep and five minutes waking time (Adams & Johnson, 1993). Because dogs have such relatively short sleep cycles it is possible that disturbances of sleep affect them less than animals with longer sleep cycles. It is additionally possible that frequent waking times during their sleep cycles allow for night time activity to take place without disturbing the sleep-wake cycle. In the case of PTSD service dogs this might lead dogs to check up on their handler without disturbance of their own sleep-wake pattern, which would explain why no difference was found between their night-time activity pattern and that of pet dogs.

Regarding the morning timeframe (900 am – 1200 am) no distinct peak in activity was seen compared to the day timeframe (1200 am – 1200 om). A peak in activity was expected based on earlier studies (de Andrade Silva et al., 2018; Nishino et al., 1997; Tobler & Sigg, 1986) which had found dogs to be most active during the morning or early afternoon. According to these studies a lack of a morning activity peak can be caused by a disturbance of night-time rest like sleep deprivation (Tobler & Sigg 1986). Given that the dogs in our study showed a high percentage of sedentary behaviour during the night (1200-500 am) and no significant differences were found between both groups of dogs in this timeframe, sleep deprivation is unlikely in our study. It is more likely that the lack of morning peak activity as seen in the dogs of this study was caused by a lack of human activity peaking during these hours. Earlier studies to dog activity have already registered this possibility by noting that laboratory housed dogs showed less activity during weekend days when laboratory personal was scarce (Tobler & Sigg, 1986; Nishino, 1997). A lack of difference between the morning activity of service and pet dogs is further indication to this possibility since disturbance of resting patterns in pet dogs in general is not assumed.



### Differences in cortisol level

In addition to differences in activity pattern we questioned if the salivary cortisol levels of PTSD service dogs during the early morning and late evening differ from those of pet dogs. We hypothesised that salivary cortisol would be elevated in PTSD service dogs since increased activity is known to increase cortisol levels (de Groot et al., 2000; de Jong et al., 2000). Our results showed that salivary cortisol taken just before the owner/handler went to bed in the evening differed significantly between both groups of dogs. On average pet dogs ( $3.68 \pm 4.13$  nmol/l) had a higher cortisol level at this time of day than PTSD service dogs did ( $1.51 \pm 1.61$  nmol/l), even when an outlier in the pet dog group was not considered ( $2.75 \pm 2.33$  nmol/l). We additionally found that salivary cortisol taken 15 minutes after a dog's owner/handler woke up tended to be lower in service dogs ( $1.70 \pm 1.40$  nmol/l) than in pet dogs ( $3.24 \pm 3.47$  nmol/l). This difference also remained present when an outlier was ignored in the pet dog group ( $2.44 \pm 1.40$  nmol/l).

A possible explanation for the difference in cortisol at both timepoints is that some dogs were taken for a walk in the timeframe shortly before measurement. Because dogs lack a circadian cortisol cycle (Koyama et al., 2003; Thun et al., 1990) we chose to check for cortisol levels during times of day in which routine would be greatest to minimise the effect of unexpected stressors or excitement. Because the beginning and end of days are however also timepoints in which most people walk their dogs, it is possible that activity during these walks influenced cortisol levels (de Groot et al., 2000; de Jong et al., 2000). That some dogs were taken for a walk while others were not may additionally explain the high variation seen at these timepoints, even when outliers are ignored. It however seems contrary to some of the answers given by owners/handlers to questionnaire questions. According to the questionnaire (see appendix 1) service dogs were reported to walk more often than pet dogs. This is also reflected in their reported walking hours which suggests that service dogs were more active than pet dogs. Because these variables were based on handler reports however, it is possible that the reported activity levels are not representative of actual activity via actigraphy.

It is finally possible that some measurements of salivary cortisol were not taken accurately. In this study we chose to perform home measurements to minimise the effects of the research on subjects and their owners/handlers. Because measurements were taken at home though, it is possible that some individuals did not perform measurements in a correct fashion. The greatest evidence of this effect can be seen in the number of missing values in salivary cortisol and in the fact that some owners did not put the activity meter on their dog before the programmed starting time. It is therefore possible that the outliers that were encountered in this study are due to ill handling of the measurements and that the difference in salivary cortisol between service and pet dogs in the evening was influenced by handling errors. It is however

also possible that genuine effect was measured which indicates that service dogs do not differ significantly in their cortisol levels and activity from pet dogs. This assumption is supported by the fact that the results found regarding cortisol levels did not alter when two outliers were removed. The effect is therefore stronger than outlier influence, which suggests that genuine results were found between the two groups.

### Conclusion

Overall we therefore found that the activity pattern of service dogs observed during our study did not differ from that of pet dogs. We additionally found little difference in salivary cortisol levels, with the exception of the timepoint just before dog owners/handlers went to sleep. At this timepoint pet dog cortisol was higher than that of service dogs though both groups showed substantial variation. A possible explanation for this difference is that some pet dogs were walked right before measurements were taken. Additional salivary cortisol measurements in a controlled environment might therefore be warranted. Nonetheless we found no evidence for increased stress levels in service dogs compared to pet dogs, based on activity levels and cortisol data. This indicates that service dog welfare does not seem to be impaired by their daily duties. Further studies are needed to study long-term effects of work as a service dog, for instance on oxidative stress and aging.

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**Data Availability Statement:** The data presented in this study are available on request from the corresponding author.



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## Appendix 1 (Dutch)

### Vragenlijst over het welzijn van hulphonden

#### Algemene vragen hond

De volgende vragen zijn **algemene vragen** over uw hond.

1. Wat is het ras (of kruising) van uw hond?	.....		
2. Wat is de leeftijd van uw hond?	.....		
3. Wat is het geslacht van uw hond?	O Reu (man)	O Teef (vrouw)	
4. Is dit uw eerste hulphond?	O Ja	O Nee	O Weet niet
5. Heeft u eerder honden als huisdier gehad?	O Ja	O Nee	O Weet niet
6. Heeft u eerder (professioneel) met honden gewerkt?	O Ja	O Nee	O Weet niet
7. Zijn er andere honden in uw huishouden aanwezig?	O Ja	O Nee	O Weet niet
8. Zijn er ander huisdieren in uw huishouden aanwezig? (anders dan honden)	O Ja	O Nee	O Weet niet
Zo ja, wat voor huisdieren zijn dit (en hoeveel)?	.....		
9. Hoe vaak is uw hond het afgelopen jaar bij de dierenarts geweest?	.....		
Zo ja, wat was hiervoor de reden? (Meerdere antwoorden mogelijk)	Algemene controle Entingen Verwonding Afwijkend gedrag	Chronische ziekte Lichamelijke klacht Anders, .....	
10. Is uw hond voor zover u weet gezond?	O Ja	O Nee	O Weet niet
Zo nee, wat is de bron van de klachten? (Meerdere antwoorden mogelijk)	Gewrichten Poten Heupen Rug Allergie Huidafwijking Ontsteking	Spijsvertering Hart & bloedvaten Luchtwegen Verwonding Hersenen/zenuwen Genetisch Gedragsprobleem Anders, .....	
11. Gebruikt uw hond medicijnen?	O Ja	O Nee	O Weet niet
Zo ja, welke medicijnen?	.....		

**Algemene vragen mens**De volgende vragen zijn **algemene vragen** over de thuissituatie van uw hond.

12. Wat is uw leeftijd?	.....		
13. Wat is uw geslacht?	<input type="radio"/> Man	<input type="radio"/> Vrouw	<input type="radio"/> Anders
14. Indien van toepassing, wat is uw beroep?	.....		
15. Indien van toepassing, hoe is uw huidige werksituatie?	<input type="radio"/> Werknemer <input type="radio"/> ZZP'er	<input type="radio"/> Vrijwilliger  <input type="radio"/> Anders, .....	<input type="radio"/> Zoekende
16. Wat is uw hoogst genoten opleiding?	<input type="radio"/> Basisschool <input type="radio"/> Middelbare school <input type="radio"/> MBO <input type="radio"/> HBO	<input type="radio"/> Vakopleiding <input type="radio"/> WO <input type="radio"/> Anders, .....	
17. In welke soort omgeving woont u momenteel?	<input type="radio"/> Stad <input type="radio"/> Platteland	<input type="radio"/> Dorp <input type="radio"/> Anders, .....	
18. In welke soort woning woont u momenteel?	<input type="radio"/> Appartement <input type="radio"/> Boerderij <input type="radio"/> Woonboot	<input type="radio"/> Huis met tuin <input type="radio"/> Huis zonder tuin <input type="radio"/> Anders, .....	
19. Wat is uw huidige samenlevingsvorm?	<input type="radio"/> Alleenstaand <input type="radio"/> Gehuwd <input type="radio"/> Partnerschap <input type="radio"/> Samenwonend	<input type="radio"/> Vaste relatie <input type="radio"/> Weduwe/weduwenaar <input type="radio"/> Gescheiden <input type="radio"/> Anders, .....	
20. Uit hoeveel mensen bestaat uw huishouden?	Volwassen ... Man ... Vrouw	18-13 jaar ... Jongen ... Meisje	12-3 jaar ... Jongen ... Meisje ... Meisje
21. Heeft er naast u nog iemand in uw gezin een sterke band met uw hond?	.....		
22. Speelt binnen uw gezin een van de volgende situaties?			
a. Problemen in de relationele sfeer	<input type="radio"/> Ja	<input type="radio"/> Nee	<input type="radio"/> Weet niet
b. Langdurige ziekte van een gezinslid	<input type="radio"/> Ja	<input type="radio"/> Nee	<input type="radio"/> Weet niet
c. Recent overlijden (van dier of mens)	<input type="radio"/> Ja	<input type="radio"/> Nee	<input type="radio"/> Weet niet
d. Kind met gedragsproblemen	<input type="radio"/> Ja	<input type="radio"/> Nee	<input type="radio"/> Weet niet
e. Kind met een fysieke beperking	<input type="radio"/> Ja	<input type="radio"/> Nee	<input type="radio"/> Weet niet
f. Kind met een geestelijke beperking	<input type="radio"/> Ja	<input type="radio"/> Nee	<input type="radio"/> Weet niet
g. Volwassene met gedragsproblemen	<input type="radio"/> Ja	<input type="radio"/> Nee	<input type="radio"/> Weet niet
h. Volwassene met een fysieke beperking	<input type="radio"/> Ja	<input type="radio"/> Nee	<input type="radio"/> Weet niet
i. Volwassene met een geestelijke beperking	<input type="radio"/> Ja	<input type="radio"/> Nee	<input type="radio"/> Weet niet
j. Financiële problemen	<input type="radio"/> Ja	<input type="radio"/> Nee	<input type="radio"/> Weet niet

