The validity of the modified shelter test in the context of the risk-assessment part 2

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ABSTRACT

More than 150 000 dog-bite incidents with regard to people occur in Holland every year. These bite incidents may have frightening effects on those involved. It is recommended for a bite victim (person), or for the owner of a bite victim (dog) to have a police report made about this incident. Depending on the situation at hand the culprit dog can be taken into custody where the dog is kept in a cage in a shelter for a while. After adjusting to the environment this dog will be undergoing a behaviour test, performed by behaviour specialists. 16 Different subtests will be performed and any threat and or bite behaviour shown in these subtests will be documented. Distinction between threat and bite behaviour is made during these subtests. The overall outcome of the subtests combined with data on the biting incidents and persons involved provide the eventual advice for this culprit dog. These eventual advices can be determinative in terms of the justice department taking these into account in their decision making processes. This means it is important to make use of a reliable test which provides reliable information. To investigate this validity, we compare the behaviour documented in the police report to the behaviour shown in the test, and sensitivities, specificities, positive predictive values and negative predictive values will be calculated to determine the validity of the shelter test. This was already done in 2012 and the current research is a repeat of this validity test. The benefit of this repeat is a higher number of tested dogs with a useful police report, so this ensures a higher sample size including a more reliable outcome.

The sensitivity of biting towards persons and/or dogs in the PR vs. biting towards persons and/or dogs in one of the test elements is 0.59. This value is slightly decreased compared to the research result of 2012. The specificity did increase 0.01 point to 0.65 in the dataset of 2008-2015. Still the specificity of the entire test was low because there is no control group of dogs with no bite history. Police reports may be unreliable as regards data on non-occurrence of bite incidents: owners will generally not be interested to mention other biting incidents caused by their dog. This means that if in the police reports mention has been made of a dog-dog biting incident only, this does not necessarily mean that no persons have been bitten. To make a complete reliable conclusion about the validity of this research a bigger sample size is wanted that should include non-biters. Sometimes the sensitivities of subtests are not high enough. The sensitivity of the subtests with dolls included is low. In these subtests a comparison is trying to be made between bite behaviour towards children versus bite behaviour towards dolls. This might be because dogs do not recognize the dolls as being children.

INTRODUCTION

More than 150 000 dog-bite incidents involving persons occur in Holland every year. These bites vary from mild to very serious. Grown-ups are often bitten in arms and legs, while children are often bitten in their face (Kenneth A. Gershman, 1994). In about 48 000 incidents a year people have to go to the hospital for first aid and sometimes even plastic surgery is necessary (Cornelissen, 2008).
In Holland not only the bite-incidents with people involved are a problem, but a lot of times the bite-victim is another dog. In some cases the victim dog even gets killed by another dog. All of these situations can be very traumatizing for both the human-victim, owner of the victim dog and the dog itself. There are people who suffer from post-traumatic-stress-syndrome after a situation like this. Some people even have to quit their job because of this PTSD. Registration of dog-dog biting incidents may occur only locally and this registration will not be complete.

To do something about this growing problem it is recommended for human-victims and for the owner of the victim-dog to go to the police to have a police-report made about the incident. Only then it is possible to document all of the bite-incidents that occur in one community, and to make a plan or protocol to prevent these terrible situations. Nevertheless, often there is no police-report drafted because 70% of the bite-incidents involves a familiar dog of the victim (Cornelissen, 2008). People are afraid the dog will be taken in custody and that is why they do not go to the police to report the situation. When the police-report is documented, the culprit dog can be taken into custody. The dog will be brought to a temporary residence where the dog will be tested by dog behaviourists who use behaviour tests as part of a risk-assessment. The test used in Utrecht is based on the Shelter-test developed by Van de Borg et al (1991) and which has been adapted over the years. Every now and then this test is evaluated and adapted where necessary, to make sure that the test will be as reliable as possible. In this test a range of stimuli is used, including humans, animals and visual -and acoustic stimuli from objects (Van der Borg, 1991). The sequence of the entire test is constructed in such a way that the first subtests are less provocative than the last subtests to prevent unreliable outcome of the tests due to stress of the dog. The specification of this test will be explained later on in this research.

The main goal of this shelter-test is to find out what triggers the aggressive behaviour in the culprit dogs and if this behaviour can be provoked easily. Also the way in which a dog tries to attack contains important information. The view that aggressive potential is linked to dog breed is a point of serious concern as a dog's tendency to bite and show aggressive behaviour depends on more than just genetics, and other factors such as heredity, experience, socialisation and training, health, and victim behaviour all play a role (Cornelissen, 2009). So it is crucial to use a reliable test because the outcome can be very determinative. It is not exceptional that a dog needs to be put down after a bite-incident in combination with an negative outcome of this test. When the outcome of the test is more positive, an evaluation of reassignment or intensive training will be considered.

In this paper the validity of the shelter-test will be examined in comparison with the threat- and bite incidents that were reported by the police (PR). Therefore, the values of the sensitivity, specificity, positive predictive value and negative predictive value of the complete test were used. Also of each subtest these values are calculated. To use the value of the validity of this test it is only possible to make use of the sensitivity of the complete test because the population that was used were dogs that were only involved in bite-incidents. When the sensitivity is high it means that there is a small amount of false-negatives (the number of dogs that have bitten in real, but didn't show any bite-behaviour during the subtests). It is therefore important to reach a high sensitivity (Van der Borg J. U., 2003). The calculated specificity would be very unreliable. Not much false-positives will be seen because all dogs involved in this test did bite once in the PR.

The first research on the validity of the shelter-test was done in 2012, where the incidents that occurred in 2008, 2009, 2010, 2011 and 2012 were included. This research is a continuation of that research. The current paper will include data from 2008 until 2015. This way the test includes the information of 8 years instead of 5 years. The questions to be answered are: what are validation values for the data sampled in 2008-2015, are these different from those sampled earlier (2008-2012) and what are validation values over the total population of seized dogs. Moreover, we want to know to what degree subtests are valid. By including more dogs we hope the outcomes will be more reliable, and the goal is to achieve a more positive outcome by reaching the number of the calculated sample sizes we need.

MATERIALS AND METHODS

Over the years in this research, 449 dogs have been tested in the shelter-test from 2008 until 2015. These dogs all have a bite history (and some of them will possibly have a threat history as well) documented in a police report (PR) or in a case report of the community. The exact meaning of the terms bite and threat will be explained later on in this paper. Also, a distinction was made between threat- and bite behaviour during each subtest. From every dog the breed and sex are documented: 292 males (of which 50 neutered, 28 unknown) and 151 bitches (1 neutered, 115 unknown) and 6 dogs of unknown sex. In the outcome of the subtests a difference will be made between threat behaviour and bite behaviour. Because all of the joggers involved in a dog-bite situation did not know if they were threatened before they were bitten. That is the reason why threat behaviour involving joggers was not calculated.

Test procedure

When a dog is taken into custody it is a standard procedure that the dogs are checked by a veterinarian to make sure they are healthy. If not then this information will be included in the eventual outcome and advice. When the dogs are used to their new and temporary environment they are ready to be tested. This is a standardized test (appendix 4) which includes 16 different subtests, which are ordered in such a way that first subtests being less stressful in comparison to the last subtests which are more provocative. Every single subtest is always performed by the same test-persons and the same test-materials to prevent unreliable and divergent outcomes. Some liberty is taken when dogs appear to be very anxious: in these cases some subtests may be skipped, a short recovery time being included and sausages being provided to the dogs by means of counterconditioning.

Table 1: Short specification of all subtests

Test number	*Description*	Test number	*Description*
1	Friendly approach to the dog in kennel Fixed eye-contact Walking along the dog's kennel	*9*	Confrontation with different dolls - a. Large doll - b. Roxanne doll (doll on a stick) - c. Dark doll
2	Leashing and transport	*10*	Opening and laying down of an umbrella
3	Commands: come here, sit and down	*11*	Loud horn
4	Petting the head and if possible the back and hind limbs with a fake hand	*12*	Taking away the manger Petting during eating
5	Playing with a toy	*13*	Confrontation with real life dogs - a. Large dog - b. Small dog
6	Pull play with a toy	*14*	Passing jogger - a. With fake hand - b. Without fake hand
7	Being threatened by a male person	*15*	Being surrounded by 3 persons
8	Being threatened by a female person	*16*	Threatening of the dog-keeper

The sequence of the test is standardized as well and a deviation of this sequence will only occur when circumstances (e.g. fear in the dog) necessitate a change. No calculation of the subtests 2 and 3 were made because they are not that informative about the threat or/and bite-behaviour towards persons or other dogs. The complete protocol of the entire shelter test is included in appendix 4.

In table 2 the definitions used for threat and bite behaviour are documented. Since 2014 subtests 7 and 8 have been performed between subtests 15 and 16, as of 2015.

Table 2. Definitions of aggressive behaviour (Haverbeke, 2009)

Aggressive biting

Biting / falling out: The dog moves forward fast and opens and closes his mouth. Contact between teeth and skin takes place or the dogs attempts to do this (potentially combined with showing teeth, growling and barking).

Snapping: A bite-movement whereby the mouth opens and closes quickly (potentially combined with showing teeth, growling and barking) with a short bite forwards or a quick movement of the head, without making any real contact with an object.

Aggressive threatening:

Growling: A way of low/soft , continuous dark sounding vocalization.
Barking: Short bark-sound, with or without repetition, while looking at de tester or an object.
Showing teeth: Pulling up the upper lip to show the teeth.
Staring / fixating: Fixating look to the tester or the object, together with stiffening of the body.
raising the hackles: Brushing up the hair on the shoulder-region and of the hair on the lower back

Interpretation of the behaviour in the test

The goal of this research is to evaluate the behaviour written down in the PR, compared to the behaviour seen during the subtests. The comparison between these separate data will show the validity of the test that is used. So a distinction between threat and/or bite-behaviour as mentioned in the PR was made, as well as threat and/or –bite behaviour shown in the behaviour test. This distinction was made over the behaviour of the entire test, but also for every subtest separately.

For the interpretation of the test it is very important to realize that biting, snapping, and a restrained attempt to bite is all counted as bite-behaviour. So if one of these behaviours is seen, it is registered as a bite. Pulling up the upper lip, showing teeth, growling and barking are all counted as threat-behaviour. Also staring/fixating and raising the hackles are interpreted as threat-behaviour.
When any kind of aggressive behaviour seen in the test was not towards the test persons or test-materials, it was not counted as being threatening or biting. In every subtest, with exception of subtest 2 and 3, threat and/or -bite behaviour was tested and documented.

A comparison is made between threat and/or bite behaviour in the PR and threat and/or bite behaviour in the test. This comparison was made for the entire test, but also for each subtest separately. By calculation the outcomes of this comparison the following parameters could be determined.

- The sensitivity in relation to bite behaviour towards persons and/or dogs
- The specificity in relation to bite behaviour towards persons and/or dogs
- De positive predictive values of bite behaviour towards persons and/or dogs
- The negative predictive values of bite behaviour towards persons and/or dogs
- The sensitivity in relation to threat behaviour towards persons and/or dogs
- The specificity in relation to threat behaviour towards persons and/or dogs
- The positive predictive values of threat behaviour toward persons and/or dogs
- The negative predictive values of threat behaviour towards persons and/or dogs

Validation method

Hypothesis:
H_0: When a dog threatens and/or bites a person or another dog in the PR, he/she also shows threat and/or bite behaviour towards persons or dogs in the test. H_1: When a dog does not have a threat and/or bite history in the PR, he/she also doesn't show threat and/or bite behaviour during the test.

The validation of the test was determined by calculating the sensitivity and the specificity of the tests.

Sensitivity	The number of dogs with threat and/or bite history, which also shows threat and/or bite behaviour in the test.
Specificity	The number of dogs without threat and/or bite history, which also shows no threat and/or bite behaviour in the test.
Positive predictive value	The part of the dogs tested that showed threat and/or bite behaviour in the test, also has a threat and/or bite history.
Negative predictive value	The part of the dogs tested that didn't show threat and/or bite behaviour in the test, also did not have a threat and/or bite history.

For this calculation a standard table was used. (Table 3)

Table 3 (Petrie, 2006)

	Dog with threat/bite history	Dog without threat/bite history	Total
Dog with threat/bite behaviour in test	A	B	A + B
Dog without threat/bite behaviour in test	C	D	C + D
Total	A + C	B + D	(A + C)+(B+D) or (A+B) + (C+D)

Sensitivity: A / (A + C) Positive predictive value: A / (A + B)
Specificity: D / (B + D) Negative predictive value: D / (C + D)

The value of the sensitivity and specificity depends on the prevalence of threat and bite behaviour; if this prevalence is low a high number of false positives can be found, even if the specificity of the test is high. The higher the prevalence, the bigger the chance that a positive test is reliable (Petrie, 2006).
The positive predictive value says something about whether a dog is justly counted as being aggressive. The negative predictive value says something about whether a dog is justly counted as being not aggressive after a negative test result. So eventually a test with a high sensitivity and a high specificity is necessary (because a low number of false positive and negative results are desirable). Unfortunately, a decision needs to be made between a high sensitivity or a high specificity because it is not possible to develop a test where both these values will be high. Due to the subject of the shelter test: aggressive dogs that can threat and/or bite people or dogs, safety is very important. That is the reason why it is important to desire a test with a high sensitivity, to minimize the number of false-negatives. When a dog is counted as being false-negative, it means that this dog did show threat and/or bite behaviour in the PR (so this dog has proven to show aggressive behaviour), but did not show any of this behaviour in the test (so the advice for this dog could be too mild).
Dogs could only participate in this research when there was any bite behaviour towards dogs or persons. Dogs that showed aggressive behaviour towards other subjects like cattle, sheep or cats could nog participate because these objects are not included in the subtests. So this behaviour could not be tested in a test situation. When the information from a PR was incomplete the dog was not participating in this research. Sometimes it happened that a dog was too stressed or excited after a certain subtest to proceed with the other subtests. The information of the subtests that were taken are processed in this research. Those subtests that were not fulfilled were counted as unknown.
If a dog showed aggressive behaviour towards another dog in the PR, there is not necessarily aggressive behaviour towards persons seen as well. In cases where a dog only showed aggressive behaviour towards another dog in the PR, these dogs can be used as control dogs to calculate the specificity of a test where aggressive behaviour towards persons in the PR is compared to showing aggressive behaviour towards persons in the test. The expectation, which helps a specificity to increase, would be that a dog that does not show aggressive behaviour towards persons in the PR does not show this behaviour in the subtests too.

95% Reliability interval

To determine the real reliability of the outcome of calculations of the sensitivity and the specificity, the 95% reliability interval is used (95% CI) (Petrie, 2006). To calculate the reliability intervals, the calculated values of table 3 were used.