k. Verslavingsproblematiek (bij uzelf of een gezinslid)  Ja  Nee  Weet nietl. Andere mogelijk stressvolle situaties  Ja  Nee  Weet niet**Voeding**De volgende vragen gaan over de **voeding** van uw hond.

23. Wat krijgt uw hond over het algemeen te eten? (Meerdere antwoorden mogelijk)	<input type="radio"/> Basis droogvoer <input type="radio"/> Basis nat voer <input type="radio"/> Vers vlees <input type="radio"/> Met de pot mee	<input type="radio"/> Dieet droogvoer <input type="radio"/> Dieet nat voer <input type="radio"/> Anders, .....			
Indien van toepassing, welk merk voer?	.....				
24. Hoeveel maaltijden krijgt uw hond per dag?	.....				
25. Hoe zwaar is uw hond (ongeveer)?	..... Kg				
26. Mijn hond krijgt ...	<input type="radio"/> Nooit	<input type="radio"/> Zelden	<input type="radio"/> Soms	<input type="radio"/> Vaak	<input type="radio"/> Altijd
a. ... iedere dag rond dezelfde tijdstippen voer	<input type="radio"/> 0	<input type="radio"/> 0	<input type="radio"/> 0	<input type="radio"/> 0	<input type="radio"/> 0
b. ... iedere dag ongeveer dezelfde hoeveelheid voer	<input type="radio"/> 0	<input type="radio"/> 0	<input type="radio"/> 0	<input type="radio"/> 0	<input type="radio"/> 0
c. ... iedere dag hetzelfde aantal keer voer	<input type="radio"/> 0	<input type="radio"/> 0	<input type="radio"/> 0	<input type="radio"/> 0	<input type="radio"/> 0
d. ... voer als hij/zij er om vraagt	<input type="radio"/> 0	<input type="radio"/> 0	<input type="radio"/> 0	<input type="radio"/> 0	<input type="radio"/> 0
e. ... menselijk voedsel ("met de pot mee eten")	<input type="radio"/> 0	<input type="radio"/> 0	<input type="radio"/> 0	<input type="radio"/> 0	<input type="radio"/> 0
f. ... voer tussendoor (bv. beloningsbrokjes, kluijjes)	<input type="radio"/> 0	<input type="radio"/> 0	<input type="radio"/> 0	<input type="radio"/> 0	<input type="radio"/> 0
g. ... vrije toegang tot een bak water (ad libitum)	<input type="radio"/> 0	<input type="radio"/> 0	<input type="radio"/> 0	<input type="radio"/> 0	<input type="radio"/> 0
h. ... vrije toegang tot voer (ad libitum)	<input type="radio"/> 0	<input type="radio"/> 0	<input type="radio"/> 0	<input type="radio"/> 0	<input type="radio"/> 0
i. ... zijn hoofdmaaltijden uit een voerbak	<input type="radio"/> 0	<input type="radio"/> 0	<input type="radio"/> 0	<input type="radio"/> 0	<input type="radio"/> 0
j. ... zijn hoofdmaaltijden in voerspellen	<input type="radio"/> 0	<input type="radio"/> 0	<input type="radio"/> 0	<input type="radio"/> 0	<input type="radio"/> 0
k. ... tussendoortjes uit een voerbak	<input type="radio"/> 0	<input type="radio"/> 0	<input type="radio"/> 0	<input type="radio"/> 0	<input type="radio"/> 0
l. ... tussendoortjes uit voerspellen	<input type="radio"/> 0	<input type="radio"/> 0	<input type="radio"/> 0	<input type="radio"/> 0	<input type="radio"/> 0
Indien van toepassing, wat voor voerspellen gebruikt u? (Meerdere antwoorden mogelijk)	<input type="radio"/> Voerbal <input type="radio"/> Vakken puzzel <input type="radio"/> Fles	<input type="radio"/> Voer doolhof <input type="radio"/> Kong <input type="radio"/> Anders, .....			

**Beweging**Nu volgen enkele vragen over de **beweging** die uw hond gemiddeld krijgt per dag.

27. Hoe vaak wandelt uw hond gemiddeld per dag?	<input type="radio"/> 0 x	<input type="radio"/> 0 1-2 x	<input type="radio"/> 0 3-4 x	<input type="radio"/> 0 5-6 x	<input type="radio"/> 0 >6 x
28. Hoe lang wandelt uw hond gemiddeld per dag?	..... uur				
29. Mijn hond ...	<input type="radio"/> Nooit	<input type="radio"/> Zelden	<input type="radio"/> Soms	<input type="radio"/> Vaak	<input type="radio"/> Altijd
a. ... wandelt in een park, de stad, of het dorp	<input type="radio"/> 0	<input type="radio"/> 0	<input type="radio"/> 0	<input type="radio"/> 0	<input type="radio"/> 0
b. ... wandelt in het bos of de natuur	<input type="radio"/> 0	<input type="radio"/> 0	<input type="radio"/> 0	<input type="radio"/> 0	<input type="radio"/> 0

c. ... heeft afwisselende wandelroutes	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
d. ... geeft zelf aan dat hij/zij naar buiten wil	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
e. ... loopt los tijdens het wandelen	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
f. ... loopt aan een vaste riem tijdens het wandelen	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
g. ... loopt aan een rol-lijn tijdens het wandelen	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
h. ... draagt een halsband tijdens het wandelen	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
i. ... draagt een tuigje/harnas tijdens het wandelen	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

**Assistentie werk**De volgende vragen gaan over de **assistentie** die uw hond verleent.

30. Wat zijn, volgens u, de taken die uw hond voor u vervult? (Meerdere antwoorden mogelijk)	Gezelschap	Aanvullend zintuig
	Emotionele steun	Zintuig vervangen
	Voorwerpen aanreiken	Gedrag spiegel
	Voorwerpen bedienen	Anders, namelijk
	Mij begeleiden	.....

31. Mijn hond ...	Nooit	Zelden	Soms	Vaak	Altijd
a. ... is gehoorzaam	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
b. ... assisteert mij overdag	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
c. ... assisteert mij 's nachts	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
d. ... assisteert mij tijdens (vrijwilligers)werk (indien van toepassing)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
e. ... assisteert mij tijdens visite of afspraak	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
f. ... assisteert mij in winkels of op markten	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
g. ... assisteert mij in het openbaar vervoer	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
h. ... assisteert mij tijdens recreatie/sport/hobby	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

32. Zoekt uw hond contact als u ...	Nooit	Zelden	Soms	Vaak	Altijd
a. ... een gerichte hulpvraag geeft?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
b. ... bedroefd/terneergeslagen bent?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
c. ... geagiteerd/opgewonden bent?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
d. ... angstig bent?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
e. ... stress ervaart?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
f. ... blij bent?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
g. ... geen specifieke emotie vertoont?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

33. Reageert uw hond op een gezinslid als die ...	Nooit	Zelden	Soms	Vaak	Altijd
a. ... een gerichte hulpvraag geeft?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
b. ... bedroefd/terneergeslagen is?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
c. ... geagiteerd/opgewonden is?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
d. ... angstig is?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
e. ... stress ervaart?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

f. ... blij is?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
g. ... geen specifieke emotie vertoont?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Zo ja, is er een gezinslid waarbij dit vaak voorkomt? .....

34. Hoeveel uur assisteert uw hond u ongeveer per dag? .....

**Slaap en Rust**De volgende vragen gaan over de **slaap en rust mogelijkheden** van uw hond.

35. Mijn hond heeft een eigen rust/slaapplaats.	<input type="radio"/> Ja	<input type="radio"/> Nee	<input type="radio"/> Weet niet
Zo ja, waar is deze plaats? (meerdere antwoorden mogelijk)	Mand Kussen Bench	Stoel/bank Vloer Anders, .....	

36. Mijn hond ...

a. ... verblijft dagelijks verplicht op zijn eigen plaats	..... uur
b. ... kan per dag rust opzoeken (is niet aan het werk)	.....uur
c. ... slaapt per dag (24 uur) ongeveer	..... uur

37. Waar slaapt uw hond 's nachts vaak? (Meerdere antwoorden mogelijk)	Mand Kussen Bench	Stoel/bank Vloer Anders, .....
--	-------------------------	--------------------------------------

**Sociaal gedrag (naar mensen)**De volgende vragen gaan over de **sociale** interacties en het spelgedrag van uw hond met **personen**.

38. Hoe lang is uw hond meestal dagelijks ...	0 uur	1-4 uur	5-8 uur	9-12 uur	>12 uur
a. ... zonder u?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
b. ... zonder mensen (alleen thuis)?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
c. ... aan het spelen met mensen?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

39. Hoe vaak ...	Nooit	Zelden	Soms	Vaak	Altijd
a. ... spreekt u buitenshuis af?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
b. ... neemt u uw hond mee op bezoek bij anderen?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
c. ... bezoeken vrienden/familie u thuis?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
d. ... verblijft uw hond in dezelfde ruimte als u?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
e. ... verblijft uw hond in een ruimte met vreemden?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>



40. Mijn hond ...	Nooit	Zelden	Soms	Vaak	Altijd
a. ... mag contact hebben met andere personen dan mijzelf	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
b. ... benadert zelf andere personen dan mijzelf	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
c. ... vermijdt andere personen dan mijzelf	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
d. ... negeert andere personen dan mijzelf	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
e. ... is bang voor bepaalde personen	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
f. ... is agressief naar bepaalde personen	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
g. ... is vriendelijk naar andere personen	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

41. Mijn hond ...	Nooit	<1x per week	1x per week	2 a 3x per week	Elke dag
a. ... speelt met mij	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
b. ... speelt met gezinsleden	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
c. ... speelt met bekende personen	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
d. ... speelt met vreemde personen	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

42. Wie is degene die meestal begint met spelen?	<input type="radio"/> De mens	<input type="radio"/> De hond	<input type="radio"/> Beide	<input type="radio"/> Afwisselend

**Sociaal gedrag (naar honden)**

De volgende vragen gaan over de **sociale** interacties en het spelgedrag van uw hond met **andere honden**.

43. Mijn hond ...	Nooit	Zelden	Soms	Vaak	Altijd
a. ... kan contact hebben met andere honden	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
b. ... heeft (niet agressief) contact met andere honden	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
c. ... speelt met andere honden	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
d. ... is bang voor sommige andere honden	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
e. ... is agressief naar sommige andere honden	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
f. ... is vriendelijk naar andere honden	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

44. Als uw hond contact heeft met een andere hond, wie begint dan meestal het contact?	<input type="radio"/> Mijn hond	<input type="radio"/> De andere hond	<input type="radio"/> Beide	<input type="radio"/> Afwisselend

45. Hoe vaak heeft uw hond ongeveer positief/speels contact met een andere hond?	<input type="radio"/> Nooit	<input type="radio"/> <1x per week	<input type="radio"/> 1x per week	<input type="radio"/> 2 a 3x per week	<input type="radio"/> Elke dag

46. Met hoeveel verschillende honden heeft uw hond per week ongeveer contact?	<input type="radio"/> 0	<input type="radio"/> 1	<input type="radio"/> 2	<input type="radio"/> 3	<input type="radio"/> >3

**Slot**

Tot **slot** volgen nog deze laatste vragen.

47. Het hebben van een hond is mij ...	<input type="radio"/> Meegevallen	<input type="radio"/> Neutraal	<input type="radio"/> Tegengevallen
48. Heeft u spijt van het hebben van uw hond?	<input type="radio"/> Ja	<input type="radio"/> Nee	<input type="radio"/> Weet niet
49. Heeft u er wel eens over nagedacht om uw hond weg te doen?	<input type="radio"/> Ja	<input type="radio"/> Nee	<input type="radio"/> Weet niet

Zo ja, wilt u dit antwoord toelichten? .....

.....

50. Heeft u nog aanvullingen of opmerkingen over deze vragenlijst?

.....

.....

Dit is het einde van de vragenlijst. Hartelijk dank voor uw medewerking!



# Chapter 8

## **General discussion**

## 8.1 Summary of results

This thesis revolved around three central questions. The first and primary of these questions asked if PTSD service dogs are an effective method to reduce PTSD related symptoms. This question was asked because the interest in PTSD service dogs as a complementary treatment for PTSD has grown over the years, yet scientific study of the topic remains scarce. Additionally it was questioned if the welfare of PTSD service dogs is negatively affected by their assistance work. ? In this question good welfare is defined as the ability of an animal to actively adapt to their environment and to reach a state which it experiences as positive. The maintenance of such a state is important to service dogs because they are asked to perform trained behaviours at irregular intervals which might be experienced as stressful by the animal. Prolonged exposure to stressors could lead to both reduced welfare and loss of function as a service dog which makes stress in service dogs undesirable from both an ethical and a practical point of view. The third question was finally an overarching one which asked what was currently known regarding PTSD service dogs and whether or not the above questions can already be (partially) answered by existing literature?

### *What is currently known about PTSD Service dogs?*

To answer the three questions of this thesis, a total of six studies were performed. **Chapter 2** concerned the overarching question and investigated how much scientific literature was available on PTSD service dogs for veterans and first aid responders. To answer this question a literature study was conducted on available literature. Specifically this was done on literature available regarding service dogs for veterans with PTSD because this group was the one that was most prominently discussed.

The results of this study revealed several core themes in PTSD service dog literature. These themes were: the definition of a service dog, lack of consensus regarding service dog development, social/physiological benefits of a service dog, cost and availability barriers, the welfare of service dogs, expectations veterans have of a service dog, reservations about service dogs, the role of the service dog in the overall treatment plan, and best practice regarding service dog. Unfortunately only a limited number of studies was available per individual theme. Available literature was additionally mainly based on subjective measurements and observations which leave room for placebo effect and bias. This made it difficult to formulate irrefutable answers to many questions within the themes and to questions regarding PTSD service dogs in general. After conducting the literature review it therefore became clear that future research would require the inclusion of objective measurements and control groups to answer the questions of this thesis, while maintaining the use of subjective measurements for the evaluation of individual welfare experience.

### *Are PTSD service dogs an effective method to reduce PTSD related symptomatology?*

Among the tools used for the assessment of individual welfare experience was the Monash Dog Owner Relationship Score (MDORS) questionnaire. This questionnaire was important because it helped evaluate the bond value that individuals with PTSD placed on their service dog. Because the MDORS had not yet been validated in Dutch however, it was not reliable for study in Dutch-speaking individuals. **Chapter 3** of this thesis therefore concerns a Dutch validation of the MDORS and showed that three questions of the questionnaire were no longer relevant for its overall result. Because these questions were no longer relevant, it was recommended to remove them from the questionnaire. In addition, it was advised to remove all questions regarding interaction between humans and dogs because they could not be answered equally by all participants in the study.

**Chapter 4** of this thesis subsequently made use of the new Dutch MDORS, among other measurements of PTSD service dog effect. These measurements included both subjective and objective ones, as per the recommendation of **Chapter 2**. The results of the subjective measurements showed that individuals with a service dog rated their own wellbeing and sleep quality higher, while they experienced fewer PTSD symptoms than individuals without a service dog. They however still rated their own well-being lower than the veterans without PTSD, which signals that the PTSD service dog lessened but not fully removed the effects of PTSD. Additional analysis of objective measures showed less clear results. The analysis of salivary cortisol levels showed no difference between the different groups of participants. There was a difference based on activity though. Individuals with a service dog walked more than those without PTSD. They did not walk more than individuals with PTSD without a service dog though. Because a difference between these latter two groups was found in a previous study, further research into this measurement is necessary. Overall, the results therefore indicate that individuals with PTSD and a service dog suffer less from PTSD symptoms and have better wellbeing than individuals with PTSD without a service dog. PTSD service dogs therefore seem an effective method in treating PTSD related symptoms. This effect is not or at least difficult to measure in objective measurements though. Moreover no relationship between subjective and objective measurements was found. Further study of this relationship and objective measurements of service dog effect in general is therefore warranted

### *Is the welfare of PTSD service dogs negatively affected by their assistance work?*

The **Chapters 5, 6, and 7** of this thesis finally concerned its third question, by asking if the welfare of PTSD service dogs is influenced by their assistance work. In **Chapter 5** it was questioned whether service dogs show physiological signs of stress during a training session for active service dogs, and if so, whether they can recover from this



stress within a time span of 45–60 min. Results showed that dogs had lower cortisol levels in their saliva immediately after training than before training. The variation between dogs was additionally smaller after than before training. This indicates that the dogs did not experience the training as stressful and therefore suggested against welfare impairments as a consequence of training.