The 95% CI for

sensitivity (sens) =

$$\left(Sens - 1.96\sqrt{\frac{sens(1-sens)}{a+c}}, \quad sens + 1{,}96\sqrt{\frac{sens(1-sens)}{a+c}} \right)$$

The 95% CI for specificity (spec) =

$$\left(Spec - 1.96\sqrt{\frac{spec(1-spec)}{b+d}}, \quad spec + 1{,}96\sqrt{\frac{spec(1-spec)}{b+d}} \right)$$

Minimal sample-size

The minimum number of dogs that need to be tested for a reliable outcome of the entire test also needs to be calculated. That is why the value of the minimal sample size for the sensitivity and specificity is determined. (Petrie, 2006)

Data analysis

To document information from the PR and the behavioural tests Microsoft EXCEL was used. Each behaviour was divided in threat and bite behaviour. Each action has its own table in EXCEL. For each subtest a 0 (zero) and a 1 score is filled in. A 0 means that the threat and/or bite behaviour was absent. The score of 1 means threat and/or bite behaviour was seen in the PR or in the subtests. In some cases information was unknown, in these cases the score 2 was used. Information in the PR is naturally concentrated to the incident but in the PR also questions about previous incidents are asked to the people involved. This way also information of other incidents can he included in the research. Often there is no previous threat and/or bite behaviour seen. A 0 (zero) is filled in at all the other behaviour then mentioned in the PR.

RESULTS

Frequency of threat and bite behaviour in the complete test (2008-2015)

In the complete test 449 dogs have been used. 79 Of these dogs did not show any threat behaviour at all in the test (17.6% false-negatives). 189 Dogs did not show any bite behaviour at all during the test (42% false-negatives). 366

Dogs threat at least ones during the test and 256 dogs bit or attacked at least once during the test. The outcome of the results and calculations are written in appendix 1 and 2.

Sometimes it happens that a dog is in a fight with another dog, while a person tries to separate the dogs from each other. In those cases it is possible that a dog also bites a person, while this person is interfering with the dogs. As can be seen in the next tables, a difference was made between these dog bites: when a dog bites a person during a fight with another dog, this dog is counted as a human-biter (table 4) , but also a table is made where these dogs are not counted as human-biters, because this bite can be seen as 'accidental-bite'(table 5).
Making a distinction between those tables increases the reliability of this test, because it is possible that a dog that bites a person during a dog-fight, never intended to bite a person at all. So for these dogs it is likely they will not threat and/or bite during a test with a human involved (true-negative).

Dogs that have bitten persons in conflict with another dog are counted as 'human-biter'

***Table 4**: Group of dog: when biting and threatening persons and dogs during the whole test will not be accepted. Dogs which have bitten persons in conflict with another dog are counted as 'human-biter'. Data on the complete set of tests.*

Threat and/or bite in at least one PR-component vs **threat and/or bite** in at least one test-component

	Threat/bite history	**No threat/bite history**	Total
Positive test	365	17	382
Negative test	56	7	63
Total	421	24	445

Sensitivity: 0.87 Positive predictive value: 0.96 False negatives: 56
Specificity: 0.29 Negative predictive value: 0.11

Threat in at least one PR-component vs **threat** in at least one test-component

	Threat history	**No threat/bite history**	Total
Positive test	112	251	363
Negative test	18	61	79
Total	130	312	442

Sensitivity: 0.86 Positive predictive value: 0.31 False negatives: 18
Specificity: 0.20 Negative predictive value: 0.77

Threat in at least one PR-component vs **bite** in at least one test-component

	Threat history	**No threat/bite history**	Total
Positive test	83	172	255
Negative test	47	140	187
Total	130	312	442

Sensitivity: 0.64 Positive predictive value: 0.33 False negatives: 47
Specificity: 0.45 Negative predictive value: 0.75

Bite in at least one PR-component vs **bite** in at least one test-component

	Bite history	**No threat/bite history**	Total
Positive test	244	11	255
Negative test	169	20	189
Total	413	31	444

Sensitivity: 0.59 Positive predictive value: 0.96 False negatives: 169
Specificity: 0.65 Negative predictive value: 0.11

Bite in at least one PR-component vs **threat** in at least one test-component

	Bite history	**No threat/bite history**	Total
Positive test	342	23	365
Negative test	71	8	79
Total	413	31	444

Sensitivity: 0.83 Positive predictive value: 0.94 False negatives: 71
Specificity: 0.26 Negative predictive value: 0.10

Dogs that have bitten persons in conflict with another dog are <u>not</u> counted as 'human-biter'.

Table 5*: Group of dog: when biting and threatening persons and dogs during the whole test will be accepted. Dogs which have bitten persons in conflict with another dog are* ***not*** *counted as 'human-biter'.*

Threat and/or bite in at least one PR-component vs **threat and/or bite** in at least one the test-components

	Threat/bite history	**No threat/bite history**	Total
Positive test	365	17	382
Negative test	56	7	63
Total	421	24	445

Sensitivity: 0.87 Positive predictive value: 0.96 False negatives: 56
Specificity: 0.29 Negative predictive value: 0.11

Threat in at least one PR-component vs **threat** in at least one test-component

	Threat history	**No threat/bite history**	Total
Positive test	111	252	363
Negative test	18	61	79
Total	129	313	442

Sensitivity: 0.86 Positive predictive value: 0.31 False negatives: 18
Specificity: 0.19 Negative predictive value: 0.77

Threat in at least one PR-component vs **bite** in at least one test-component

	Threat history	**No threat/bite history**	Total
Positive test	83	173	256
Negative test	46	140	186
Total	129	313	442

Sensitivity: 0.64 Positive predictive value: 0.32 False negatives: 46
Specificity: 0.45 Negative predictive value: 0.75

Bite in at least one PR-component vs **bite** in at least one test-component

	Bite history	**No threat/bite history**	Total
Positive test	244	11	255
Negative test	169	20	189
Total	413	31	444

Sensitivity: 0.59 Positive predictive value: 0.96 False negatives: 169
Specificity: 0.65 Negative predictive value: 0.11

Bite in at least one PR-component vs **threat** in at least one test-component

	Bite history	**No threat/bite history**	Total
Positive test	342	23	365
Negative test	71	8	79
Total	413	31	444

Sensitivity: 0.83 Positive predictive value: 0.94 False negatives: 71
Specificity: 0.26 Negative predictive value: 0.10

COMMENT ON RESULTS

Overall the test has a high sensitivity for both threat and bite behaviour. The highest sensitivity (0.87) is for the comparison between *threat and/or bite behaviour in at least one PR-component* vs. *threat and/or bite behaviour in at least one of the test components*, followed by the comparison of *threat in at least one PR-component* vs. *bite in at least one subtest* (sensitivity: 0.86). This means that these dogs that showed certain behaviour towards true victims, did show the same behaviour during the test, so these subtests have a high sensitivity in challenging this behaviour. Which makes the test more valid. The comparison between *bite behaviour in the PR* vs. *threat behaviour in the test* shows a high sensitivity as well (0.83). It is possible that this is due to dogs being more restrained during the test then when they are walking on the street with their owner in their own surrounding. The lowest sensitivity is found in the comparison of *bite behaviour in the PR* vs. *bite behaviour in the test* (0.59).

The values of the specificity vary between 0.20 and 0.65. This high value of 0.65 is found in the comparison of *bite behaviour in the PR* vs. *bite behaviour in the test*. The lowest value is for the comparison of *threat behaviour in the PR* vs. *threat behaviour in the test*, followed by the second lowest value of 0.26 for the comparison of *bite behaviour in the PR* vs. *threat behaviour in the test*. A specificity of 0.45 was found when *threat behaviour in the PR* was compared to *bite behaviour in the test.*
The positive predictive value is the highest for two different comparisons. *Threat and/or bite behaviour in the PR* vs. *threat and/or bite behaviour in the test* and *bite behaviour in the PR* vs. *bite behaviour in the test* both have a positive predictive value of 0.96. The lowest value is found in the comparison of *threat behaviour in the PR* vs. *threat behaviour in the test* (0.31). There are only two high values of the negative predictive values. Those are the comparisons of *threat behaviour in the PR* vs. *threat behaviour in the test* and *threat behaviour in the PR* vs. *bite behaviour in the test.*

A small difference can be seen in the second table because in this table dogs that bit a person, while this dog was in conflict with another dog, are not counted as human-biters. A few values are changed within this table compared with the table number 5 but these changes are so small that the sensitivities do not change.
The specificity of the comparison of *threat behaviour in the PR* vs. *threat behaviour in the test* is decreased to 0.19. The other values of the specificity stayed the same. The positive predictive value of the comparison of *threat behaviour in the PR* vs. *bite behaviour in the test* did decrease 0.01 point to 0.32. All of the outcomes of the negative predictive value stayed the same as in table 4.

Of the total number of 449 tested dogs, there seem to be 63 dogs that have bitten a person in real life by accident. This means that these dogs were in a fight with another dog and while a person tried to separate the dogs, this persons was bitten by one of the dogs. Initially there was no bite intention from the dog towards a person, so these dogs are not counted as human biters, because it was an accident. It is important to know whether these 63 dogs are justly counted as accidental biters. That is why from these 63 dogs bite behaviour towards persons in the test was investigated. The results showed that 22 of these dogs did actually show bite behaviour towards a person in in the test. This behaviour could be showed in any subtest with a human being involved. This means that 35% of the dogs are unfairly counted as accidental biters (false positives) because they did show bite behaviour towards persons in the test. The other 65% were justly counted as accidental biters.

Reliability intervals for sensitivity and specificity

The calculated reliability intervals for sensitivity and specificity are tabled below:

Table 6 The 95% reliability intervals for sensitivity and specificity of the complete test.

	Dogs that bit a person in conflict with another dog counted as 'human-biter'		Dogs that bit a person in conflict with another dog **not** counted as 'human-biter'	
	95% CI sensitivity	95% CI specificity	95% CI sensitivity	95% CI specificity
Threat in at least one PR-component vs. **threat** in at least one subtest.	0.80-0.92	0.16-0.24	0.80-0.92	0.15-0.23
Threat in at least one PR-component vs. **bite** in at least one subtest.	0.56-0.72	0.39-0.51	0.56-0.72	0.39-0.51

Bite in at least one PR-component vs. **bite** in at least one subtest.	0.54-0.64	0.48-0.82	0.54-0.64	0.39-0.91
Bite in at least one PR-component vs. **threat** in at least one subtest.	0.79-	0.11-0.41	0.79-0.87	0.11-0.41
Threat and/or bite in at least one PR-component vs. **bite and/or threat** in at least one subtest.	0.83-0.90	0.11-0.47	0.84-0.90	0.11-0.47

Necessary sample-size

The minimal sample size necessary for the lower limit of the 95% CI may deviate to a maximum of 5% of the calculated sensitivity or specificity (table 7 and 8). In these tables the necessary sample sizes are compared to the sample-sizes used in this research. The used sample sizes are not big enough so that the calculated sensitivity and also the specificity fall within the 95% in any subtest. The current sample-sizes for the sensitivity and specificity of this test can be found in the tables of appendix 1 and 2. The comprehensive calculation can be found in appendix 3.

Table 7 *The minimal sample size necessary for the lower limit of the 95% CI can deviate to a maximum of 5% of the calculated sensitivity or specificity. When the current sample-size is big enough, it's written down in bold letters. Dogs that bit a person in conflict with another dog* ***are*** *counted as 'human-biter'.*

	Sample-size sensitivity lower limit	True sample-size sensitivity	Sample-size specificity lower limit	True sample-size specificity
Threat in at least one PR-component vs. **threat** in at least one subtest.	185	130	246	**312**
Threat in at least one PR-component vs. **bite** in at least one subtest.	354	130	380	312
Bite in at least one PR-component vs. **bite** in at least one subtest.	371	**413**	350	31
Bite in at least one PR-component vs. **threat** in at least one subtest.	217	**413**	296	31
Threat and/or bite in at least one PR-component vs. **bite and/or threat** in at least one subtest.	174	**421**	316	24

Table 8 *Minimal Sample-sizes necessary when the lower limit of 95% CI may deviate to a maximum of 5% of the calculated sensitivity and specificity, compared to the real sample-size. The current sample-sizes which are big enough are written in bold letters.*

Dogs that bite a person in conflict with another dog ***are not*** *counted as 'human-biter'.*

	Sample-size sensitivity lower limit	True sample-size sensitivity	Sample-size specificity lower limit	True sample-size specificity
Threat in at least one PR-component vs. **threat** in at least one subtest.	185	129	236	**313**
Threat in at least one PR-component vs. **bite** in at least one subtest.	354	129	380	313
Bite in at least one PR-component vs. **bite** in at least one subtest.	371	**413**	350	31
Bite in at least one PR-component vs. **threat** in at least one subtest.	217	**413**	296	31
Threat and/or bite in at least one PR-component vs. **bite and/or threat** in at least one subtest.	174	**421**	316	24

Validity of the subtests

Threat behaviour towards children
The values for threat behaviour towards children can be found in table 9. The subtests that include threat behaviour towards children have a low sensitivity. The specific doll-test which scored the highest value for sensitivity was the dark doll test (test 9c). It seems that this doll best provokes the behaviour seen in the PR of all doll-tests. The threat test with the Roxanne-doll involved has a sensitivity of 0.38 (subtest 9b). The subtest with the large doll has a sensitivity of 0.25 (test 9a). The highest sensitivity value (0.43) is for the comparison between *threat child PR* vs. *threat in at least one doll-test*. The sample-size of the number of dogs which have shown threat behaviour towards children in the PR is 28. This sample-size is not big, with a total number of 406 dogs tested.
The highest value of specificity (0.80) was calculated in the subtest with the large doll-test (subtest 9a). Followed by a specificity of 0.78 in the Roxanne-doll test (9b). The lowest specificity (0.76) was found in the dark doll-test (9c). When the doll-tests are all combined, a high specificity of 0.80 was found. The positive predictive values are found between 0.09 (all doll-tests combined) and 0.16 (subtest 9c, dark-doll). The values of the other two doll-tests lay between these two tests: 0.12 for test 9b (Roxanne test) and 0.14 for test 9a (large-doll test).The negative predictive values lay very close to each other. They vary between 0.89 for test 9a and 0.94 for test 9b and for all the doll-test combined. Subtest 9c lays in between these values with a negative predictive value of 0.91.

Threat behaviour towards adults
The values for threat behaviour towards adults can be found in table 9. The sensitivity of threat behaviour towards adults varies between 0.12 for the test with a fake petting hand (subtest 4) and 0.75 for the outcome where all the test outcomes of adult-tests are combined. The second highest sensitivity of 0.54 is found in the comparison of *threat adult PR* vs. *threat male threat* (subtest 7). The comparison *threat adult PR* vs. *being threatened by a female* has a sensitivity of 0.49 (subtest 8). The comparison *threat adult PR* vs. *threat person who threats the dog keeper* has a sensitivity of 0.23 (subtest 16) and the test where the dog is *threatened in the surrounding* test has a sensitivity of 0.37 (subtest 15). The specificity of these tests vary between 0.45 for the outcome where all the threat-tests are combined and 0.89 for subtest 4. Subtest 15 has a specificity of 0.70, where subtests 7 and 8 have specificities of consecutive 0.56 and 0.59. The specificity of subtest 16 is 0.79. These specificity values are quite high. The positive predictive values are a bit low with values that vary between 0.23 and 0.28. The highest positive predictive value is for the threat-tests all combined (subtests 4, 7, 8, 15 and 16). The negative predictive values are relatively high and vary between 0.78 (subtest 4) and 0.86 (subtests 4, 7, 8, 15 and 16).