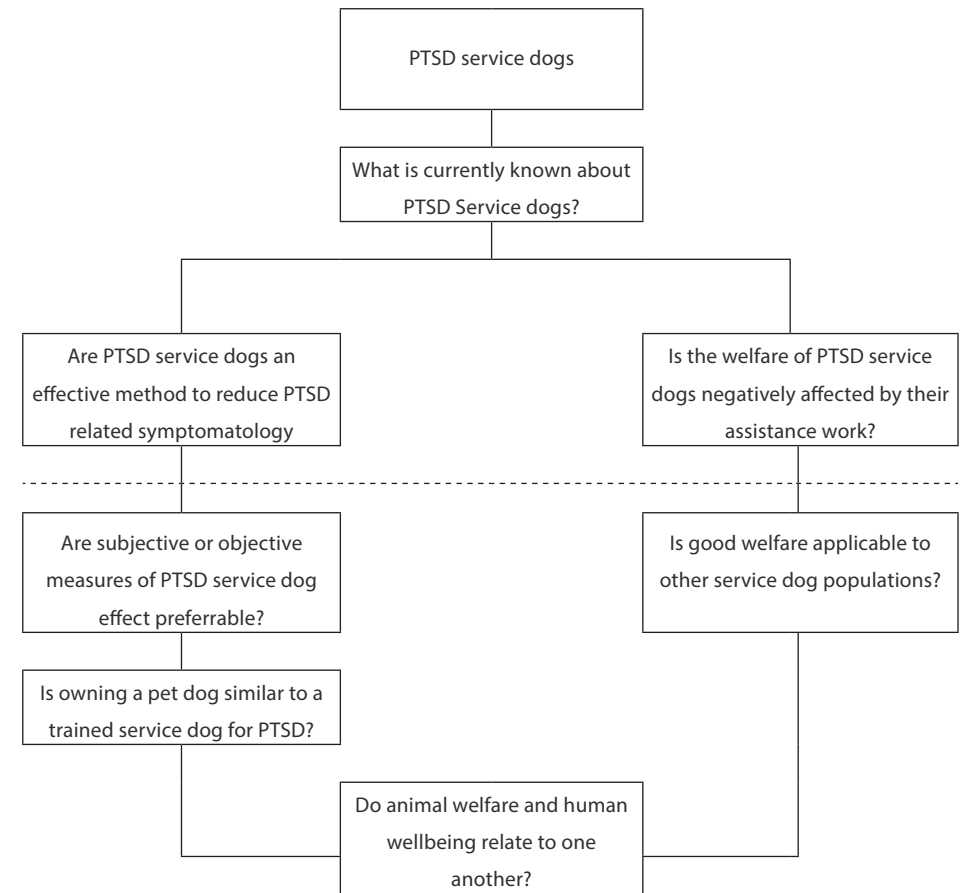
In **Chapter 6** the level of cortisol in the hair of service dogs was compared to that of companion dogs, as a measurement of stress accumulation. No difference in hair cortisol was found between these two groups. There was additionally no influence of age, gender, hair colour, and seasonality on the amount of hair cortisol found. There did appear to be an influence of the presence of other pets though, suggesting that dogs that lived with other animals had a higher hair cortisol than dogs that lived alone or only with other dogs. This was not significant however, which indicate that there was little to no difference between the hair cortisol of domestic dogs and the PTSD service dogs in our study.

In **Chapter 7** of this thesis the effect of assistance work on the activity pattern and salivary cortisol level of service dogs was finally evaluated. This was done by comparing the 24 hour activity pattern of service dogs to that of companion dogs of the same breed. The results showed that the service dogs had no different activity pattern than the domestic dogs. In addition, almost no difference in salivary cortisol levels was seen except in the evening just before the owner went to bed and in the morning 15 minutes after the owner got up. These levels were higher in the domestic dogs than in the service dogs, although variation was also high. Because cortisol may increase due to activity it is possible that this difference was caused by some dogs being walked just before the samples were collected. These results therefore indicate that there is little to no difference between the salivary cortisol levels and activity patterns of service dogs and domestic dogs, suggested against welfare impairments as a consequence of assistance work.

### 8.2 Reflection on results

Collectively the studies presented in this thesis contribute to both the understanding of human wellbeing and animal welfare in the field of PTSD service dogs. The results of **Chapters 2 and 4** show that PTSD service dogs do seem effective in reducing PTSD symptomatology. The results of **Chapters 5,6,7** meanwhile show no influence of training or assistance work on physiological indicators of stress like altered salivary and hair cortisol in service dogs. Activity was further unaltered compared to companion dogs, which together indicate an absence of direct welfare issues in the service dogs that were observed during this study. This is not to say that these results count for all service dogs though as there are different ways in which dogs can be selected, trained,

and prepared for their work. It can therefore be questioned if the found results of this study are applicable to other service dog populations or just the one studied during this thesis. This one and other questions that can be raised based on the Chapters of this Thesis, will be discussed below (See also Figure 1).



**Figure 1:** The three different questions posed for this Thesis and the new questions that were formulated based on the results of **Chapters 2, 3, 4, 5, 6, and 7.**

### *Is good welfare applicable to other service dog populations?*

To know whether the results found in **Chapters 5, 6, and 7** of this Thesis are applicable to other PTSD service dog populations, a comparison between different sub populations of service dogs would be needed. This is not possible within the studies of this Thesis however, since all studied service dogs were selected and trained by the same organisation. Alternatively the results of **Chapters 5, 6, and 7** could be compared to results of studies in other PTSD service dog populations. This is also difficult though, since studies of PTSD service dog welfare are scarce.

To date the studies performed in this thesis appear to be the only ones specifically directed at PTSD service dogs. Studies to comparable populations of dogs within AAI exist however. One of these populations are Autism Spectrum Disorder (ASD) service dogs (Burrows et al., 2008). ASD service dogs are dogs that are specifically trained to assist an individual with ASD. Similar to PTSD service dogs, they support an individual over longer periods of time and are available 24 hours a day. According to a study by Burrows et al. (2008) this long term assistance introduces a risk for limited resting periods and excessive exposure to physical stressors. These welfare concerns are similar if not identical to the ones studied in **Chapter 7**, since they may therefore also be present in PTSD service dogs. It should be noted however that ASD knows different symptoms than PTSD and may therefore burden a service dog in a different manner. This notion is supported by the fact that ASD service dogs are often distributed to children, most of which are not fully capable of mediating their own behavioural outbursts. It is therefore possible that the work of an ASD service dog is a heavier burden on dog welfare than the work of a PTSD service dog, which results in limited resting periods and excessive exposure to physical stressors being less of an issue for this type of AAI, as was found in **Chapter 7**.

Another population of dogs that is comparable to PTSD service dogs are therapy dogs (Glenk et al., 2013; Glenk et al., 2014; Glenk et al., 2017; Clark et al., 2019; and Clark et al., 2020; Serpell et al., 2020). Therapy dogs are dogs that are specifically trained to assist individuals in a therapeutic setting. Unlike PTSD and ASD service dogs they therefore do not stay with a single individual permanently, but interact with multiple individuals in different settings. According to Glenk et al., (2017) this imposes risks to animal welfare in the form of novelty of the therapy environment, lack of control over the environment and social interactions, and unfamiliarity with therapy recipients (Glenk et al., 2017; Glenk, 2020). These welfare concerns are different from the ones studied in PTSD service dogs in **Chapter 5, 6, and 7**, because they are mainly oriented to the changing aspects of therapy dog work.

There are also concerns which are similar though, like the risk of high work frequency. According to Glenk et al., (2017) the frequency and duration of therapy sessions pose an additional threat to animal welfare in therapy dogs (Glenk et al., 2017; Glenk, 2020). To see what impact frequent sessions have on therapy dogs Clark et al. (2019) studied the effect of differing frequencies. They found that dogs who performed in more sessions per week mounted a lower cortisol response than those who worked fewer sessions. Because cortisol is known to elevate in dogs in reaction to stressors (Beerda et al., 1998) this reaction indicated a lower physiological stress response to therapy work. Glenk et al (2013, 2014) additionally found that therapy dogs do not mount a cortisol elevation in response to individual therapy sessions. Taken together the studies of Clark et al. (2019) and Glenk et al. (2013, 2014) therefore indicate that the studied therapy dogs do not show signs of physiological stress due to therapy work. This is in line with the results found in **Chapter 5** of this Thesis in which a similar lack of reaction of PTSD service dogs to training was observed. It could therefore be stated that the dogs observed by these studies were capable of handling the work that was required of them and showed no apparent signs of welfare reduction. Whether or not this holds true for a larger population of dogs in AAI remains to be seen since again only a select population of animals was observed. The observations in all of the above studies were additionally only performed over a short period of time which raises doubt on whether welfare would be affected over longer periods of time.

Overall it thus appears that multiple populations of dogs in AAI were in good welfare at the time they were studied. It is therefore possible that a broader group of PTSD service dogs is in good welfare than the group that was observed during **Chapters 5, 6, and 7** of this thesis. This statement has to be made with caution though. Like stated above, observations on service dog welfare have only been made over a short period of time which does not address concerns over long-term exposure to stressors and affiliated welfare issues. Additionally there are still potential risks for service dog welfare, as shown in ASD service dogs by Burrows et al. (2008). It can therefore be questioned what the requirements are to ensure good welfare in service dogs. Like stated by Glenk et al. (2017, 2020) there are several risk factors which can affect animal welfare in therapy dogs. These are partially transferable to other types of dogs in AAI like PTSD service dogs. An addition to this list comes from Serpell et al. (2020) who argued that the organisation that manages a dog in AAI has an impact on welfare risks. In therapy dogs for example the risk of long therapy sessions can be reduced by setting time limits. The study by Serpell et al. (2020) however, found that only half of the therapy dog organisations imposes such a time limit. Most organisations that do impose a time limit further allow for therapy sessions of up to two hours while only one hour is advised by various guidelines (Ianuzzi & Rowan, 1991; Serpell et al., 2010; Ng, 2019; Serpell et al., 2020). It therefore appears that appropriate management of dogs in AAI is the basis for good welfare and the control of welfare risks.