Threat behaviour towards dogs
The values of threat behaviour towards dogs can be found in table 9. The sensitivity of the subtests with real dogs involved vary between 0.21 and 0.49. The highest sensitivity of 0.49 is calculated in the comparison of *PR threat dog* vs. *threat in at least one dog-test* (subtest 13a and 13b combined). The comparison of *threat small dog PR* vs. *threat real small* dog is 0.21. The comparison *threat large dog PR* vs. *threat real large dog* has a sensitivity of 0.44. Also a calculation was made of the comparison of *dogs that threat in the PR* vs. *dogs that threat small and/or large real dogs in the tests*. This calculation renders a sensitivity of 0.46.
The specificity for the comparison *threat small dog PR* vs. *threat life small dog* is the highest with 0.66. Followed by the comparison where the *dog threatened a large dog in the PR* vs. *threat life large dog* (0.63).
Dogs that *threatened a dog in the PR* and also *threatened small and/or large life dogs in the test a sensitivity* of 0.46 was found. The comparison of dogs that *threatened a dog in the PR* vs. *threat in at least one dog test* has a sensitivity of 0.52.
The positive predictive values are very low and vary between 0.04 (subtest 13b) and 0.10 (threat in subtest 13a and/or 13b). The negative predictive values are quite high and vary between 0.90 (threat in subtest 13a and/or 13b) and 0.94 (subtest 13a).

Validation of the bite-behaviour in subtests

Bite behaviour towards children
The values for bite behaviour towards children can be found in table 9. The sensitivity of these subtests are very low. They vary between 0.16 (large doll test 9a) and 0.56 (*bite child PR* vs. bite and/or *threat in at least one doll test*). The highest sensitivity of the doll-tests separately is found in the subtest with the doll on the stick, Roxanne-test (subtest 9b): 0.27. This subtests are low sensitive, just as the threat-child subtests. The comparison of *bite child in PR* vs. *bite in at least one doll-test* has a sensitivity of 0.33. The specificities of these tests are quite high. They vary between 0.95 (subtest 9a with the large doll) and 0.67 (*bite child PR* vs. bite and/or *threat in at least one doll-test*). So this specificity decreases slightly when both bite-behaviour and threat behaviour are taken into account. The positive predictive values of the subtests are low with the highest value of 0.36 from subtest 9a. All the doll-tests together have positive predictive value of 0.28. The negative predictive value are relatively high and vary between 0.86 (subtest 9a and bite/and or threat behaviour combined) and 0.82 (subtest 9c).

Bite behaviour towards adults
The values for bite behaviour towards adults can be found in table 9. The subtests which measures bite behaviour towards adults are low specific, with the highest specificity of 0.42 for the calculation where all the adult-tests are combined together (subtests 4, 7, 8, 15 and 16). The comparison of *bite adult PR* vs. *bite the person who threats the dog keeper* (subtest 16) has the second highest specificity of 0.30. The lowest sensitivity is for subtest 4 (*bite adult PR* vs. *bite during petting test*): 0.05. The specificities are quite high, as they vary between 0.75 (bite-tests combined: subtests 4, 7, 8, 15 and 16) and 1 (subtest 4: *bite adult in PR* vs. *bite during petting test*), followed by a specificity of 0.94 in the *surroundings test* (subtest 15). The positive predictive value the highest for subtest 4 (0.92) and the lowest for subtest 8 (0.29). The negative predictive value is the highest for subtest 7 (0.67) and the lowest for subtest 4 (0.45).

In table 9 dogs that accidentally bit a person are also counted as dogs that have bitten a person. But because this could be accidental it is also necessary to compare the outcomes when this certain dog is not counted as human-biter (accidental biter), but only as a dog-biter. Small differences between the calculated values can be seen between these tables. Subtest 7 has the highest sensitivity of 0.54 (*threatened by a male*), followed by a sensitivity of 0.49 for subtest 8. When all the adult subtests are combined, a sensitivity of 0.75 was calculated. Overall two of the sensitivities are increased in table 10 compared to table 9.
The highest specificity is for subtest 4 and has a value of 0.89 (instead of 0.90 in table 9). The lowest specificity is 0.56 for subtest 7. When all the adult-tests are combined together a specificity of 0.46 was found. So after all in 5 subtests the specificity did increase compared to table 9. The positive predictive value did increase in 4 subtests (subtests 7, 8, and 15 and also in the calculation where all the sub-tests were combined). The negative predictive values did increase with 0.02 in all the subtests.

Bite behaviour towards joggers or cyclists
The values of bite behaviour towards joggers or cyclists can be found in table 9. The sensitivity for subtest 14 is very low. The values vary between 0.06 and 0.5. The highest sensitivity is for subtest 14b, where the comparison between *bite jogger PR* vs. *bite jogger without fake hand* in test was calculated. The outcomes of the subtest where dogs are

involved that bit a cyclist are not sensitive (0.06 and 0.09) because there was only one dog which had a bite history which also showed bite behaviour during the test. All the jogger tests combined have a specificity of 0.44.
The comparison of *bite jogger in PR* vs. *bite jogger without fake hand* (subtest 14b) has the highest specificity of 0.83. Followed by a specificity of 0.81 for subtest 14b but then compared with bite behaviour towards a cyclist in the PR. All the jogger subtests together have a specificity of 0.78.
The positive predictive values are very low and vary between 0.01 and 0.08. The highest value is for subtest 14b.
The negative predictive values are very high and vary between 0.94 and 0.98. The highest value is for subtests 14a and 14b. All the jogger subtests together have a negative predictive value of 0.98 as well.

Bite behaviour towards dogs
The values of bite behaviour towards dogs can be found in table 9. The sensitivities for the dog subtests with bite behaviour in the PR are low. The highest sensitivity is for the comparison of a history of *dog biting in the PR* vs. *threat and/or bite in at least one dog subtest* (0.63). This is the highest value because in this calculation threat behaviour is taken into account as well. When a dog with a bite history towards a small dog is compared with biting a small dog in the test, a sensitivity of 0.29 is found. The subtest where a dog showed bite behaviour towards a large dog compared with biting a large dog in the test has a sensitivity of 0.26. When a dog did show bite behaviour in the PR is compared with showing bite behaviour to at least one dog a sensitivity of 0.37 was found (subtest 13a + 13b).
The highest specificity (0.79) was found for the comparison of *bite a small dog in the PR* vs. *bite a small dog in the test* (subtest 13b). The lowest specificity was found for the calculation where *bite history* was compared to *threat and/or bite behaviour in at least one test* (0.53). The positive predictive values vary between 0.30 (subtest 13a) and 0.69 (because in this test threat behaviour is taken into account). The negative predictive values vary between 0.48 (*dog bite history in PR* vs. *bite small and/or large life dog in test*) and 0.75 (subtest 13a).

Table 9 *Results when dogs that have bitten a person in conflict with another dog are counted as human-biters.*

	Sensitivity	**Specificity**	**Positive predictive value**	**Negative predictive value**	**Number of dogs tested**	**Number of dogs in tested group with bite and/or threat history**
Total results PR vs. total results test						
Threat and/or bite in at least one PR-component vs. **bite and/or threat** in at least one subtest.	0.87	0.29	0.96	0.11	445	421
Threat in at least one PR-component vs. **threat** in at least one subtest.	0.86	0.20	0.31	0.77	442	130
Threat in at least one PR-component vs. **bite** in at least one subtest.	0.64	0.45	0.33	0.75	442	130
Bite in at least one PR-component vs. **bite** in at least one subtest.	0.59	0.65	0.96	0.11	444	413
Bite in at least one PR-component vs. **threat** in at least one subtest.	0.83	0.26	0.94	0.10	444	413

	Sensitivity	Specificity	Positive predictive value	Negative predictive value	Number of dogs tested	Number of dogs in tested group with bite and/or threat history
THREAT BEHAVIOUR						
Threat behaviour towards a child						
Threat child PR vs. **threat** in at least one of the doll tests (9)	0.43	0.70	0.09	0.94	406	28
Threat child PR vs. **threat** large doll (9a)	0.25	0.80	0.14	0.89	205	24
Threat child PR vs. **threat** doll Roxanne (9b)	0.38	0.78	0.12	0.94	417	29
Threat child PR vs. **threat** dark doll (9c)	0.39	0.76	0.16	0.91	265	28
Threat behaviour towards an adult						
Threat adult PR vs. **threat** in at least one of the adult tests (4,7,8,15,16)	0.75	0.45	0.28	0.86	356	79
Threat adult PR vs. **threat** petting hand (4)	0.12	0.89	0.23	0.79	360	77
Threat adult PR vs. **threat** surrounding test (15)	0.37	0.70	0.25	0.81	334	70
Threat adult PR vs. **threat** female threat (8)	0.49	0.59	0.23	0.81	342	71
Threat adult PR vs. **threat** male threat (7)	0.54	0.56	0.25	0.82	310	65
Threat adult PR vs. **threat** keeper threat (16)	0.23	0.79	0.23	0.78	336	74

THREAT BEHAVIOUR						
Threat behaviour towards a dog						
Threat dog PR **threat** in at least one of the dog tests (13a, b, c, d)	0.49	0.52	0.09	0.91	417	39
Threat small dog PR vs. **threat** small life dog (13b)	0.21	0.66	0.04	0.92	275	19
Threat large dog PR vs. **threat** life large dog (13a)	0.44	0.63	0.09	0.94	373	27
Threat dog PR vs. **threat** large and/or small life dog (13a + 13b)	0.46	0.54	0.10	0.90	400	39

BITE BEHAVIOUR						
Bite behaviour towards a child						
	Sensitivity	Specificity	Positive predictive value	Negative predictive value	Number of dogs tested	Number of dogs in tested group with bite and/or threat history
Bite child PR vs. **bite** in at least one doll test (9a, b, c)	0.33	0.80	0.28	0.84	446	85
Bite child PR vs. **bite** large doll (9a)	0.16	0.95	0.36	0.86	205	31
Bite child PR vs. **bite** Roxanne (9b)	0.27	0.83	0.27	0.83	456	86
Bite child PR vs. **bite** dark doll (9c)	0.22	0.85	0.27	0.83	281	55
Bite child PR vs. **threat and/or bite** in at least once of the dolltests	0.56	0.67	0.27	0.86	446	85
Bite behaviour towards an adult						
Bite adult PR vs. **bite** in at least one of the adult tests (4,7,8,15,16)	0.42	0.75	0.67	0.52	435	238
Bite adult PR vs. **bite** petting hand (4)	0.05	1.00	0.92	0.45	462	260
Bite female PR vs. **bite** female threat (8)	0.08	0.90	0.29	0.67	412	134
Bite male PR vs. **bite** male threat (7)	0.17	0.93	0.55	0.67	371	130
Bite adult PR vs. **bite** surrounding test (15)	0.10	0.94	0.67	0.46	408	226
Bite adult PR vs. **bite** threat female (8)	0.11	0.93	0.66	0.45	420	235
Bite adult PR vs. **bite** male threat (7)	0.12	0.91	0.63	0.45	379	213
Bite adult PR vs. **bite** keeper threat (16)	0.30	0.81	0.66	0.48	410	228
Bite behaviour towards a jogger						
Bite jogger PR vs. **bite** in at least one jogging test (14)	0.44	0.78	0.04	0.98	420	9
Bite jogger PR vs. **bite** jogger fake hand (14)	0.44	0.78	0.04	0.98	428	9
Bite jogger PR vs. **bite jogger** without fake hand (14)	0.50	0.83	0.08	0.98	200	6
Bite cyclist PR vs. **bite** jogger fake hand (14)	0.06	0.77	0.01	0.95	426	17
Bite cyclist PR vs. **bite** jogger without fake hand (14)	0.09	0.81	0.03	0.94	200	11

Bite behaviour towards a dog						
Bite dog PR vs. **bite** in at least one of the dog tests (13a, b, c, d)	0.37	0.74	0.64	0.49	438	241
Bite dog PR vs. **threat and/or bite** in at least one of the dog tests (13a, b, c, d)	0.63	0.53	0.62	0.54	439	241
Bite small dog PR vs. **bite** small life dog (13b)	0.29	0.79	0.55	0.55	298	141
Bite large dog PR vs. **bite** large life dog (13a)	0.26	0.78	0.30	0.75	395	104
Bite dog PR vs. **bite** large and/or small dog (13a + b)	0.33	0.78	0.65	0.48	434	241
Bite dog PR vs. **threat and/or bite** large and/or small life dog (13a + 13b)	0.52	0.72	0.69	0.55	395	216

Table 10 *Results when dogs that have bitten a person in conflict with another dog are* ***not*** *counted as human-biters.*

	Sensitivity	Specificity	Positive predictive value	Negative predictive value	Number of dogs tested	Number of dogs in tested group with bite and/or threat history
Total results PR vs. total results test						
Threat and/or bite in at least one PR-component vs. **bite and/or threat** in at least one subtest.	0.87	0.29	0.96	0.11	445	421
Threat in at least one PR-component vs. **threat** in at least one subtest.	0.86	0.19	0.30	0.77	442	129
Threat in at least one PR-component vs. **bite** in at least one subtest.	0.64	0.45	0.32	0.76	444	129
Bite in at least one PR-component vs. **bite** in at least one subtest.	0.59	0.65	0.96	0.11	444	413
Bite in at least one PR-component vs. **threat** in at least one subtest.	0.83	0.26	0.94	0.10	444	413
Threat behaviour towards an adult						
Threat adult PR vs. **threat** in at least one of the adult tests (4,7,8,15,16)	0.75	0.46	0.26	0.88	383	77
Threat adult PR vs. **threat** petting hand (4)	0.12	0.90	0.23	0.81	380	75
Threat adult PR vs. **threat** surrounding test (15)	0.38	0.72	0.24	0.83	353	68
Threat adult PR vs. **threat** female threat (8)	0.49	0.59	0.22	0.83	342	70
Threat adult PR vs. **threat** male threat (7)	0.54	0.57	0.23	0.84	328	63
Threat adult PR vs. **threat** keeper threat (16)	0.24	0.80	0.23	0.80	354	72
BITE BEHAVIOUR						
Bite behaviour towards an adult						
Bite adult PR vs. **bite** in at least one of the adult tests (4,7,8,15,16)	0.43	0.72	0.50	0.66	435	172
Bite adult PR vs. **bite** petting hand (4)	0.05	1.00	0.91	0.61	450	182
Bite female PR vs. **bite** female threat (8)	0.11	0.90	0.24	0.77	365	85
Bite male PR vs. **bite** male threat (7)	0.17	0.91	0.43	0.75	363	98

Bite adult PR vs. **bite** surrounding test (15)	0.11	0.94	0.53	0.63	397	151
Bite adult PR vs. **bite** threat female (8)	0.13	0.93	0.55	0.62	411	162
Bite adult PR vs. **bite** male threat (7)	0.14	0.91	0.51	0.62	370	147
Bite adult PR vs. **bite** keeper threat (16)	0.32	0.79	0.49	0.64	399	155

COMPARING OUTCOMES

The comparison of the 2012 and 2016 research results

The goal of this research was to compare the validation values of the test done in 2012 to the current test done which includes information from 2008 until 2015. The comparison of the test where the dog shows any *threat and/or bite behaviour in the PR* vs. *showing any threat and/or bite behaviour in the tests* remained the same value for sensitivity of 0.87. Important to determine was the sensitivity of bite behaviour in the PR compared to the test. This value has decreased from 0.64 to 0.59.
Also a comparison is made between the results of the data including the years 2008-2012 with those from 2013-2015. Out of these results we can explain the decrease of sensitivity of the bite tests. The sensitivity value of *bite behaviour in the PR* compared to *bite behaviour in the test* was 0.52 for the period of 2013-2015 (appendix 1). Looking at the results of each subtests where bite behaviour is involved an explanation of the decrease can be found. When *bite behaviour towards a person in the PR* is compared to *bite behaviour towards the person who threatens the dog keeper* a decrease of the sensitivity can be found (from 0.36 to 0.22). A total decrease from 0.43 to 0.39 was found in the comparison of *bite behaviour towards a person in the PR* vs. *showing bite behaviour once in a test with a person involved.* A very big decrease of sensitivity value is found in the subtest of *bite behaviour towards a large dog in the PR* vs. *bite behaviour towards a real life large dog in the test* (0.41 to 0.14). The same subtests with small dogs involved also has a decreased sensitivity (0.33 to 0.27). When *bite behaviour towards any dog in the PR* is compared to *bite behaviour in at least one dog test* the sensitivity went from 0.45 to 0.30. Striking was that there was also an increased sensitivity value with bite behaviour involved. The value of the three doll subtests is improved. *Bite behaviour towards a child in the PR* compared to *showing bite behaviour once in the subtests with dolls involved* went from 0.25 to 0.50. This increase could be distorted because the previous research reached a sensitivity of 0 in the large doll and dark doll subtests. The sensitivities of these subtests are now increased to a value of 0.18 and 0.32.