In order for the results of **Chapters 5, 6, and 7** to be applicable to other groups of service dogs it appears that service dogs need to be of a similar selection, training and guidance background to the ones studied in these Chapters. Comparison between these factors are not always easy to do though because it is not standard practice to report selection, training and guidance criteria of dogs in AAI in welfare related studies (Serpell et al., 2020). Doing so could therefore prove an improvement to existing literature and is highly recommended for future research. Additionally it can be recommended that the impact of diverse selection, training, and guidance strategies is studied to find the one which best supports good animal welfare.

### *Do animal welfare and human wellbeing relate to one another?*

This latter advice is important because the selection, training, and guidance that a service dog receives often primarily aims to improve the wellbeing of humans. The welfare of the dog is not directly involved and may instead be added as a secondary purpose. This does not necessarily mean that the welfare of a dog is unimportant however. Not only can it be considered ethically right to ensure good welfare in animals, good welfare in service dogs may actively contribute to human wellbeing. The improvement of human wellbeing through animal intervention is only possible if the animal involved actively participates in the interaction. In the case of service dogs, a dog may find it difficult to intervene in PTSD related behaviours of the person it is supporting when it feels tired, distressed, ill, or distracted. If a service dog becomes enters such a negative emotional state as a result of its work this can additionally cause distress in the human they are supporting which may lead to a worsening of symptoms. A worsening of symptoms may in turn lead to distress or more work for the dog which can make it even more tired, distressed, or ill. As such, an exchange of negative influence can grow between human and dog, which negatively affects both human wellbeing and animal welfare. In order to prevent an exchange of negative influence, it is thus important to keep a PTSD service dog in good welfare. In this manner it can contribute to human wellbeing and an exchange of positive influence might be established between the two.

### *Are subjective or objective measures of PTSD service dog effect preferable?*

In what manner the positive influence of service dogs on human wellbeing can best be measured remains a topic for discussion. According to **Chapter 2** the use of subjective measurements in PTSD service dog research leaves room for placebo effect and bias in the interpretation of study results. To counter these risks, **Chapter 2** advised the use of objective measurements and altered study design. According to **Chapter 4** however subjective measurements of wellbeing and PTSD symptomatology are currently more useful in measuring PTSD service dog effect than objective measurements. This has two main reasons. The first of these reasons is a lack of correlation between subjective and current objective measures of PTSD service dog effect. Such a lack was found in the

studies of Rodriguez et al. (2018), Lessard et al. (2020), and later in **Chapter 4** of this Thesis. Because of this lack in correlation it is possible that an individual with PTSD is physiologically improving due to service dog presence, yet does not consciously experience this improvement. Because of this possibility, it can be questioned which of the two aspects is more important for those assisted by a service dog; physiological or mental improvement?

The second reason why subjective measurements of wellbeing and PTSD symptomatology are currently more reliable is because their results can be replicated between studies. Studies like those by Stern et al. (2013), Kloep et al. (2017), Vincent et al. (2017), Yarborough et al. (2017), and Rodriguez et al. (2020a) have shown that measures of PTSD symptomatology are lowered in those with PTSD who are supported by a service dog. Meanwhile they also showed that various measurements of anger, sleep quality, and depression are improved. A study by Tedeschi et al. (2010) finally found that those with a service dog report more control of their life, more sense of worth, and more self-efficacy, while Crowe et al. (2017) reported that individuals with a service dog feel more connected with society and experience better quality of life. All of this is in line with the results found in **Chapter 4** of this Thesis, which found that PTSD symptomatology, sleep quality and quality of life are improved by service dog allocation.

The use of objective measures on the other hand has shown contradictions between studies. In the study of Rodriguez et al. (2018) morning waking salivary cortisol levels were compared between individuals with and without a PTSD service dog. By doing so Rodriguez et al. (2018) found an elevating effect of service dog presence on morning cortisol levels. Because morning and evening cortisol levels can be lowered in those with PTSD compared to healthy controls (Yehuda et al., 1996; Pierce & Prichard, 2016; Als et al., 2017), these results indicated a normalisation of cortisol levels. This lowering of cortisol does not always occur though as concluded by Meeuwse et al. (2007) and observed in **Chapter 4** of this Thesis. Because of this the use of cortisol elevation as a measure of service dog effect currently seems highly susceptible to methodological variation and variation between participants. This in turn makes results difficult to compare between studies and makes cortisol levels currently not a reliable clinical measure of service dog effect.

The use of activity levels as an objective measure of service dog effect similarly knows obstacles. This conclusion was drawn when comparing the results of Lessard et al. (2020) with those found in **Chapter 4** of this Thesis. Contrary to Lessard et al. (2020) **Chapter 4** only found a small significant effect between individuals. Most likely this was due to **Chapter 4** measuring differences between individuals for the period of 24 hours while Lessard et al. (2020) measured within individuals over longer time periods. Because of





this however, the effect of service dogs on activity in those with PTSD seems small. It additionally seems unreliable for use between individuals since variation between individuals might disturb results.

Taken together the above leads to the conclusion that it is currently more easy, quick, and reliable to judge PTSD service dog effect through subjective measures of wellbeing and PTSD symptomatology. Potentially novel ways of objective measurement can change this however, like the measurement of medication use proposed by Rodriguez et al. (2021), or the measurement of adverse effects of PTSD like alcohol abuse and suicide rates. This would require further research however before it can replace or compliment the use of subjective measures.

### *Is owning a pet dog similar to a trained service dog for PTSD?*

Despite the above, the use of subjective measurements to evaluate service dog effect is still not without risks. To counter these risks, **Chapter 2** advised the use of objective measurements and altered study design. Since the use of objective measurements has proven troublesome however, the alteration of study design remains. In **Chapter 4** such an alteration was attempted with the inclusion of individuals with PTSD that owned a pet dog opposed to a service dog. It was found that these individuals scored worse regarding their overall quality of life, sleep quality, and PTSD symptomatology than those with a trained service dog. These results indicated that the trained behaviours of a service dog contributed to the experience of wellbeing and the reduction of symptomatology in those with PTSD. This effect is supported by results from Rodriguez et al. (2020b) who found that on average individuals with a service dog rated the dog's trained behaviours higher than untrained behaviours. Untrained behaviours were still valued however since they were rated more important overall (Rodriquez et al., 2020b).

Because pet dogs can also display these untrained behaviours it could be expected that individuals with a pet dog would have a better wellbeing and fewer PTSD related symptoms than those without a dog. No significant difference between these groups was found in **Chapter 4** however. Because of these results, it can thus be argued that service dogs clearly had a greater effect on wellbeing and PTSD symptomatology than pet dogs. Whether this was caused by the actual presence of the service dog or by the support that it warrants from service dog organisations could still not be determined with certainty though.

## **8.3 Critical remarks on study design**

### *Treatment allocation*

To make the definitive distinction between the above mentioned effects, another alteration to study design in **Chapter 4** would have been necessary. This alteration

would entail the random allocation of pet and service dogs to individuals with PTSD without telling them which is which. Not only would placebo effect be countered in this manner, it would also establish randomisation of treatment, which counters bias. It is questionable if such an intervention is ethically acceptable though, given that it has implications for both human wellbeing and dog welfare.

Unlike service dogs, pet dogs are not trained to intervene if PTSD symptoms arise. A study by Rodriguez et al. (2020b) however showed that individuals on a waiting list for a service dog expect to make frequent use of such interventions. If this use turns out not to be possible, it can lead to frustration which can lead to a worsening of PTSD symptoms. Additionally some individuals might deduce that they have received a pet dog due to it not intervening. This defeats the purpose of randomising treatment allocation and makes it difficult in practice. The welfare of the randomly allocated pet dogs may furthermore be at risk. Pet dogs are generally not trained or accustomed to the interaction with highly emotional individuals. Depending on the dog, the confrontation with PTSD symptoms in humans might therefore be stressful for the animal and endanger their overall welfare. Service dogs on the other hand are specifically selected and trained to cope with the symptoms of PTSD which might result in better coping mechanisms for stressful situations. From a welfare point of view it thus seems advisable to only allocate trained service dogs to individuals with PTSD.

In addition to the above it is questionable if random allocation of pet dogs instead of service dogs is currently possible. A major limitation encountered during this Thesis was the availability of study participants. Because service dogs are a developing discipline within AAI, only a finite number of dog-human combinations are available for research. This effect is seen in multiple studies in the field in which a low number of participants was one of the limiting factors (**Chapter 2**). In addition to this the individuals that train and guide PTSD service dogs throughout their lives are equally small in number. The number of applications for a service dog remains high however, as evident from the long waiting lists for service dogs (Winkle et al., 2012). Overall this thus causes for a thin spread of resources in the field of PTSD service dogs which should not be reallocated to pet dogs that do not offer an expected treatment effect.