Combining the two data sets, the total sample size is much bigger now than then. Some of the outcomes of the research in 2012 were that there needed to be more research and numbers of this shelter test to make the calculations reliable. With adding 3 more test years, we now have numbers of 8 years in total (2008 until 2015). Because the shelter test keeps improving, some differences of the subtests are made over the years. This makes an exact repeat of the validation test harder. For example, the previous tests, up to 2012 still used the subtest with the stuffed dogs. The sensitivity of these subtests were that low that these subtests were removed from the shelter test, that is the reason data of the stuffed animal test does appear in this research. Also during the tests in 2012 (Roekel, 2012), the testers found out that the test including the *jogger with a fake hand* was not that reliable. Testers found out that dogs sometimes fixated towards the fake hand instead of the real jogger. This makes the subtest less reliable because the goal of this test was to find out whether this dog had aggression towards joggers and not towards fake hands (which they could see as a toy passing by). Therefore the jogging test without holding a fake hand was introduced later on. The sensitivity of the subtest without fake hand is higher than the sensitivity with the test including a fake hand (0.50 compared to 0.44. This means that dogs that have a bite history towards joggers, do show this more often during a subtest when there was no use of a fake hand. The only thing is that the total sample size of these subtests will be lower than the other subtests because this element was not introduced yet in 2008. The same counts for the subtests with the *dolls.* The subtest with the *doll on wheels* was removed from the entire test. In the previous research the test with the *doll on wheels* was the first doll test introduced to the dog. This test scored a relatively high sensitivity. Back then the second doll introduced to the dog was the *large doll.* This doll clearly had a lower sensitivity then the *doll on wheels* test. This could be due to the novelty of the first doll introduced. When the second doll is introduced to a dog, the dog can already know and recognize that the previous doll was not that scary and harmful. The dog might react more relaxed towards the second doll because of it.
There was also a change in sequence of the subtests since 2014. Subtests 7 and 8 are moved to be taken after subtest 16 because sometimes dogs could become too stressed or excited by subtest 7 and 8 and this could interfere with the outcomes of the later subtests. The influence of this change of sequence was not examined.

Even though the research in 2012 was done by another person, standardization of interpretation was tried to be maintained. There has been contact between the two students to make sure interpretation of each component and subtest would be the same. Differences in interpretation would interfere with a correct repeat of the validation of this research. Nevertheless small changes were made to improve the interpretations of the outcomes of the calculations. In some calculations of the subtests in 2012 unknown information (value of 2 in the Excel sheet) was counted as negative outcomes (value of 0 in the Excel sheet). In the current research more dogs were included in the research, leading to an increased sample size, and the unknown outcomes (value 2 in the Excel sheet) were not included in the calculations. To improve the reliability of the subtests it is important to include only the tested dogs we have certain outcomes of. If unknown values are also included, the reliability will decrease automatically.
It is clear that the number of subtests which reached the necessary sample size is improved compared to the test in 2012 (table 7). The eventual goal for the future would be to reach each value of the necessary sample sizes for sensitivity and specificity together. This can be a goal for a repeating research in the future.

DISCUSSION

In this research results from 2012, spanning the period between 2008 and 2012, were augmented with data form the period 2013-2015. The previous research was done before in 2012. Back then a dog population of 257 dogs was tested. The current research used the information of these same 257 dogs and added data and information of 2013, 2014 and 2015, which made the entire population 449 dogs. In every research there are certain things that can have an influence on the outcomes These items will be discussed in this section.

Calculations were also made from the information of the years 2013-2015. In the subtests taken in this period some serious decreases were found in especially the subtests with *bite behaviour towards persons in the PR* compared to *bite behaviour towards persons in the test.* Also a big decrease was found in the subtest when *bite behaviour towards a large dog in the PR* was compared to *bite behaviour towards a real life large dog in the test*. The same counts for this subtests with *small dogs* involved. A clear explanation for this decrease in the real life dog tests is difficult to find because there have not been made changes in these particular subtests compared to the previous research from 2008-2012. In the period of 2008-2012 18% of the tested dogs have a history of *bite behaviour towards a large dog.* This value has increased in the period of 2013-2015 to 30%. An average of 20,9% of the tested dogs (2008-2012: 22% and 2013-2015: 19,8%) showed *bite behaviour towards a large real life dog in the subtest.* But the results of the value of sensitivity of the subtest where *bite behaviour towards a large dog in the PR* is compared to *bite behaviour towards a real life dog in the test* show us that there is a large number of false positive outcomes (dogs that have no bite history towards large dogs but that do show bite behaviour towards large dogs in the test). This could be due to a high stress level during the tests. Perhaps these stressed dogs, that are leashed on a fence, show different behaviour to what they would normally show. It is possible that these dogs are not sure what to do with the situation of a strange dog walking by. It is also possible that the behaviour these dogs show is unfairly counted as bite behaviour. These dogs might growl and show a fast forward movement but it is possible they would not eventually bite the other dog. Vice versa a lot of dogs that did show *bite behaviour towards a large dog in the PR* did not show this behaviour in the subtests, this leads to the low sensitivity. Probable reasons for this low sensitivity are described below.

The sensitivity of bite behaviour subtests has decreased in the research comparing 2008-2012 to the current research which includes 2008-2015. Different reasons could explain these decreases. Due to a larger sample size the outcome of the research becomes more valid, so it is possible that the sensitivity of the research of 2012 was actually not as high as was calculated. Few subtests were changed or removed since 2013 with the goal to strive for situations closer to the real life situations. These changes provide a more reliable test outcome and also a more valid research. That means that the new sensitivity value which is decrease from 0.64 to 0.59 for bite behaviour is trustworthy.

Comparing the calculated outcomes of the research of 2012 to the current research (appendix 1), certain differences need to be discussed. When you look at the calculation of the comparison *threat and/or bite in at least once PR component* vs. *that and/or bite in at least one test component* the sensitivity stayed exactly the same but the specificity did increase from 0.25 to 0.29. Also the positive predictive value did increase from 0.93 to 0.96. In 28 subtests the positive predictive value did increase. This means that dogs that showed threat and/or bite behaviour in the test, also showed this same behaviour in the PR. The outcomes of the compared sensitivities differs. Big differences were seen in the subtest where *threat adult in the PR* was compared with *threatening an adult male in the test* (a decrease from 0.65 to 0.54). Also subtest 13a *threat large dog in PR* vs. *threat real large dog in test* showed a decrease of the sensitivity value of 0.27 (from 0.71 to 0.44). The same happened with the subtest with small dogs involved, a decrease

from 0.64 to 0.46 was calculated. This made the sensitivity of the combined calculation of *threat any dog PR* vs. *threat dog in at least one dog test* decrease from 0.71 to 0.49 as well. In all these subtests the specificity stayed the same or did decrease as well. With a large increase of the total sample sizes of these tests we can assume that the outcomes of the sensitivities and specificities comes closer to the official real values these subtests will have when all necessary sample sizes will be reached.
A big difference of the calculated values of the *Roxanne doll test* can be seen in appendix 1 also. The sensitivity of subtest 9b is increased from 0.23 to 0.27. Also the specificity was increased from 0.49 to 0.83. The negative predictive value was increased from 0.43 to 0.83. These are very high improvements of the validity of this subtest.

Sample sizes
The sample sizes that were used were big enough for most tests for measuring the sensitivity. For the specificity we only reach the necessary sample size in one component (*threat in at least one PR-component* vs. *threat in at least one subtest*) (table 7 ad 8). For the other components our sample-size was too small, what leads to the fact that one cannot make a clear conclusion about these components. The outcomes of the necessary sample size of the research in 2012 compared, we now achieve more components where we did use a big enough sample size. Still, the used sample size is not big enough to reach the necessary simple size in each subtest . That is something that can be achieved if the same validation research can be done again in the future where data and information of 3 or 4 more years will be included. To reach the goal to decrease the value of 95%- reliability interval (and thereby increase the reliability of the entire research) it is necessary to increase the entire sample-size. Then the values of the sensitivity and specificity will not change, but these values will fall with 95% certainty within a smaller margin than the current sample sizes do. No calculation was made of the sample sizes for each subtest separately because that was not the goal of this research. Of course the reliability of a subtest will increase with the increase of the sample-size. In the previous research of 2012 there were certain subtests with a very low number of tested dogs, because some subtests were added in the last year (2012). That is the reason why only the number of 205 and 265 (instead of 449) was reached in respectively *the threat subtests* with the *large doll* and the *dark doll*. The sample size of the test with the jogger without the fake hand is small due to the same reason.

Information pertaining to police records
The population used in this research, contains of dogs that all have a history of biting. That is the reason why it is impossible to calculate the specificity of the entire research because the specificity says something about the true negatives (dogs that did not show threat and/or bite behaviour in the PR, also did not show threat and/or bite behaviour in the tests). So for the measuring of the specificity a control-group of dogs which did not have a threat and/or bite behaviour is necessary. In theory it would be possible to use a control-group for the future research, but it could be hard to realize such thing because it would take extra costs and time, which might be not available.
Looking at the subtests, the specificity could in principle be reliable because the tested dogs can be their own control-dogs. When a dog bit a child in the PR, there is a big chance that this dog did not bite a dog in the PR. So this dog could be a control-dog for **not** having a bite history towards dogs. Still, it could be possible that this control-dog is not completely reliable because it has a bite history and this dog could react differently to unexpected movements or threats by persons or objects. Moreover, owners could nog have given full info the biting history of their dogs. The PR information often is limited and owners are not always completely honest about certain behaviour history of their dog because they can be afraid it would affect the eventual advice for their dog. This means that the calculated specificities presented in this paper should be viewed upon with the necessary caution.

It is also very hard to say something about the reliability of threat behaviour reported in the PR. Often victims cannot remember whether they have seen threat behaviour before the attack. Also when a dog only shows threat behaviour and not bite behaviour, often there will not be made a police report about this dog because it did not really harm anyone seriously. So these dogs will not be reported in this research. The bite behaviour included in the PR will also not always be complete. The validity of biting is not easy to determine because victims cannot always describe the situation clearly because of their emotions and because of information they might have suppressed due to the traumatic nature of the situation. Yet, bite behaviour history will more often be documented than threat behaviour, because of the severity of it. In case of lacking information about bite behaviour in the PR it is possible the sensitivity will be calculated higher or lower than it really appears to be.

Subtests

There are a few subtests that need to be discussed because certain components can have an important influence on the outcome of each subtest. This happens for example in the *cage test*. The dog is always kept in the shelter for a certain amount of time before the dog is tested, so that the dog can adjust to his/her new environment. It is always possible that a dog needs more time to adjust. This dog might expresses insecure behaviour because of that. It can be imagined that for this dogs the chance of showing threat and or bite behaviour during the *cage test* is bigger than dogs that adjust to their new environment more easily.

Another example is the *doll test*. In this subtest the dogs' behaviour towards children is tested. Some dogs might react differently towards children compared to these dolls because of the different look, smell, sound and movement these dolls have compared to real children. It is possible that the dogs do not recognize the dolls as being children. Some dogs might have never been in contact with a large or dark doll like this. Even a dog without threat and/or bite behaviour could react scared and/or start barking at the doll because of the unknown origin. When a tested dog shows bite behaviour towards a doll, this absolutely should be taken serious because the dog is not allowed to show bite behaviour in any test at all. However, it is not always possible to translate this behaviour one-to-one to bite behaviour towards children. There is a real possibility that it concerns a false positive reaction, to a stimulus that is in some way threatening to the dog. Information from the doll tests increases the sensitivity of the entire research (*bites once in PR* vs. *bites once in test*), but decreases the reliability of the subtest. The sensitivity of the entire doll test is 0.56, which is not very high. This means the test outcomes include a high number of false negative tested dogs. The sensitivity of the doll test is improved compared to the sensitivity value of the research in 2012 (0.46). So that means that it is possible that a dog would show threat and/or bite behaviour towards children in real, but does not show this behaviour in the test because the dog does not interprets the doll as a real child. This makes the number of false negative increase. The best way to show threat and/or bite behaviour towards children is testing the dogs with real children. Obviously, this would not be ethical approved.

Another footnote could be made by the *real dog tests.* In these subtests threat and/or bite behaviour towards other dogs is tested. Mostly the PR says that during a bite situation, which is documented, the culprit dog bites the victim dog without showing any prior threat behaviour. It is very possible the threat behaviour has been missed by the owner of the victim dog, or it was too subtle too recognize. This means that the number of dogs that have shown a threat behaviour towards the bitten dogs is not that big (39). This makes the reliability of this subtest doubtful. The number of dogs tested that have a bite history towards dogs was higher (241). During this subtest a real dog passes the tested dog on a leash on a certain distance to make sure the dogs cannot reach each other. The fact that of these 241 dogs with a bite history, 90 dogs made a bite movement towards the real dog in the test, makes the sensitivity of 0.52 not really high which means a lot of false-negative dogs appear in this subtest. The specificity of this subtest is 0.72. The reason for this outcome might be that the aggression in the situation documented in the PR was towards a certain dog in the neighbourhood, where this culprit has a negative history with the victim dog. Or the culprit dog might only have aggressive behaviour towards a certain breed of dog, which was not used in the subtest. In this case, the sensitivity can be increased by using the same dog breed as the victim was. Unfortunately, this is not always possible to achieve, because 1) a suitable stimulus dog was not available or 2) the PR did not show information as to what breed the victim was. Sometimes dogs show aggressive behaviour toward other dogs because they are defending their owners, which makes the situation and cause of the aggression completely different. The dog which is being tested is leashed on a gate or railing during the entire test. Often, a dog involved in a bite incident on the street is not leashed at all. This could make a difference for the dog to feel less free to show bite behaviour towards the real dog passing by. In the test attempts were made to let a real dog (with preferably the same sex) pass the tested dog. Unfortunately, this was not always possible to achieve, so this could interfere with the outcome as well. On the other hand, leashed dogs tend to be more aggressive than when off leash.