### *Retrospective research*

Because of the arguments against random allocation, the field of PTSD service dog study currently only makes use of existing human-service dog combinations (Stern et al., 2013; Kloep et al., 2017; Vincent et al., 2017; Yarborough et al., 2017; Rodriguez et al., 2020a). This was also true for the **Chapters 4, 5, 6, and 7** of this thesis, which studied these cases via a retrospective study design. The term retrospective entails that the measurements necessary for the completion of the study are collected from existing cases rather than



from new cases or interventions (Hess, 2004; Sedgwick, 2014). It is the opposite of prospective study, which follows new cases or interventions over longer periods of time to register outcome.

The use of retrospective research entails risks. These risks include the earlier mentioned lack of randomisation, which can lead to bias on found results (Hess, 2004; Sedgwick, 2014). Retrospective research also allows for a quick gathering of participants though, since cases are already known with medical authorities or other organisations. Because participant numbers were a major limitation in the studies of this thesis, the use of a retrospective design ensured a greater availability of participants. Retrospective study further made it easier to allocate participants to different study groups because treatment allocation had already taken place. It is for these reasons that the use of retrospective study was preferred. Regardless the use of other study designs is encouraged in future research if a greater number of potential participants were to become available. The use of prospective study for example should not be excluded from future research since it can help answer research questions that are currently difficult to study. Examples include the earlier mentioned lack of study of long term welfare effects in service dogs as well as aging problems that may arise in these animals. Prospective study may finally help reduce some of the bias risks in studies that use subjective welfare measurements as a main outcome parameter, since questionnaires may be validated to accurately show changes within an individual over time.

### *Measurement strategies*

Two other alterations study designs that can be added to PTSD service dog research, are studies within individuals and studies in controlled standardised settings. Currently most studies to PTSD service dogs are based on the opposite, with comparisons between individuals and outside controlled clinical settings. This was also true for the studies in **Chapters 4, 6, and 7** of this thesis. These chapters studied service dog effect through measurements between individuals in home environments. In doing so the effort necessary from individual participants was minimised. This led to a potential greater number of participants, which helped combat the limited participant availability in service dog research.

Performing measurements between individuals and in a home environment also introduced several risks to study outcome though. For measurements between individuals the most prominent of these risks was high variation between individual participants. High variation makes significant results harder to find. Several measures were thus taken to reduce high variation within the studies of this Thesis. The most prominent of these measures was that only humans and dogs related to one service dog provider were allowed to participate. This ensured similarity in the background of

all participants, since both humans and dogs had received standardised training. The influence of variation could not be fully reduced however, as evidenced by the variation in activity measurements performed in **Chapter 4**. To prevent the influence of high variation the use of measurements within the same individual is therefore advisable for future research.

For home measurements the most prominent risk to study outcome was missing measurements or measurements being performed in poor fashion. Failed or poorly performed measurements may lead to missing values or outliers, which both threaten the reliability of study outcomes. Several measures were thus taken to prevent missing values and outliers within the studies of this Thesis. The most prominent of these measures was the provision of thorough instruction to all participants. Instructions were additionally provided on paper, so participants would have instructions at hand at all time. This could not fully prevent missing values though, as evidenced by missing salivary samples and activity data in **Chapters 4 and 7**. To prevent the influence of missing values the measurement of variables within a controlled settings is therefore advisable for future research.

### **8.4 Future research directions**

To improve study design in future research the use of measurements within individuals and studies in controlled standardised settings are thus advisable. In combination with prospective study this could lead to an entirely new approach to PTSD service dog research. Additionally new study topics might be explored. Throughout this general discussion several topics have already been highlighted in which further study of PTSD service dogs and the effect they have on humans with PTSD is possible. For dogs these topics included the impact of diverse selection, training, and guidance strategies on service dog performance and welfare

#### *The influence of service dog selection methods*

Regarding service dog selection, most service dog organisation currently uses their own criteria to detect potential service dogs at an early age. These criteria do not always guarantee good candidates though, since up to 50% of dogs may drop out during actual training (Batt et al., 2008). Dropout can occur either because of undesirable behavioural traits or because dogs are unable to cope with the required workload. Because of this latter indication a high dropout rate also indicates a danger to animal welfare and can thus be considered undesirable for multiple reasons.

To prevent dropout it is essential to know which traits that are predictive of a good service dog so that dogs can be selected at an early age. Studies by Weiss (2002) and Duffey & Serpell (2012) studied this question and found that certain behavioural



traits for good service dogs can be evaluated via questionnaire scores. The Canine Behavioural Assessment & Research Questionnaire (C-BARQ) is a good example of such a questionnaire (Duffey & Serpell, 2012). Traits of interest in this questionnaire are: (a lack of) aggressiveness, trainability, and (a lack of) excitability. These traits are mainly oriented towards human benefit however, and do not necessarily offer welfare improvement to the service dogs themselves. This is also true for other favourable traits that are mentioned in literature which include; even temperament, intelligence, human directed behaviour, and will to work (Parenti et al., 2015).

Because there are many different favourable traits, it is currently difficult to determine which are the most important or predictive of latter results. These traits additionally do not take animal welfare into account but instead solely focus on the human benefit of dog behaviour. It is therefore recommended that further study is conducted to the behavioural traits of service dogs to determine which predict both the best service dogs and which predict the highest standard of animal welfare. Examples of such studies may include research to the shared genetic background of successful service dogs to predict successful candidates based on gene typing or to the effect of stress exposure in utero and in early life on coping mechanisms in future service dogs.

### ***The influence of service dog training methods***

Besides selection criteria most service dog organisations currently have their own training methods. Some of these methods may be more effective than others. Because all aim to produce the best and most stable service dogs though, it might be beneficial to study which training elements can be shared between organisations. A study by LaFolette et al. from 2019 investigated this question. They found that different training methods for service dogs were associated with different outcomes. Positive reinforcement or bond-based training methods seemed to produce the most positive outcome while positive punishment training methods produced the most negative outcomes. Because of these results it appears that positive reinforcement seems the best training method. It is therefore advisable that organisations adopt this method to ensure the best training outcomes.

This does not mean that the entire training routine of service dogs has been studied however. The study by LaFolette et al (2019) only describes the overall training method and not individual elements of training. Whether a dog should for example be trained for 18 months from an early age (Parenti et al., 2015) or should first receive obedience training as a pet dog is unclear. Further study to this topic is therefore warranted. Examples of such studies may include a comparison between training programs of different service dog organisations on service dog success, or an evaluation of different training programs on service dog welfare parameters.

### ***The influence of service dog guidance strategies***

After selection and training have been completed, service dogs are matched with a human with PTSD. This does not necessarily mean the end of a service dog organisation's involvement though. Placed service dogs may be followed, trained, and checked throughout their entire working life. The manner in which this occurs is not necessarily equal between organisations though. These different strategies may each have a different influence on service dog welfare. Additionally they may influence the degree in which individuals with PTSD feel supported by a service dog, through both the dog itself and the extra care given by the training organisation.

Specific study of follow up strategies in PTSD service dogs is lacking. This currently makes it difficult to determine the influence of individual strategies or elements on dog welfare and human wellbeing. To determine which strategy produces the best service dogs and the best animal welfare further study is therefore warranted. Examples of such studies may include the influence of control visits and retraining on service dog performance and the influence or guidance styles on human well-being and animal welfare.

### ***Retirement issues***

A final question that can be asked regarding service dogs, is whether or not they experience retirement issues. Because the deployment of PTSD service dogs picked up in the last few years, most dogs in the studies of this Thesis were of relatively young age. This means that old age or end of life problems have not been studied. Such problems may include separation from the handler at retirement, handing over service dog tasks to a younger dog, wear and tear of the body over time, and coping with age related diseases. Questions may be asked on how to prepare dogs for these life events and if selection and/or training can influence smooth transitions. Additionally it can be questioned whether current retirement ages for service dogs take wear and tear, and age related diseases into account and if so whether these ages are adequate to prevent welfare issues in old age due to assistance work.

### ***PTSD service dogs for individuals other than veterans and first aid responders***

In addition to dog oriented topics some topics oriented at humans were mentioned earlier in this Chapter. These included the possibility of exploring new objective measures of PTSD service dog effect like medication use (Rodriguez et al., 2021), alcohol abuse, and suicide rates. Because they are objective measurements these variables might provide further insight in PTSD service dog effect without the risk of bias or placebo effect. A significant research investment is needed to study them though, since these variables will all require comparisons over large groups or the same individuals over longer periods of time.



One way to establish such larger groups is via the inclusion of individuals other than veterans and first aid responders in PTSD service dog research. PTSD does not exclusively occur among veterans and first aid responders. Like mentioned in **Chapter 1** there are also individuals who develop PTSD after encountering violence, natural disasters, rape, abuse and other traumatic life events (American Psychiatric Association [APA], 2013). If these groups would benefit from service dogs similar to veterans and first aid responders is unknown however, due to a lack of specific research. It is therefore recommended that the study of service dogs for individuals with PTSD is expanded to include individuals with PTSD of different origins. Studies could for example include rape victims or those who suffer from complex trauma that is difficult to treat with conventional methods.