In the previous research done in 2012 fake, stuffed dogs were used to test threat and/or bite behaviour towards other dogs. This subtest was removed from this research because of the low sensitivities of these subtest in the research of 2012 (lower than 0.20), probably because these stuffed dogs were not recognized as being real dogs at all, so they did not provide useful information .

In subtest 16 (*threat of dog keeper)* aggressive behaviour towards an adult, who is trusted by the dog, is tested. In some cases the dog might see this dog keeper the way he/she sees their owner. So the dog might react the same as he does on the street towards other dogs to protect this persons in certain situations. It is also possible that the dog has a different connection with the dog keeper compared to his or her owner. Then this subtest unfortunately does not reach its' goal.

Accidental biters
35% Of the dogs counted as accidental biters did actually show aggressive bite behaviour towards persons in the test. This means that 35% of the accidental biters are unfairly counted as accidental biters. This could be due to incomplete police reports with a lack of information about the history of the dog. It is possible that the behaviour history of the dog was not known, or it was not told by the owner due to fear of losing their dog. Another possibility could be that the tested dog was stressed during the test and for this reason did show abnormal behaviour this dog would not normally show.

CONCLUSION

With a sample size of 449 dogs this test has a high sample size compared to previous tests (Willem J. Netto, 1997). The sensitivity of the bite tests towards persons and dogs combined is 0.59. This value is decreased in comparison to the research result of 2012 (Roekel, 2012). The specificity did increase 0.01 point to 0.65 in the current research. When *bite behaviour in the PR* is compared to *threat behaviour in the test*, a sensitivity of 0.83 is found, which is the same as in the previous research. The specificity did decrease 0.06 point to 0.26. Looking at the values of *threat behaviour in PR* vs *threat behaviour in the test* the sensitivity is decreased from 0.91 to 0.86. The specificity of these subtests remained the same. The comparison of the entire test comparing *threat and/or bite* behaviour at least once in the PR vs. *threat and/or bite* behaviour at least once in the test has a sensitivity of 0.87, which remains equal to the previous research of 2012. The specificity increased from 0.25 to 0.29. Also, the positive predictive value did increase from 0.93 to 0.96. In conclusion, the outcomes of this research have improved the reliability of the entire research. Unfortunately, this does not also count for each subtest separately yet.

RECOMMENDATIONS

To reach a higher and better outcome of all the tests together, as well as for the subtests it is recommended to repeat this test again within a few years from now on. All of the values reaching a higher sample size can be calculated, which improves the reliability of each test and also of the entire research. It can be concluded from table 6 and 7 that the necessary sample sizes can be reached when the group of tested dogs is increased by approximately 200 dogs. Based on about 70 useful police reports a year, this research should be repeated after 3 years from now. It could also be useful to change the way the *real dog tests* are taken. Dogs can show aggressive behaviour towards certain breeds, while they do not necessarily show aggressive behaviour towards other breeds. It would be interesting for *the dog test* to use dogs of the same dog breed where the aggression was directed to in the PR. But it also remains useful to use stimulus dogs from a different breed than the one bitten, in order to assess whether or not the culprit tends to aggress dogs from other breed too. This is of interest with regard to diagnosis, but will probably have a decreasing effect on validity.
Although the information in the PR's has improved compared to the previous research, this still can be improved more by making a comprehensive questionnaire about the recognition of threat behaviour prior to the attack of the dog. It is hard to change components of the *doll tests.* Ethically, it will not be approved to use real children in this subtest. This also could be very dangerous. However, the fact that a lot of dogs do not recognize a doll as being a child cannot be ignored. Improvements of this subtests can be made by using children sounds/voices or larger dolls who can talk, walk and with arms and legs which can move. These kind of robot dolls can be an accomplished component for future research.

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APPENDIX 1

Aggression in conflict with another dog = human biter.

Period 2013-2015

Calculation of threat and/or bite behaviour over the complete set of tests

Threat and/or bite in at least one PR-component vs. **threat and/or bite** in at least one subtest

	Threat/bite behaviour	**No threat/bite behaviour**	Total
Positive test	159	2	161
Negative test	25	2	27
Total	184	4	188

Sensitivity:159/184 = 0.86 Positive predictive value: 159/161=0.99
Specificity: 2/4= 0.50 Negative predictive value: 2/27=0.07

Calculated threat behaviour of/over complete test

Threat in at least one PR-component vs. **threat** in at least one subtest

	Threat behaviour	**No threat behaviour**	Total
Positive test	70	84	154
Negative test	14	19	33
Total	84	103	187

Sensitivity: 70/84 = 0.83 Positive predictive value: 70/154 = 0.45
Specificity: 19/103 = 0.18 Negative predictive value: 19/33 = 0.58

Threat in at least one PR-component vs. **bite** in at least one subtest

	Threat behaviour	**No threat behaviour**	Total
Positive test	46	51	97
Negative test	38	52	90
Total	84	103	187

Sensitivity: 46/84 = 0.55 Positive predictive value: 46/97 = 0.47
Specificity: 52/103 = 0.50 Negative predictive value: 52/90 = 0.58

Calculated bite behaviour of/over complete test

Bite in at least one PR-component vs. **bite** in at least one subtest

	Bite behaviour	**No bite behaviour**	Total
Positive test	93	3	96
Negative test	85	6	91
Total	178	9	187

Sensitivity: 93/178 = 0.52 Positive predictive value: 93/96 = 0.97
Specificity: 6/9 = 0.67 Negative predictive value: 6/91 = 0.07

Bite in at least one PR-component vs. **threat** in at least one subtest

	Bite behaviour	**No bite behaviour**	Total
Positive test	146	8	154
Negative test	32	1	33
Total	178	9	187

Sensitivity: 146/178 = 0.82 Positive predictive value: 146/154 = 0.95
Specificity: 1/9 = 0.11 Negative predictive value: 1/33 = 0.03

Calculation threat behaviour towards children

PR **threat** child vs. **threat** large doll

	Threat history	**No threat history**	Total
Positive test	6	32	38
Negative test	17	130	147
Total	23	162	185

Sensitivity: 6/23 = 0.26 Positive predictive value: 6/38 = 0.16
Specificity: 130/162 = 0.80 Negative predictive value: 130/147 = 0.88

PR **threat** child vs. **threat** dark doll

	Threat history	**No threat history**	Total
Positive test	10	39	49
Negative test	14	125	139
Total	24	164	188

Sensitivity: 10/24 = 0.42 Positive predictive value: 10/49 = 0.20
Specificity: 125/164 = 0.76 Negative predictive value: 125/139 = 0.90

PR **threat** child vs. **threat** large Roxanne

	Threat history	**No threat history**	Total
Positive test	11	40	51
Negative test	13	126	139
Total	24	166	190

Sensitivity: 11/24 = 0.46 Positive predictive value: 11/51 = 0.22
Specificity: 126/166 = 0.76 Negative predictive value: 126/139 = 0.91

PR **threat** child vs. **threat** at least once of the doll tests.

	Threat history	**No threat history**	Total
Positive test	11	52	63
Negative test	12	114	126
Total	23	166	189

Sensitivity: 11/23 = 0.48 Positive predictive value: 11/63 = 0.17
Specificity: 114/166 = 0.69 Negative predictive value: 114/126 = 0.90

Calculation threat behaviour towards adults

PR **Threat** adult vs. **threat** petting hand

	Threat history	**No threat history**	Total
Positive test	7	10	17
Negative test	42	125	167
Total	49	135	184

Sensitivity: 7/49 = 0.14 Positive predictive value: 7/17 = 0.41
Specificity: 125/135 = 0.93 Negative predictive value: 125/167 = 0.75

PR **Threat** adult vs. **threat** surrounding test

	Threat history	**No threat history**	Total
Positive test	14	40	54
Negative test	30	88	118
Total	44	128	172

Sensitivity: 14/30 = 0.47 Positive predictive value: 14/54 = 0.26
Specificity: 88/128 = 0.69 Negative predictive value: 88/118 = 0.75

PR **Threat** adult vs. **threat** female threat

	Threat history	**No threat history**	Total
Positive test	20	52	72
Negative test	26	77	103
Total	46	129	175

Sensitivity: 20/46 = 0.43 Positive predictive value: 20/72 = 0.28
Specificity: 77/129 = 0.60 Negative predictive value: 77/103 = 0.75

PR **Threat** adult vs. **threat** male threat

	Threat history	**No threat history**	Total
Positive test	20	50	70
Negative test	22	70	92
Total	42	120	162

Sensitivity: 20/42 = 0.48 Positive predictive value: 20/70 = 0.29
Specificity: 70/120 = 0.58 Negative predictive value: 70/92 = 0.76

PR **Threat** adult vs. **threat** keeper threat

	Threat history	**No threat history**	Total
Positive test	8	28	36
Negative test	38	101	139
Total	46	129	175

Sensitivity: 8/46 = 0.17 Positive predictive value: 8/36 = 0.22
Specificity: 101/129 = 0.78 Negative predictive value: 101/139 = 0.73

PR **Threat** adult vs. **threat** in at least one adult test

	Threat history	**No threat history**	Total
Positive test	36	74	110
Negative test	15	62	77
Total	51	136	187

Sensitivity: 36/51 = 0.71 Positive predictive value: 36/110 = 0.33
Specificity: 62/136 = 0.46 Negative predictive value: 62/77 = 0.81

Calculation threat behaviour towards dogs

PR **Threat** small dog vs. **threat** life small dog

	Threat history	**No threat history**	Total
Positive test	3	58	61
Negative test	11	106	117
Total	14	164	178

Sensitivity: 3/14 = 0.21 Positive predictive value: 3/61 = 0.05
Specificity: 106/164 = 0.65 Negative predictive value: 106/117 = 0.91

PR **Threat** large dog vs. **threat** life large dog

	Threat history	**No threat history**	Total
Positive test	7	61	68
Negative test	13	99	112
Total	20	160	180

Sensitivity: 7/20 = 0.35 Positive predictive value: 7/68 = 0.10
Specificity: 99/160 = 0.62 Negative predictive value: 99/112 = 0.88

PR **Threat** dog vs. **threat** in at least one dogtest

	Threat history	**No threat history**	Total
Positive test	9	83	92
Negative test	16	79	95
Total	25	162	187

Sensitivity: 9/25 = 0.36 Positive predictive value: 9/92 = 0.10
Specificity: 79/162 = 0.49 Negative predictive value: 79/95 = 0.83

Calculation bite behaviour towards children

PR **bite** child vs. **bite** large doll

	Bite history	**No bite history**	Total
Positive test	5	9	14
Negative test	23	148	171
Total	28	157	185

Sensitivity: 5/28 = 0.18 Positive predictive value: 5/14 = 0.36
Specificity: 148/157 = 0.94 Negative predictive value: 148/171 = 0.87

PR **bite** child vs. **bite** dark doll

	Bite history	**No bite history**	Total
Positive test	9	29	38
Negative test	19	130	149
Total	28	159	187

Sensitivity: 9/28 = 0.32 Positive predictive value: 9/38 = 0.24
Specificity: 130/159 = 0.82 Negative predictive value: 130/149 = 0.87

PR **bite** child vs. **bite** Roxanne doll

	Bite history	**No bite history**	Total
Positive test	10	29	39
Negative test	19	131	150
Total	29	160	189

Sensitivity: 10/29 = 0.34 Positive predictive value: 10/39 = 0.26
Specificity: 131/160 = 0.82 Negative predictive value: 131/150 = 0.87

PR **bite** child vs. **bite** in at least one doll test

	Bite history	**No bite history**	Total
Positive test	14	35	49
Negative test	14	126	140
Total	28	161	189

Sensitivity: 14/28 = 0.50 Positive predictive value: 14/49 = 0.29
Specificity: 126/161 = 0.78 Negative predictive value: 126/140 = 0.90

Calculation bite behaviour towards joggers

PR **bite** jogger vs. **bite** jogger with fake hand

	Bite history	**No bite history**	Total
Positive test	2	30	32
Negative test	2	149	151
Total	4	179	183

Sensitivity: 2/4 = 0.50 Positive predictive value: 2/32 = 0.06
Specificity: 149/179 = 0.83 Negative predictive value: 149/151 = 0.99

PR **bite** jogger vs. **bite** jogger without fake hand

	Bite history	**No bite history**	Total

Positive test	1	24	25
Negative test	3	154	157
Total	4	178	182

Sensitivity: 1/4 = 0.25 Positive predictive value: 1/25 = 0.04
Specificity: 154/178 = 0.87 Negative predictive value: 154/157 = 0.98

PR **bite** cyclist vs. **bite** jogger with fake hand

	Bite history	**No bite history**	Total
Positive test	0	32	32
Negative test	9	142	151
Total	9	174	183

Sensitivity: 0/9 = 0 Positive predictive value: 0/32 = 0
Specificity: 142/174 = 0.82 Negative predictive value: 142/151 = 0.94

PR **bite** cyclist vs. **bite** jogger without fake hand

	Bite history	**No bite history**	Total
Positive test	0	25	25
Negative test	9	148	157
Total	9	173	182

Sensitivity: 0/9 = 0 Positive predictive value: 0/25 = 0
Specificity: 148/173 = 0.86 Negative predictive value: 148/157 = 0.94

PR **bite** jogger vs. **bite** in at least one joggertest

	Bite history	**No bite history**	Total
Positive test	2	31	33
Negative test	2	150	152
Total	4	181	185

Sensitivity: 2/4 = 0.50 Positive predictive value: 2/33 = 0.06
Specificity: 150/181 = 0.83 Negative predictive value: 150/152 = 0.99

Calculation bite behaviour towards adults

PR **bite** adult vs. **bite** petting test

	Bite history	**No bite history**	Total
Positive test	5	4	9
Negative test	78	97	175
Total	83	101	184

Sensitivity: 5/83 = 0.06 Positive predictive value: 5/9 = 0.56
Specificity: 97/101 = 0.96 Negative predictive value: 97/175 = 0.55

PR **bite** female vs. **bite** female threat

	Bite history	**No bite history**	Total
Positive test	6	13	19
Negative test	41	111	152
Total	47	124	171

Sensitivity: 6/47 = 0.13 Positive predictive value: 6/19 = 0.32
Specificity: 111/124 = 0.90 Negative predictive value: 111/152 = 0.73

PR **bite** male vs. **bite** male threat

	Bite history	**No bite history**	Total
Positive test	8	11	19
Negative test	36	104	140

Total	44	115	159

Sensitivity: 8/44 = 0.18 Positive predictive value: 8/19 = 0.42
Specificity: 104/115 = 0.90 Negative predictive value: 104/140 = 0.74

PR **bite** adult vs. **bite** surrounding test

	Bite history	**No bite history**	Total
Positive test	7	7	14
Negative test	73	85	158
Total	80	92	172

Sensitivity: 7/80 = 0.09 Positive predictive value: 7/14 = 0.50
Specificity: 85/92 = 0.92 Negative predictive value: 85/158 = 0.54

PR **bite** adult vs. **bite** female threat

	Bite history	**No bite history**	Total
Positive test	9	10	19
Negative test	73	83	156
Total	82	93	175

Sensitivity: 9/82 = 0.11 Positive predictive value: 9/19 = 0.47
Specificity: 83/93 = 0.89 Negative predictive value: 83/156 = 0.53

PR **bite** adult vs. **bite** male threat

	Bite history	**No bite history**	Total
Positive test	10	10	20
Negative test	64	78	142
Total	74	88	162

Sensitivity: 10/74 = 0.14 Positive predictive value: 10/20 = 0.50
Specificity: 78/88 = 0.89 Negative predictive value: 78/142 = 0.55

PR **bite** adult vs. **bite** keeper threat

	Bite history	**No bite history**	Total
Positive test	18	13	31
Negative test	64	80	144
Total	82	93	175

Sensitivity: 18/82 = 0.22 Positive predictive value: 18/31 = 0.58
Specificity: 80/93 = 0.86 Negative predictive value: 80/144 = 0.56

PR **bite** adult vs. **bite** in at least one of the adult tests

	Bite history	**No bite history**	Total
Positive test	33	25	58
Negative test	52	76	128
Total	85	101	186

Sensitivity: 33/85 = 0.39 Positive predictive value: 33/58 =0.57
Specificity: 76/101 = 0.75 Negative predictive value: 76/128 = 0.59

<u>Calculation bite behaviour towards dogs</u>

PR **bite** small dog vs. **bite** small life dog test

	Bite history	**No bite history**	Total
Positive test	23	19	42
Negative test	63	69	132
Total	86	88	174

Sensitivity: 23/86 = 0.27 Positive predictive value: 23/42 = 0.55
Specificity: 69/88 = 0.78 Negative predictive value: 124/224 = 0.52

PR **bite** large dog vs. **bite** large life dog test

	Bite history	**No bite history**	Total
Positive test	8	29	37
Negative test	50	89	139
Total	58	118	176

Sensitivity: 8/58 = 0.14
Positive predictive value: 8/37 = 0.22
Specificity: 89/118 = 0.75
Negative predictive value: 89/139 = 0.64

PR **bite** dog vs. **bite** in at least one dogtest

	Bite history	**No bite history**	Total
Positive test	36	18	54
Negative test	84	48	132
Total	120	66	186

Sensitivity: 36/120 = 0.30
Positive predictive value: 36/54 = 0.67
Specificity: 48/66 = 0.73
Negative predictive value: 48/132 = 0.36

PR **bite** dog vs. **threat and/or bite** in at least one dogtest

	Bite history	**No bite history**	Total
Positive test	72	31	103
Negative test	48	36	84
Total	120	67	187

Sensitivity: 72/120 = 0.60
Positive predictive value: 72/103 = 0.70
Specificity: 36/67 = 0.54
Negative predictive value: 36/84 = 0.43

Period 2008-2015

Calculation of threat and/or bite behaviour over the complete set of tests

Threat and/or bite in at least one PR-component vs. **threat and/or bite** in at least one subtest

	Threat/bite behaviour	**No threat/bite behaviour**	Total
Positive test	365	17	382
Negative test	56	7	63
Total	421	24	445

Sensitivity:365/421 = 0.87 Positive predictive value: 365/382=0.96
Specificity: 7/24= 0.29 Negative predictive value: 7/63 = 0.11

Calculated threat behaviour of/over complete test

Threat in at least one PR-component vs. **threat** in at least one subtest

	Threat behaviour	**No threat behaviour**	Total
Positive test	112	251	363
Negative test	18	61	79
Total	130	312	442

Sensitivity: 112/130 = 0.86 Positive predictive value: 112/363 = 0.31
Specificity: 61/312 = 0.20 Negative predictive value: 61/79 = 0.77

Threat in at least one PR-component vs. **bite** in at least one subtest

	Threat behaviour	**No threat behaviour**	Total
Positive test	83	172	255
Negative test	47	140	187
Total	130	312	442

Sensitivity: 83/130 = 0.64 Positive predictive value: 83/255 = 0.33
Specificity: 140/312 = 0.45 Negative predictive value: 140/187 = 0.75

Calculated bite behaviour of/over complete test

Bite in at least one PR-component vs. **bite** in at least one subtest

	Bite behaviour	**No bite behaviour**	Total
Positive test	244	11	255
Negative test	169	20	189
Total	413	31	444

Sensitivity: 244/413 = 0.59 Positive predictive value: 244/255 = 0.96
Specificity: 20/31 = 0.65 Negative predictive value: 20/189 = 0.11

Bite in at least one PR-component vs. **threat** in at least one subtest

	Bite behaviour	**No bite behaviour**	Total
Positive test	342	23	365
Negative test	71	8	79
Total	413	31	444

Sensitivity: 342/413 = 0.83 Positive predictive value: 342/365 = 0.94
Specificity: 8/31 = 0.26 Negative predictive value: 8/79 = 0.10

Calculation threat behaviour towards children

PR **threat** child vs. **threat** large doll

	Threat history	**No threat history**	Total
Positive test	6	37	43
Negative test	18	144	162
Total	24	181	205

Sensitivity: 6/24 = 0.25 Positive predictive value: 6/43 = 0.14
Specificity: 144/181 = 0.80 Negative predictive value: 144/162 = 0.89

PR **threat** child vs. **threat** dark doll

	Threat history	**No threat history**	Total
Positive test	11	57	68
Negative test	17	180	197
Total	28	237	265

Sensitivity: 11/28 = 0.39 Positive predictive value: 11/68 = 0.16
Specificity: 180/237 = 0.76 Negative predictive value: 180/197 = 0.91

PR **threat** child vs. **threat** large Roxanne

	Threat history	**No threat history**	Total
Positive test	11	84	95
Negative test	18	304	322
Total	29	388	417

Sensitivity: 11/29 = 0.38 Positive predictive value: 11/95 = 0.12
Specificity: 304/388 = 0.78 Negative predictive value: 304/322 = 0.94

PR **threat** child vs. **threat** at least once of the doll tests.

	Threat history	**No threat history**	Total
Positive test	12	115	127
Negative test	16	263	279
Total	28	378	406

Sensitivity: 12/28 = 0.43 Positive predictive value: 12/127 = 0.09
Specificity: 263/378 = 0.70 Negative predictive value: 263/279 = 0.94

Calculation threat behaviour towards adults

PR **Threat** adult vs. **threat** petting hand

	Threat history	**No threat history**	Total
Positive test	9	31	40
Negative test	68	252	320
Total	77	283	360

Sensitivity: 9/77 = 0.12 Positive predictive value: 9/40 = 0.23
Specificity: 252/283 = 0.89 Negative predictive value: 252/320 = 0.79

PR **Threat** adult vs. **threat** surrounding test

	Threat history	**No threat history**	Total
Positive test	26	80	106
Negative test	44	184	228
Total	70	264	334

Sensitivity: 26/70 = 0.37 Positive predictive value: 26/106 = 0.25
Specificity: 184/264 = 0.70 Negative predictive value: 184/228 = 0.81

PR **Threat** adult vs. **threat** female threat

	Threat history	**No threat history**	Total
Positive test	34	111	145
Negative test	37	160	197
Total	71	271	342

Sensitivity: 34/71 = 0.49 Positive predictive value: 34/145 = 0.23
Specificity: 160/271 = 0.59 Negative predictive value: 160/197 = 0.81

PR **Threat** adult vs. **threat** male threat

	Threat history	**No threat history**	Total
Positive test	35	107	142
Negative test	30	138	168
Total	65	245	310

Sensitivity: 35/65 = 0.54 Positive predictive value: 35/142 = 0.25
Specificity: 138/245 = 0.56 Negative predictive value: 138/168 = 0.82

PR **Threat** adult vs. **threat** keeper threat

	Threat history	**No threat history**	Total
Positive test	17	56	73
Negative test	57	206	263
Total	74	262	336

Sensitivity: 17/74 = 0.23 Positive predictive value: 17/73 = 0.23
Specificity: 206/262 = 0.79 Negative predictive value: 206/263 = 0.78

PR **Threat** adult vs. **threat** in at least one adult test

	Threat history	**No threat history**	Total
Positive test	59	153	212
Negative test	20	124	144
Total	79	277	356

Sensitivity: 59/79 = 0.75 Positive predictive value: 59/212 = 0.28
Specificity: 124/277 = 0.45 Negative predictive value: 124/144 = 0.86

Calculation threat behaviour towards dogs

PR **Threat** small dog vs. **threat** life small dog

	Threat history	**No threat history**	Total
Positive test	4	87	91
Negative test	15	169	184
Total	19	256	275

Sensitivity: 4/19 = 0.21 Positive predictive value: 4/91 = 0.04
Specificity: 169/256 = 0.66 Negative predictive value: 169/184 = 0.92

PR **Threat** large dog vs. **threat** life large dog

	Threat history	**No threat history**	Total
Positive test	12	129	141
Negative test	15	217	232
Total	27	346	373

Sensitivity: 12/27 = 0.44 Positive predictive value: 12/141 = 0.09
Specificity: 217/346 = 0.63 Negative predictive value: 217/232 = 0.94

PR **threat** dog vs. **threat** small and/or large life dog test

	Threat history	**No threat history**	Total
Positive test	18	167	185
Negative test	21	194	215
Total	39	361	400

Sensitivity: 18/39 = 0.46 Positive predictive value: 18/185 = 0.10
Specificity: 194/361 = 0.54 Negative predictive value: 194/215 = 0.90

PR **Threat** dog vs. **threat** in at least one dogtest

	Threat history	**No threat history**	Total
Positive test	19	183	202
Negative test	20	195	215
Total	39	378	417

Sensitivity: 19/39 = 0.49 Positive predictive value: 19/202 = 0.09
Specificity: 195/378 = 0.52 Negative predictive value: 195/215 = 0.91

Calculation bite behaviour towards children

PR **bite** child vs. **bite** large doll

	Bite history	**No bite history**	Total
Positive test	5	9	14
Negative test	26	165	191
Total	31	174	205

Sensitivity: 5/31 = 0.16 Positive predictive value: 5/14 = 0.36
Specificity: 165/174 = 0.95 Negative predictive value: 165/191 = 0.86

PR **bite** child vs. **bite** dark doll

	Bite history	**No bite history**	Total
Positive test	12	33	45
Negative test	43	193	236
Total	55	226	281

Sensitivity: 12/55 = 0.22 Positive predictive value: 12/45 = 0.27
Specificity: 193/226 = 0.85 Negative predictive value: 193/236 = 0.82

PR **bite** child vs. **bite** Roxanne doll

	Bite history	**No bite history**	Total
Positive test	23	63	86
Negative test	63	307	370
Total	86	370	456

Sensitivity: 23/86 = 0.27 Positive predictive value: 23/86 = 0.27
Specificity: 307/370 = 0.83 Negative predictive value: 307/370 = 0.83

PR **bite** child vs. **bite** in at least one doll test

	Bite history	**No bite history**	Total
Positive test	28	72	100
Negative test	57	289	346
Total	85	361	446

Sensitivity: 28/85 = 0.33 Positive predictive value: 28/100 = 0.28
Specificity: 289/361 = 0.80 Negative predictive value: 289/346 = 0.84

PR **bite** child vs. **bite and/or threat** in at least one doll test

	Bite history	**No bite history**	Total

Positive test	45	120	165
Negative test	40	241	281
Total	85	361	446

Sensitivity: 45/80 = 0.56
Specificity: 241/361 = 0.67
Positive predictive value: 45/165 = 0.27
Negative predictive value: 241/281 = 0.86

Calculation bite behaviour towards joggers

PR **bite** jogger vs. **bite** jogger with fake hand

	Bite history	**No bite history**	Total
Positive test	4	92	96
Negative test	5	327	332
Total	9	419	428

Sensitivity: 4/9 = 0.44 Positive predictive value: 4/96 = 0.04
Specificity: 327/419 = 0.78 Negative predictive value: 327/332 = 0.98

PR **bite** jogger vs. **bite** jogger without fake hand

	Bite history	**No bite history**	Total
Positive test	3	33	36
Negative test	3	161	164
Total	6	194	200

Sensitivity: 3/6 = 0.5 Positive predictive value: 3/36 = 0.08
Specificity: 161/194 = 0.83 Negative predictive value: 161/164 = 0.98

PR **bite** cyclist vs. **bite** jogger with fake hand

	Bite history	**No bite history**	Total
Positive test	1	93	94
Negative test	16	316	332
Total	17	409	426

Sensitivity: 1/17 = 0.06 Positive predictive value: 1/94 = 0.01
Specificity: 316/409 = 0.77 Negative predictive value: 316/332 = 0.95

PR **bite** cyclist vs. **bite** jogger without fake hand

	Bite history	**No bite history**	Total
Positive test	1	35	36
Negative test	10	154	164
Total	11	189	200

Sensitivity: 1/11 = 0.09 Positive predictive value: 1/36 = 0.03
Specificity: 154/189 = 0.81 Negative predictive value: 154/164 = 0.94

PR **bite** jogger vs. **bite** in at least one joggertest

	Bite history	**No bite history**	Total
Positive test	4	92	96
Negative test	5	319	324
Total	9	411	420

Sensitivity: 4/9 = 0.44 Positive predictive value: 4/96 = 0.04
Specificity: 319/411 = 0.78 Negative predictive value: 319/324 = 0.98

Calculation bite behaviour towards adults

PR **bite** adult vs. **bite** petting test

	Bite history	**No bite history**	Total
Positive test	12	1	13
Negative test	248	201	449
Total	260	202	462

Sensitivity: 12/260 = 0.05 Positive predictive value: 12/13 = 0.92
Specificity: 201/202 = 1.00 Negative predictive value: 201/449 = 0.45

PR **bite** female vs. **bite** female threat

	Bite history	**No bite history**	Total
Positive test	11	27	38
Negative test	123	251	374
Total	134	278	412

Sensitivity: 11/134 = 0.08 Positive predictive value: 11/38 = 0.29
Specificity: 251/278 = 0.90 Negative predictive value: 251/374 = 0.67

PR **bite** male vs. **bite** male threat

	Bite history	**No bite history**	Total
Positive test	22	18	40
Negative test	108	223	331
Total	130	241	371

Sensitivity: 22/130 = 0.17 Positive predictive value: 22/40 = 0.55
Specificity: 223/241 = 0.93 Negative predictive value: 223/331 = 0.67

PR **bite** adult vs. **bite** surrounding test

	Bite history	**No bite history**	Total
Positive test	22	11	33
Negative test	204	171	375
Total	226	182	408

Sensitivity: 22/226 = 0.10 Positive predictive value: 22/33 = 0.67
Specificity: 171/182 = 0.94 Negative predictive value: 171/375 = 0.46

PR **bite** adult vs. **bite** female threat

	Bite history	**No bite history**	Total
Positive test	25	13	38
Negative test	210	172	382
Total	235	185	420

Sensitivity: 25/235 = 0.11 Positive predictive value: 25/38 = 0.66
Specificity: 172/185 = 0.93 Negative predictive value: 172/382 = 0.45

PR **bite** adult vs. **bite** male threat

	Bite history	**No bite history**	Total
Positive test	26	15	41
Negative test	187	151	338
Total	213	166	379

Sensitivity: 26/213 = 0.12 Positive predictive value: 26/41 = 0.63
Specificity: 151/166 = 0.91 Negative predictive value: 151/338 = 0.45

PR **bite** adult vs. **bite** keeper threat

	Bite history	**No bite history**	Total
Positive test	69	35	104
Negative test	159	147	306

Total	228	182	410

Sensitivity: 69/228 = 0.30 Positive predictive value: 69/104 = 0.66
Specificity: 147/182 = 0.81 Negative predictive value: 147/306 = 0.48