### *What makes someone qualified for a service dog?*

With a potential larger number of individuals that apply for a service dog it can be questioned which aspects make someone qualified to receive a service dog. Currently different service dog organisations each use their own set of criteria to select individuals that will receive a service dog. These criteria are mostly based on experience with prior service dog allocations and include various behavioural aspects. These aspects might for example include the absence of anger issues, presence of animal oriented behaviour, and a will to invest in a relationship with the service dog. Some organisations additionally require that someone has already undergone several PTSD treatments before applying, which further extends the already long waiting period for service dogs (Winkle et al., 2012).

Taken together these aspects form a long list of criteria that have to be fulfilled before a service dog can be received. Because this leaves many opportunities to be rejected for a service dog, training organisations should be wary of disappointment in applicants. Even if a match is successfully found there is always the possibility of the match failing later on due to altering circumstances or accumulating welfare issues. Because of these possibilities it is thus paramount that service dog training organisations have clear standards which help identify suitable and less suitable candidates throughout the entire life of a service dog, and that these standards are shared between organisations to help those with less experience in the field. Though perhaps a controversial topic, part of these standards could be a cost benefit analysis in which it is determined whether the placement of a service dog is a valuable contribution to an individual's existing treatment plan. Because the costs of training a service dog are high and a potential infringement is made on animal welfare, it could be argued that only individuals in which great reduction of symptom severity is expected should be eligible for a service dog. Individuals in which less improvement is expected or who present less severe symptomatology may be helped with less extensive forms of AAI like animal assisted therapy instead.

## **8.5 Concluding remarks**

In conclusion it can be stated that the field of PTSD service dogs is still a developing one. Research into its underlying mechanisms is currently limited due to small numbers of human-dog combinations. Nevertheless some measurements have shown consistent results across studies. Between the studies of **Chapter 4**, Stern et al. (2013), Kloep et al. (2017), Vincent et al. (2017), Yarborough et al. (2017), Rodriguez et al. (2018), and Lessard et al. (2020), it seems apparent that the provision of PTSD service dogs reduces PTSD symptoms and improves quality of life. Whether this is because of the dog or because of the service surrounding the dog remains to be seen. What also remains to be seen is whether the service dog helps because of its performance or because of the support from the training organisation. Evidence from objective measurement (Rodriguez et al., 2018; Lessard et al., 2020) suggests that the service dog does make a difference yet a definitive answer via randomised study remains absent. What should be questioned though is whether or not a definitive answer to this question is necessary. Like stated above, the service dog has proven effect. Where this effect stems from is a secondary question and mostly interesting from a financial and scientific point of view. From the viewpoint of those that are helped by a service dog however, the allocation of a service dog changes their life for the better. It returns an individual's sense of worth and is able to do so without major short term costs to animal welfare (**Chapters 5, 6 and 7**) if guided properly. Based on the findings in this thesis the evidence is therefore favourable to continue providing service dogs to veterans with PTSD. Further study of specific aspects is still advisable though to help broaden the understanding of service dog effect. Additionally research should be performed focussing on the long term welfare effects of service on service dogs to determine if they are a suitable long term solution, or if other less intensive forms of AAI like animal assisted therapy should be considered.



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# Addendum



## Dutch Summary

### Posttraumatisch Stress Stoornis

Het komt helaas voor dat veteranen, politiemensen, en andere geüniformeerden een Posttraumatisch Stress Syndroom (PTSS) ontwikkelen. PTSS is het gevolg van een zeer stressvolle of zelfs traumatische gebeurtenis in iemands leven en is zeer ingrijpend voor zowel de persoon zelf als dienst naasten. De traumatische gebeurtenis blijft als het ware keer op keer terugkeren in de vorm van herbelevingen en/of nachtmerries. Door deze constante herinnering aan de traumatische gebeurtenis kunnen mensen angstig worden, terneergeslagen of depressief zijn, niet goed meer kunnen slapen, en plekken, geluiden of mensen gaan vermijden omdat zij herinneren aan het trauma.

Er zijn verschillende mogelijkheden beschikbaar om de negatieve gevolgen van PTSS te bestrijden. De 1e stap is altijd om het dialoog aan te gaan, of dat nu is met een getraind behandelaar of met iemand anders die men in vertrouwen kan nemen. Dit zorgt er namelijk voor dat de gevoelens van de persoon met PTSS gehoord worden en een plan naar herstel kan worden opgesteld. Dit plan kan vele verschillende elementen omvatten waaronder; gesprekken met een gespecialiseerde psycholoog/psychiater, gedrag therapie, exposure therapie, groeps gesprekken, EMDR therapie, en medicatie.

### Hulphonden voor veteranen met PTSS

Daarnaast is het in Nederland voor veteranen en geüniformeerden met PTSS sinds enkele jaren mogelijk om een hulphond aan te vragen. Deze speciaal getrainde hond is 24/7 bij zijn toegewezen persoon en is getraind om hem/haar te ondersteunen tijdens stressvolle momenten. Dit doet de hond onder andere door samen met zijn persoon naar stressvolle situaties te gaan, en door zijn persoon erop te wijzen als deze gestrest raakt. Op deze manier voelt de persoon met PTSS zich gesteund en kan deze op tijd een rustige plek opzoeken of hulp inschakelen als het hem/haar allemaal even teveel wordt.

### Het onderzoek

Helaas was en is er nog maar weinig wetenschappelijk onderzoek naar de inzet van hulphonden bij PTSS. Hierdoor is het moeilijk met zekerheid vast te stellen welk aspect van de hond precies ondersteund. Is het de omgang met de hond, zijn training, de begeleiding van de hondentrainers, of misschien een combinatie van deze factoren? Omdat de ervaringen van mensen met PTSS die al een hulphond hebben echter zeer positief zijn, is onderzoek gedaan naar de inzet van hulphonden binnen dit promotieonderzoek. Hiertoe zijn in totaal zes onderzoeken uitgevoerd.

In het eerste onderzoek is onderzocht welke en hoeveel wetenschappelijke literatuur reeds beschikbaar was over de inzet van PTSS hulphonden. Er is hierbij in eerste instantie

gekozen om te kijken naar de specifieke inzet bij veteranen, omdat zij wereldwijd een van de grootste en meest onderzochte groepen zijn van mensen met PTSS. Het onderzoek is uitgevoerd door middel van een literatuur studie waarvan de resultaten zijn gepubliceerd in 2018 (**Hoofdstuk 2**). Uit deze resultaten kwam naar voren dat er enkele kern thema's waren waarover binnen de PTSS hulphonden literatuur wordt gesproken. Deze thema's zijn: de definitie van een PTSS hulphond, verschillen in de selectie en opleiding van PTSS hulphonden, de sociale en fysieke voordelen die een PTSS hulphond biedt, de kosten en beschikbaarheid barrières rondom PTSS hulphonden, het welzijn van PTSS hulphonden, de verwachtingen die veteranen hebben van PTSS hulphonden, bedenkingen bij PTSS hulphonden, de rol van PTSS hulphonden in een behandelplan, en 'best practice' voor PTSS hulphonden. Van al deze thema's individueel was helaas slechts beperkte literatuur beschikbaar. Daarnaast was het beschikbare onderzoek hoofdzakelijk gebaseerd op subjectieve metingen en observaties. Het was daarom moeilijk om onweerlegbare antwoorden te formuleren op vele vragen binnen de thema's en rondom de inzet van PTSS hulphonden voor veteranen in het algemeen. De overkoepelende conclusie van de literatuurstudie was daarom dat er meer gedegen en objectief onderzoek naar deze inzet noodzakelijk was waarbij ook objectieve maatstaven dienden te worden gebruikt.

Het tweede onderzoek (**Hoofdstuk 3**) binnen dit proefschrift betreft een validatie van de Nederlandstalige Monash Dog Owner Relationship Score vragenlijst (MDORS). Deze vragenlijst bevroegde de relatie tussen mens en hond vanuit het menselijk perspectief en produceert aan de hand hiervan een score die tussen individuen te vergelijken is. Deze score is van groot belang in het onderzoek naar PTSS hulphonden aangezien deze inzage geeft in de waarde die een persoon aan zijn hulphond toekent. Omdat de MDORS echter nog niet in het Nederlands was gevalideerd, was deze niet volledig betrouwbaar voor onderzoek bij Nederlands sprekende personen. Om een Nederlands validatie te verkrijgen is de Originele Engelse MDORS vragenlijst allereerst vertaald naar het Nederlands. Vervolgens hebben vijf experts op het gebied van mens hond relatie de vertaalde vragenlijst beoordeeld. Toen zij geen bezwaren hadden tegen de lijst is deze door 501 mensen met een hond ingevuld. Van deze 501 hebben 88 de lijst daarna na twee weken nogmaals ingevuld. Uit deze metingen kwam naar voren dat drie vragen van de vragenlijst in het Nederlands niet langer relevant leken voor de algehele uitslag van de vragenlijst. Het advies was dan ook om deze vragen uit de vragenlijst te verwijderen. Daarnaast werd geadviseerd om alle vragen betreffende interactie tussen mens en hond te verwijderen omdat deze niet door eenieder gelijkwaardig konden worden ingevuld. Tenslotte werd geadviseerd om enkele vragen toe te voegen om balans tussen kosten en baten elementen te verbeteren.