PR **bite** adult vs. **bite** in at least one of the adult tests

	Bite history	**No bite history**	Total
Positive test	99	49	148
Negative test	139	148	287
Total	238	197	435

Sensitivity: 99/238 = 0.42 Positive predictive value: 99/148 =0.67
Specificity: 148/197 = 0.75 Negative predictive value: 148/287 = 0.52

Calculation bite behaviour towards dogs

PR **bite** small dog vs. **bite** small life dog test

	Bite history	**No bite history**	Total
Positive test	41	33	74
Negative test	100	124	224
Total	141	157	298

Sensitivity: 41/141 = 0.29 Positive predictive value: 41/74 = 0.55
Specificity: 124/157 = 0.79 Negative predictive value: 124/224 = 0.55

PR **bite** large dog vs. **bite** large life dog test

	Bite history	**No bite history**	Total
Positive test	27	64	91
Negative test	77	227	304
Total	104	291	395

Sensitivity: 27/104 = 0.26 Positive predictive value: 27/91 = 0.30
Specificity: 227/291 = 0.78 Negative predictive value: 227/304 = 0.75

PR **bite** dog vs. **bite** small and/or large life dog test

	Bite history	**No bite history**	Total
Positive test	79	42	121
Negative test	162	151	313
Total	241	193	434

Sensitivity: 79/241 = 0.33 Positive predictive value: 79/121 = 0.65
Specificity: 151/193 = 0.78 Negative predictive value: 151/313 = 0.48

PR **bite** dog vs. **bite and/or threat** small and/or large life dog test

	Bite history	**No bite history**	Total
Positive test	113	51	164
Negative test	103	128	231
Total	216	179	395

Sensitivity: 113/216 = 0.52 Positive predictive value: 113/164 = 0.69
Specificity: 128/179 = 0.72 Negative predictive value: 128/231 = 0.55

PR **bite** dog vs. **bite** in at least one dogtest

	Bite history	**No bite history**	Total
Positive test	90	51	141
Negative test	151	146	297
Total	241	197	438

Sensitivity: 90/241 = 0.37 Positive predictive value: 90/141 = 0.64
Specificity: 146/197 = 0.74 Negative predictive value: 146/297 = 0.49

PR **bite** dog vs. **threat and/or bite** in at least one dogtest

	Bite history	**No bite history**	Total
Positive test	153	94	247
Negative test	88	104	192
Total	241	198	439

Sensitivity: 153/241 = 0.63 Positive predictive value: 153/247 = 0.62

Specificity: 104/198 = 0.53 Negative predictive value: 104/192 = 0.54

APPENDIX 2

Aggressive behaviour in In conflict with another dog = NOT human biter.

Period 2013-2015

Calculation of threat and/or bite behaviour over the complete test

Threat and/or bite in at least one PR-component vs. **threat and/or bite** in at least one subtest

	Threat/bite history	**No threat/bite history**	Total
Positive test	161	1	162
Negative test	25	1	26
Total	186	2	188

Sensitivity:161/186 = 0.87 Positive predictive value: 161/162=0.99
Specificity: 1/2= 0.50 Negative predictive value: 1/26 = 0.04

Calculated threat behaviour of/over complete test

Threat in at least one PR-component vs. **threat** in at least one subtest

	Threat history	**No threat history**	Total
Positive test	70	84	154
Negative test	14	19	33
Total	84	103	187

Sensitivity: 70/84 = 0.83 Positive predictive value: 70/154 = 0.45
Specificity: 19/103 = 0.18 Negative predictive value: 19/33 = 0.58

Threat in at least one PR-component vs. **bite** in at least one subtest

	Threat history	**No threat history**	Total
Positive test	37	65	102
Negative test	34	52	86
Total	71	117	188

Sensitivity: 37/71 = 0.52 Positive predictive value: 37/102 = 0.36
Specificity: 52/117 = 0.44 Negative predictive value: 52/86 = 0.60

Calculated bite behaviour of/over complete test

Bite in at least one PR-component vs. **bite** in at least one subtest

	Bite behaviour	**No bite history**	Total
Positive test	93	3	96
Negative test	85	6	91
Total	178	9	187

Sensitivity: 93/178 = 0.52 Positive predictive value: 93/96 = 0.97
Specificity: 6/9 = 0.67 Negative predictive value: 6/91 = 0.07

Bite in at least one PR-component vs. **threat** in at least one subtest

	Bite history	**No bite history**	Total
Positive test	148	7	155
Negative test	32	0	32
Total	180	7	187

Sensitivity: 148/180 = 0.82 Positive predictive value: 148/155 = 0.95
Specificity: 0/7 = 0 Negative predictive value: 0/32 = 0

Calculation threat adult

PR **Threat** adult vs. **threat** petting hand

	Threat history	**No threat history**	Total
Positive test	7	10	17
Negative test	42	125	167
Total	49	135	184

Sensitivity: 7/42 = 0.17 Positive predictive value: 7/17 = 0.41
Specificity: 125/135 = 0.93 Negative predictive value: 125/167 = 0.75

PR **Threat** adult vs. **threat** surrounding test

	Threat history	**No threat history**	Total
Positive test	14	40	54
Negative test	30	88	118
Total	44	128	172

Sensitivity: 14/44 = 0.32 Positive predictive value: 14/54 = 0.26
Specificity: 88/128 = 0.69 Negative predictive value: 88/118 = 0.75

PR **Threat** adult vs. **threat** female threat

	Threat history	**No threat history**	Total
Positive test	20	52	72
Negative test	26	77	103
Total	46	129	175

Sensitivity: 20/46 = 0.43 Positive predictive value: 20/72 = 0.28
Specificity: 77/129 = 0.60 Negative predictive value: 77/103 = 0.75

PR **Threat** adult vs. **threat** male threat

	Threat history	**No threat history**	Total
Positive test	20	50	70
Negative test	22	70	92
Total	42	120	162

Sensitivity: 20/42 = 0.48 Positive predictive value: 20/70 = 0.29
Specificity: 70/120 = 0.58 Negative predictive value: 70/92 = 0.76

PR **Threat** adult vs. **threat** keeper threat

	Threat history	**No threat history**	Total
Positive test	8	28	36
Negative test	38	101	139
Total	46	129	175

Sensitivity: 8/46 = 0.17 Positive predictive value: 8/36 = 0.22
Specificity: 101/129 = 0.78 Negative predictive value: 101/139 = 0.73

PR **Threat** adult vs. **threat** in at least one adult test

	Threat history	**No threat history**	Total
Positive test	36	74	110
Negative test	15	62	77
Total	51	136	187

Sensitivity: 36/51 = 0.71 Positive predictive value: 36/110 = 0.33
Specificity: 62/136 = 0.46 Negative predictive value: 62/77 = 0.81

Calculation bite adult

PR **bite** adult vs. **bite** petting test

	Bite history	**No bite history**	Total
Positive test	5	4	9
Negative test	58	117	175
Total	63	121	184

Sensitivity: 5/63 = 0.08 Positive predictive value: 5/9 = 0.56
Specificity: 117/121 = 0.97 Negative predictive value: 117/175 = 0.67

PR **bite** female vs. **bite** female threat

	Bite history	**No bite history**	Total
Positive test	5	14	19
Negative test	30	122	152
Total	35	136	171

Sensitivity: 5/30 = 0.17 Positive predictive value: 5/19 = 0.26
Specificity: 122/136 = 0.90 Negative predictive value: 122/152 = 0.80

PR **bite** male vs. **bite** male threat

	Bite history	**No bite history**	Total
Positive test	6	13	19
Negative test	29	111	140
Total	35	124	159

Sensitivity: 6/35 = 0.17 Positive predictive value: 6/19 = 0.32
Specificity: 111/124 = 0.90 Negative predictive value: 111/140 = 0.79

PR **bite** adult vs. **bite** surrounding test

	Bite history	**No bite history**	Total
Positive test	5	9	14
Negative test	55	103	158
Total	60	112	172

Sensitivity: 5/55 = 0.09 Positive predictive value: 5/14 = 0.36
Specificity: 103/112 = 0.92 Negative predictive value: 103/158 = 0.65

PR **bite** adult vs. **bite** female threat

	Bite history	**No bite history**	Total
Positive test	7	12	19
Negative test	55	101	156
Total	62	113	175

Sensitivity: 7/62 = 0.11 Positive predictive value: 7/19 = 0.37
Specificity: 101/113 = 0.89 Negative predictive value: 101/156 = 0.65

PR **bite** adult vs. **bite** male threat

	Bite history	**No bite history**	Total
Positive test	8	12	20
Negative test	48	94	142
Total	56	106	162

Sensitivity: 8/56 = 0.14 Positive predictive value: 8/20 = 0.40
Specificity: 94/106 = 0.89 Negative predictive value: 94/142 = 0.66

PR **bite** adult vs. **bite** keeper threat

	Bite history	**No bite history**	Total
Positive test	13	18	31
Negative test	49	95	144

Total	62	113	175

Sensitivity: 13/62 = 0.21 Positive predictive value: 13/31 = 0.42
Specificity: 95/113 = 0.84 Negative predictive value: 95/144 = 0.66

PR **bite** adult vs. **bite** in at least one of the adult tests

	Bite history	**No bite history**	Total
Positive test	5	54	59
Negative test	7	113	120
Total	12	167	179

Sensitivity: 5/12 = 0.42 Positive predictive value: 5/59 =0.08
Specificity: 113/167 = 0.68 Negative predictive value: 113/120 = 0.94

Period 2008-2015

Calculation of threat and/or bite behaviour over the complete test

Threat and/or bite in at least one PR-component vs. **threat and/or bite** in at least one subtest

	Threat/bite history	**No threat/bite history**	Total
Positive test	365	17	382
Negative test	56	7	63
Total	421	24	445

Sensitivity:365/421 = 0.87 Positive predictive value: 365/382=0.96
Specificity: 7/24= 0.29 Negative predictive value: 7/63 = 0.11

Calculated threat behaviour of/over complete test

Threat in at least one PR-component vs. **threat** in at least one subtest

	Threat history	**No threat history**	Total
Positive test	111	254	365
Negative test	18	61	79
Total	129	315	442

Sensitivity: 111/129 = 0.86 Positive predictive value: 111/365 = 0.30
Specificity: 61/315 = 0.19 Negative predictive value: 61/79 = 0.77

Threat in at least one PR-component vs. **bite** in at least one subtest

	Threat history	**No threat history**	Total
Positive test	83	173	256
Negative test	46	142	188
Total	129	315	444

Sensitivity: 83/129 = 0.64 Positive predictive value: 83/256 = 0.32
Specificity: 142/315 = 0.45 Negative predictive value: 142/188 = 0.76

Calculated bite behaviour of/over complete test

Bite in at least one PR-component vs. **bite** in at least one subtest

	Bite behaviour	**No bite history**	Total
Positive test	244	11	255
Negative test	169	20	189
Total	413	31	444

Sensitivity: 244/413 = 0.59 Positive predictive value: 244/255 = 0.96
Specificity: 20/31 = 0.65 Negative predictive value: 20/189 = 0.11

Bite in at least one PR-component vs. **threat** in at least one subtest

	Bite history	**No bite history**	Total
Positive test	342	23	365
Negative test	71	8	79
Total	413	31	444

Sensitivity: 342/413 = 0.83 Positive predictive value: 342/365 = 0.94
Specificity: 8/31 = 0.26 Negative predictive value: 8/79 = 0.10

Calculation threat adult

PR **Threat** adult vs. **threat** petting hand

	Threat history	**No threat history**	Total
Positive test	9	31	40
Negative test	66	274	340
Total	75	305	380

Sensitivity: 9/75 = 0.12 Positive predictive value: 9/40 = 0.23
Specificity: 274/305 = 0.90 Negative predictive value: 274/340 = 0.81

PR **Threat** adult vs. **threat** surrounding test

	Threat history	**No threat history**	Total
Positive test	26	81	107
Negative test	42	204	246
Total	68	285	353

Sensitivity: 26/68 = 0.38 Positive predictive value: 26/107 = 0.24
Specificity: 204/285 = 0.72 Negative predictive value: 204/246 = 0.83

PR **Threat** adult vs. **threat** female threat

	Threat history	**No threat history**	Total
Positive test	34	120	154
Negative test	36	173	209
Total	70	293	342

Sensitivity: 34/70 = 0.49 Positive predictive value: 34/154 = 0.22
Specificity: 173/293 = 0.59 Negative predictive value: 173/209 = 0.83

PR **Threat** adult vs. **threat** male threat

	Threat history	**No threat history**	Total
Positive test	34	114	148
Negative test	29	151	180
Total	63	265	328

Sensitivity: 34/63 = 0.54 Positive predictive value: 34/148 = 0.23
Specificity: 151/265 = 0.57 Negative predictive value: 151/180 = 0.84

PR **Threat** adult vs. **threat** keeper threat

	Threat history	**No threat history**	Total
Positive test	17	57	74
Negative test	55	225	280
Total	72	282	354

Sensitivity: 17/72 = 0.24 Positive predictive value: 17/74 = 0.23
Specificity: 225/282 = 0.80 Negative predictive value: 225/280 = 0.80

PR **Threat** adult vs. **threat** in at least one adult test

	Threat history	**No threat history**	Total
Positive test	58	166	224
Negative test	19	140	159
Total	77	306	383

Sensitivity: 58/77 = 0.75 Positive predictive value: 58/224 = 0.26
Specificity: 140/306 = 0.46 Negative predictive value: 140/159 = 0.88

Calculation bite adult

PR **bite** adult vs. **bite** petting test

	Bite history	**No bite history**	Total
Positive test	10	1	11
Negative test	172	267	439
Total	182	268	450

Sensitivity: 10/182 = 0.05 Positive predictive value: 10/11 = 0.91
Specificity: 267/268 = 1.00 Negative predictive value: 267/439 = 0.61

PR **bite** female vs. **bite** female threat

	Bite history	**No bite history**	Total
Positive test	9	29	38
Negative test	76	251	327
Total	85	280	365

Sensitivity: 9/85 = 0.11 Positive predictive value: 9/38 = 0.24
Specificity: 251/280 = 0.90 Negative predictive value: 251/327 = 0.77

PR **bite** male vs. **bite** male threat

	Bite history	**No bite history**	Total
Positive test	17	23	40
Negative test	81	242	323
Total	98	265	363

Sensitivity: 17/98 = 0.17 Positive predictive value: 17/40 = 0.43
Specificity: 242/265 = 0.91 Negative predictive value: 242/323 = 0.75

PR **bite** adult vs. **bite** surrounding test

	Bite history	**No bite history**	Total
Positive test	17	15	32
Negative test	134	231	365
Total	151	246	397

Sensitivity: 17/151 = 0.11 Positive predictive value: 17/32 = 0.53
Specificity: 231/246 = 0.94 Negative predictive value: 231/365 = 0.63

PR **bite** adult vs. **bite** female threat

	Bite history	**No bite history**	Total
Positive test	21	17	38
Negative test	141	232	373
Total	162	249	411

Sensitivity: 21/162 = 0.13 Positive predictive value: 21/38 = 0.55
Specificity: 232/249 = 0.93 Negative predictive value: 232/373 = 0.62

PR **bite** adult vs. **bite** male threat

	Bite history	**No bite history**	Total
Positive test	21	20	41
Negative test	126	203	329
Total	147	223	370

Sensitivity: 21/147 = 0.14 Positive predictive value: 21/41 = 0.51
Specificity: 203/223 = 0.91 Negative predictive value: 203/329 = 0.62

PR **bite** adult vs. **bite** keeper threat

	Bite history	**No bite history**	Total
Positive test	49	52	101
Negative test	106	192	298

Total	155	244	399

Sensitivity: 49/155 = 0.32 Positive predictive value: 49/101 = 0.49
Specificity: 192/244 = 0.79 Negative predictive value: 192/298 = 0.64

PR **bite** adult vs. **bite** in at least one of the adult tests

	Bite history	**No bite history**	Total
Positive test	74	74	148
Negative test	98	189	287
Total	172	263	435

Sensitivity: 74/172 = 0.43 Positive predictive value: 74/148 =0.50
Specificity: 189/263 = 0.72 Negative predictive value: 189/287 = 0.66

APPENDIX 3

Formulas used for calculation of the reliability intervals

$$\left(Sens - 1.96\sqrt{\frac{sens(1-sens)}{a+c}}, \quad sens + 1{,}96\sqrt{\frac{sens(1-sens)}{a+c}} \right)$$

$$\left(Spec - 1.96\sqrt{\frac{spec(1-spec)}{b+d}}, \quad spec + 1{,}96\sqrt{\frac{spec(1-spec)}{b+d}} \right)$$

Reliability interval for sensitivity and specificity when persons during a dogfight are scored as 'bitten'.