Het derde onderzoek (**Hoofdstuk 4**) binnen dit proefschrift betreft een onderzoek naar de invloed van hulphonden op veteranen en hulpverleners met PTSS. Voor dit

onderzoek zijn verschillende groepen mensen met elkaar vergeleken. Allereerst hebben 20 veteranen/hulpverleners met PTSS en een hulphond deelgenomen aan het onderzoek, daarnaast hebben er ook 10 met PTSS en een huishond en 12 met PTSS zonder hond deelgenomen. Tenslotte hebben 23 veteranen zonder PTSS deelgenomen aan het onderzoek. Allen hebben zij drie metingen uitgevoerd die vervolgens tussen de verschillende groepen zijn vergeleken. Deze metingen waren 24 uur een activiteitenmeter dragen, 10 speekselmonsters inleveren verdeeld over twee dagen en enkele vragenlijsten over hun welzijn invullen. Uit de gegevens die op deze manier zijn verzameld is gebleken dat veteranen met een hulphond hun eigen welzijn, slaap kwaliteit hoger inschatten terwijl zij hun PTSS symptoomlast lager inschatten dan deelnemers met een huishond. Wel schatten zij zichzelf slechter in dan de veteranen zonder PTSS. Dit wijst erop dat de gevolgen van PTSS mogelijk worden verlicht maar niet geheel worden weggenomen door de aanwezigheid van een hulphond. Er was daarnaast geen verschil te zien tussen de speekselmonsters van deelnemers en weinig tot geen verschil in de metingen van activiteit. Hierin was wel een verschil te zien tussen deelnemers met een hulphond en de controle groep maar niet met de groep zonder hulphond. Omdat een dergelijk verschil in een eerder studie wel is gevonden is verder onderzoek noodzakelijk. Al met al duiden de resultaten er daarom op dat mensen met PTSS en een hulphond minder last hebben van PTSS symptomen dan individuen zonder hulphond. Dit is echter moeilijk te meten in lichamelijke reacties en het gedrag van mensen, welke tevens niet lijken te zijn gekoppeld aan het welzijn dat mensen beleven. Met name door dit laatste moet worden overwogen welke van de twee belangrijker is om de effectiviteit van hulphonden te beoordelen; objectieve waarneming aan lichaam en gedrag of de beleving die mensen hebben van hun eigen welzijn.

In het vierde, vijfde, en zesde onderzoek binnen dit proefschrift is gekeken naar het welzijn van hulphonden. Zo is in het vierde onderzoek (**Hoofdstuk 5**) gekeken naar de hoeveelheid cortisol die PTSS hulphonden afscheiden via hun speeksel tijdens een training. Door cortisol te meten voor en na een gebeurtenis kan de aan- of afwezigheid van een stressreactie op deze gebeurtenis worden bepaald. In deze studie is daarom bij 19 hulphonden een dergelijke meting afgenomen tijdens een trainingmiddag. Tijdens deze trainingmiddag werd op totaal vier momenten rondom de training metingen uitgevoerd; 15 minuten na aankomst op het trainingsveld, vlak voor de training, vlak na de training, en afsluitend na een rustperiode. Uit de resultaten is gebleken dat honden direct na de training minder cortisol in hun speeksel hadden dan voor de training. Ook was het verschil tussen honden kleiner na dan voor de training. Dit duidt erop dat de honden de training niet als stressvol ervoeren.

Het vijfde onderzoek (**Hoofdstuk 6**) betreft een onderzoek naar de verschillen in haar cortisol tussen huishonden en PTSS hulphonden. Alhoewel de exacte mechanisme nog

niet bekend zijn lijkt het erop dat cortisol uit het bloed wordt ingebouwd in haar tijdens de haargroei. Door deze inbouw kan haar worden gebruikt om de cortisol concentratie van een lichaam over langere tijd te bestuderen. In deze studie hebben we het verschil in haarcortisol onderzocht tussen 11 hulphonden en 19 huishonden. Tussen deze twee groepen hebben we geen verschil in haarcortisol gevonden. Tevens was er geen invloed van leeftijd, geslacht, haarkleur, en afname seizoen op de hoeveelheid gevonden haarcortisol. Wel leek er een invloed te zijn van de aanwezigheid van andere huisdieren, waarin honden die met andere dieren samenleefden een hoger haarcortisol hadden dan honden die alleen of enkel met andere honden samenleefden. Dit was echter niet significant. Al met al duiden de resultaten er dus op dat er weinig tot geen verschil is tussen het haarcortisol van huishonden en de PTSS hulphonden in onze studie.

Het zesde en laatste onderzoek (**Hoofdstuk 7**) betreft een onderzoek naar de invloed van assistentie werk op het activiteitenpatroon en speekselcortisol niveau van hulphonden. Uit eerdere studies is gebleken dat gedomesticeerde honden met name tijdens de dag actief zijn en rusten tijdens de nacht. Doordat een hulphond echter op elk moment van de dag om hulp gevraagd kan worden wordt dit natuurlijke ritme mogelijk verstoord. Om te onderzoeken of er verstoring plaatsvindt is het activiteiten patroon van 20 hulphonden vergeleken met dat van 23 gezelschapshonden. Uit de resultaten bleek dat de hulphonden geen ander activiteitenpatroon hadden dan de huishonden. Daarnaast was nagenoeg geen verschil in speeksel cortisol niveaus te zien behalve in de avond vlak voordat de eigenaar naar bed ging en in de ochtend 15 minuten nadat de eigenaar was opgestaan. Deze niveaus waren hoger bij de huishonden al was variatie hierin ook hoog. Het is daarom mogelijk dat het verschil is veroorzaakt doordat sommige honden net voor het afnemen van het monster werd uitgelaten, omdat activiteit een verhoging van cortisol kan geven. Al met al duiden de resultaten er dus op dat er weinig tot geen verschil is tussen de activiteitenpatronen van hulphonden en huishonden. Mogelijk is er een verschil tussen de cortisol niveaus van deze twee groepen honden al kan dit verschil ook veroorzaakt zijn door een verschil in kortstondige activiteit.

## Conclusie

Als conclusie van dit proefschrift kan het volgende worden gesteld. PTSS-hulphonden zijn nog volop in ontwikkeling. Onderzoek naar de manier waarop honden mensen met PTSS ondersteunen is momenteel beperkt vanwege het kleine aantal mens-hond combinaties. Desalniettemin zijn consistente resultaten te zien tussen onderzoeken. Meerdere studies laten zien dat hulphonden PTSS-symptomen verminderen en de kwaliteit van leven verbeteren. Of dit komt door de hond of door de ondersteuning rondom de hond is echter onduidelijk. Wat ook nog onduidelijk is, is of de hulphond helpt vanwege zijn aanwezigheid of vanwege de hulp die hij geeft. Dit laatste onderscheid is een van de belangrijkste vragen van recent onderzoek geweest, maar blijft gedeeltelijk

onbeantwoord. Bewijs uit objectieve metingen suggereert dat de hulphond wel degelijk een verschil maakt, maar een definitief antwoord via gerandomiseerde studie ontbreekt. Wat echter de vraag moet zijn, is of een definitief antwoord op deze vraag nodig is. Zoals hierboven vermeld, heeft de hulphond bewezen effect. Waar dit effect vandaan komt is een secundaire vraag en vooral interessant vanuit financieel en wetenschappelijk oogpunt. Vanuit het oogpunt van degenen die worden geholpen door een hulphond, verandert de toewijzing van een hulphond hun leven ten goede. Hij geeft het gevoel van eigenwaarde van het individu terug en doet dit zonder duidelijke kosten voor dierenwelzijn (**Hoofdstukken 5, 6 en 7**) mits de hond goed wordt begeleid. Het lijkt daarom raadzaam om de verspreiding van hulphonden voort te zetten om het welzijn van mensen met PTSS te verbeteren. Verdere studie van specifieke aspecten is daarnaast raadzaam om het begrip van het hulphonden en de mogelijke lange termijn effecten voor dierenwelzijn te verbreden.



## About the author

Emmy van Houtert was born on the 30<sup>th</sup> of march 1993 in Breda the Netherlands. In 2011 she started her Bachelor studies Animal Sciences at Wageningen University in the Netherlands. In 2014 She finished this study with a specialisation in Terrestrial animals, and environmental education. That same year she enrolled in the Master Animal Sciences, also at Wageningen University. During her Master studies she specialised further in the direction of Animal health and behaviour. She went on to completed a Master thesis and research internship, both focussing on the interaction between humans and dogs. Her thesis considered the effect of human vocal pitch and body posture on the response time to commands in companion dogs. Her internship was conducted at the working dog school of the Royal Dutch Air force where she observed the manner in which handler behaviour influenced tracking results in dogs. In 2016 she obtained her Master degree and went on to orientate herself on a future career path. This lead to a PhD position in 2017 at the faculty of Animals in Science and Society of Utrecht University.



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## List of publications

### Chapter 2

van Houtert, E. A., Endenburg, N., Wijnker, J. J., Rodenburg, B., & Vermetten, E. (2018). The study of service dogs for veterans with Post-Traumatic Stress Disorder: a scoping literature review. *European journal of psychotraumatology*, 9(sup3), 1503523.

### Chapter 3

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### Chapter 4

To be submitted to *Frontiers in Psychiatry*

### Chapter 5

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### Chapter 6

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### Chapter 7

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