Threat and/or bite in at least one PR-components vs **threat and/or bite** in at least one test-component.
Sensitivity 0.87

$$Sens \pm 1.96\ SE\ (sens) = \left(0.87 - 1.96\sqrt{\frac{0.87(1-0.87)}{421}}, \quad 0.87 + 1{,}96\sqrt{\frac{0.87(1-0.87)}{421}} \right)$$

95% CI sensitivity [0.83;0.90]

Specificity 0.29

$$Spec \pm 1.96\ SE(spec) = \left(0.29 - 1.96\sqrt{\frac{0.29(1-0.29)}{24}}, \quad 0.29 + 1{,}96\sqrt{\frac{0.29(1-0.29)}{24}} \right)$$

95% CI specificity [0.11;0.47]

Threat in at least one PR-components vs **threat** in at least once test-component.

Sensitivity 0.86

$$Sens \pm 1.96\ SE\ (sens) = \left(0.86 - 1.96\sqrt{\frac{0.86(1-0.86)}{130}}, \quad 0.86 + 1{,}96\sqrt{\frac{0.86(1-0.86)}{130}} \right)$$

95% CI sensitivity [0.80;0.92]

Specificity 0.20

$$Spec \pm 1.96\ SE(spec) = \left(0.20 - 1.96\sqrt{\frac{0.20(1-0.20)}{312}}, \quad 0.20 + 1{,}96\sqrt{\frac{0.20(1-0.20}{312}} \right)$$

95% CI specificity [0.16;0.24]

Threat in at least one PR-component vs **bite** in at least one test-component

Sensitivity 0.64

$$Sens \pm 1.96\ SE\ (sens) = \left(0.64 - 1.96\sqrt{\frac{0.64(1-0.64)}{130}},\quad 0.64 + 1{,}96\sqrt{\frac{0.64(1-0.64)}{130}}\right)$$

95% CI sensitivity [0.56;0.72]

Specificity 0.45

$$Spec \pm 1.96\ SE(spec) = \left(0.45 - 1.96\sqrt{\frac{0.45(1-0.45)}{312}},\quad spec + 1{,}96\sqrt{\frac{0.45(1-0.45}{312}}\right)$$

95% CI specificity [0.39;0.51]

Bite in at least one PR-component vs **bite** in at least one test-component.

Sensitivity 0.59

$$Sens \pm 1.96\ SE\ (sens) = \left(0.59 - 1.96\sqrt{\frac{0.59(1-0.59)}{413}},\quad sens + 1{,}96\sqrt{\frac{0.59(1-0.59)}{413}}\right)$$

95% CI sensitivity [0.54;0.64]

Specificity 0.65

$$Spec \pm 1.96\ SE(spec) = \left(0.65 - 1.96\sqrt{\frac{0.65(1-0.65)}{31}},\quad spec + 1{,}96\sqrt{\frac{0.65(1-0.65)}{31}}\right),$$

95% CI Specificity [0.48;0.82]

Bite in at least one PR-component vs **threat** in at least one test-component

Sensitivity 0.83

$$Sens \pm 1.96\ SE\ (sens) = \left(0.83 - 1.96\sqrt{\frac{0.83(1-0.83)}{413}},\quad 0.83 + 1{,}96\sqrt{\frac{0.83(1-0.83)}{413}}\right)$$

95% CI sensitivity [0.79;0.87]

Specificity 0.26

$$Spec \pm 1.96\ SE(spec) = \left(0.26 - 1.96\sqrt{\frac{0.26(1-0.26)}{31}},\quad 0.26 + 1{,}96\sqrt{\frac{0.26(1-0.26)}{31}}\right)$$

95% CI specificity [0.11;0.41]

Reliability interval for sensitivity and specificity when persons during a dogfight are NOT scored as 'bitten'.

Threat and/or bite in at least one PR-components vs **threat and/or bite** in at least one test-component.
Sensitivity 0.87

$$Sens \pm 1.96\ SE\ (sens) = \left(0.87 - 1.96\sqrt{\frac{0.87(1-0.87)}{421}},\quad 0.87 + 1{,}96\sqrt{\frac{0.87(1-0.87)}{421}}\right)$$

95% CI sensitivity [0.84;0.90]

Specificity 0.29

$$Spec \pm 1.96\ SE(spec) = \left(0.29 - 1.96\sqrt{\frac{0.29(1-0.29)}{24}},\quad 0.29 + 1{,}96\sqrt{\frac{0.29(1-0.29)}{24}}\right)$$

95% CI specificity [0.11;0.47]

Threat in at least one PR-components vs **threat** in at least once test-component.

Sensitivity 0.86

$$Sens \pm 1.96\ SE\ (sens) = \left(0.86 - 1.96\sqrt{\frac{0.86(1-0.86)}{129}},\quad 0.86 + 1{,}96\sqrt{\frac{0.86(1-0.86)}{129}}\right)$$

95% CI sensitivity [0.80;0.92]

Specificity 0.19

$$Spec \pm 1.96\ SE(spec) = \left(0.19 - 1.96\sqrt{\frac{0.19(1-0.19)}{313}},\quad 0.19 + 1{,}96\sqrt{\frac{0.19(1-0.19}{313}}\right)$$

95% CI specificity [0.15;0.23]

Bite in at least one PR-component vs **bite** in at least one test-component.

Sensitivity 0.59

$$Sens \pm 1.96\ SE\ (sens) = \left(0.59 - 1.96\sqrt{\frac{0.59(1-0.59)}{413}},\quad sens + 1{,}96\sqrt{\frac{0.59(1-0.59)}{413}}\right)$$

95% CI sensitivity [0.54;0.64]

Specificity 0.65

$$Spec \pm 1.96\ SE(spec) = \left(0.65 - 1.96\sqrt{\frac{0.65(1-0.65)}{31}},\quad spec + 1{,}96\sqrt{\frac{0.65(1-0.65)}{31}}\right)$$

95% CI specificity [0.39;0.91]

Bite in at least one PR-component vs **threat** in at least one test-component

Sensitivity 0.83

$$Sens \pm 1.96\ SE\ (sens) = \left(0.83 - 1.96\sqrt{\frac{0.83(1-0.83)}{413}},\quad 0.83 + 1{,}96\sqrt{\frac{0.83(1-0.83)}{413}}\right)$$

95% CI sensitivity [0.79;0.87]

Specificity 0.26

$$Spec \pm 1.96\ SE(spec) = \left(0.26 - 1.96\sqrt{\frac{0.26(1-0.26)}{31}},\quad 0.26 + 1{,}96\sqrt{\frac{0.26(1-0.26)}{31}}\right)$$

95% CI specificity [0.11;0.41]

Threat in at least one PR-component vs **bite** in at least one test-component

Sensitivity 0.64

$$Sens \pm 1.96\ SE\ (sens) = \left(0.64 - 1.96\sqrt{\frac{0.64(1-0.64)}{129}},\quad 0.64 + 1{,}96\sqrt{\frac{0.64(1-0.64)}{129}}\right)$$

95% CI sensitiviy [0.56;0.72]

Specificity 0.45

$$Spec \pm 1.96\ SE(spec) = \left(0.45 - 1.96\sqrt{\frac{0.45(1-0.45)}{313}},\quad spec + 1{,}96\sqrt{\frac{0.45(1-0.45}{313}}\right)$$

95% CI specificity [0.39;0.51]

APPENDIX 4

The behaviour test:

Subtest 1: cage test. Duration: 30 seconds
The dog stays in his own cage and the test person tries to make gently contact with the dog. Then the test persons stares the dog in the eyes for 5 seconds. Then the test persons runs beyond the cage for 3 times.
Behaviour reaction of the dog was:

- Aggressive behaviour: in combination of showing 2 threat behaviour more than two times. Like: growling, showing teeth, loud and repeated barking, staring and fixating with the eyes, brushing of the coat.
- Aggressive behaviour: loose threat behaviour:
- Falling out, biting/ bite attempt
- Reason for discontinue the test
- The dog is unapproachable, not able to be manipulate or tested. The test was discontinued
- The dog is not aggressive, but tries to flee continues, is very scared, does not recover and the test was discontinued
- In the cage test no aggressive behaviour was showed, the test was continued
- In the cage test friendly behaviour was showed, like:
    - Tail wagging
    - Sniffing and licking the fake hand
    - Sniffing and licking hand of the test person.
- Excited:
    - Fast tail wagging
    - Panting
    - Quick locomotion
    - Barking
    - Squealing
- Trying to find support
- Different:….

Subtest 2: Leashing and transport. Dog keeper leashes the dog in the cage. The dog is brought to a secluded part of the terrain and secured on a safe fixation place with two leashes.

- The dog cannot be manipulated without any danger
- The dog was manipulated without danger
- The dog had to be manipulated with a dog catcher (stick)

Subtest 3: The dog keeper tries the dog to perform the next 3 commands: come, sit and down. Each command will at most be tried for three times.

- The dog obeys to the command COME after being asked
    - 1 time
    - 2 times
    - 3 times
- The dog obeys to the command SIT after being asked
    - 1 time
    - 2 times
    - 3 times
- The dog obeys to the command DOWN after being asked
    - 1 time
    - 2 times
    - 3 times
- The dog does not obey to this commands

Subtest 4: Petting with a fake hand. The dog is being petted over the head, and if possible over the flanks and hind limbs, with a fake hand during 20 seconds.

- It is able to pet the dog
- It is not able to pet the dog
- The dog tries to prevent the test person from petting him/her
- The dog reacts scared, namely:

- Threat behaviour, namely …….. and then bite behaviour / falling out in the following manner:
- The dog bites / falls out without any prior visible threat behaviour
- The bite is a:
    - Short bite, and the dog lets go directly
    - Hard bite, and the dog lets go directly
    - Hard bite, and the dog does not let go directly
    - Hard bite with tearing / shaking
- No threat behaviour, no falling out / biting
- Excited:
    - Fast tail wagging
    - Panting
    - Quick locomotion
    - Barking
    - Squealing
- Socially positive response:
    - Tries to provocate play behaviour
    - Quietly tail wagging
- Submissive
- Licking lips
- Approaching
- Trying to find support
- Different: ….

Subtest 5: playing. The tester tries to play with the dog using a toy. Duration max. 1 minute.

- It is possible to play with the dog
- It is not possible to play with the dog
- The dog tries to avoid the toy
- The dog reacts scared: ….
- The dog let's go of the toy after a command
- The dog does not let go of the toy after a command
- The dog reacts with threat behaviour: …..
- Threat behaviour, namely: … and then bite behaviour / falling out in the following manner:
- The dog bites / falls out without any prior visible threat behaviour
- The bite is a:
    - Short bite, and the dog lets go directly
    - Hard bite, and the dog lets go directly
    - Hard bite, and the dog does not let go directly
    - Hard bite with tearing / shaking
- No threat behaviour, no falling out / biting
- Excited:
    - Fast tail wagging
    - Panting
    - Quick locomotion
    - Barking
    - Squealing
- Socially positive response:
    - Tries to provocate play behaviour
    - Quietly tail wagging
- Submissive
- Licking lips
- Approaching
- Trying to find support
- Different: ….

Subtest 6: pulling game. If the dog holds the toy of test 5, the test persons tries to play a pull play with the dog. Duration: 20 seconds.

- It is possible to play with the dog

- It is not possible to play with the dog: because …..
- The dog reacts scared: ….
- The dog let's go of the toy after a command
- The dog does not let go of the toy after a command
- The dog reacts with threat behaviour: …..
- Threat behaviour, namely: … and then bite behaviour / falling out in the following manner:
- The dog bites / falls out without any prior visible threat behaviour
- The bite is a:
    - Short bite, and the dog lets go directly
    - Hard bite, and the dog lets go directly
    - Hard bite, and the dog does not let go directly
    - Hard bite with tearing / shaking
- No threat behaviour, no falling out / biting
- Excited:
    - Fast tail wagging
    - Panting
    - Quick locomotion
    - Barking
    - Squealing
- Socially positive response:
    - Tries to provocate play behaviour
    - Quietly tail wagging
- Submissive
- Licking lips
- Approaching
- Trying to find support

Different: ….

Subtest 7: being threatened by a male person. The dog, fixated with two leashes, is being approached by a test person (male) who stares at the dog for 5 seconds, from a distance of 2 meters. Then the person makes one step forwards and makes a movement with his arms as if he is trying to hit the dog. Then the persons keeps standing in front of the dog for 5 seconds, while staring at the dog; the test person then turns around and does not look at the dog for 10 seconds (recover time).

- The dog reacts with threat behaviour:….
- Threat behaviour, namely ….. and then falling out in the following manner:
- The dog falls out without any prior visible threat behaviour
- No threat behaviour, no falling out / biting
- The dog reacts scared, namely…..
- In case of fright or fear:
    - The dog recovers:
        - Fast (within a few seconds)
        - Slow (it takes more than 10 seconds)
        - The dog does not recover during the entire test
- Excited:
    - Quick tail wagging
    - Panting
    - Quick locomotion
    - Barking
    - Squealing
- Socially positive approach:
    - Tries to provocate play behaviour
    - Quiet tail wagging
    - Licking lips
    - Approaching
    - Trying to find support
    - Different:…..

Subtest 8: being threatened by a female person (the same way as in test 7)

- The dog reacts with threat behaviour:….
- Threat behaviour, namely ….. and then falling out in the following manner:
- The dog falls out without any prior visible threat behaviour
- No threat behaviour, no falling out / biting
- The dog reacts scared, namely…..
- In case of fright or fear:
    - The dog recovers:
        - Fast (within a few seconds)
        - Slow (it takes more than 10 seconds)
        - The dog does not recover during the entire test
- Excited:
    - Quick tail wagging
    - Panting
    - Quick locomotion
    - Barking
    - Squealing
- Socially positive approach:
    - Tries to provocate play behaviour
    - Quiet tail wagging
    - Licking lips
    - Approaching
    - Trying to find support

Different:…..

Subtest 9a: Large doll. A large doll is being held from a 5 meter distance and is moved towards the dog to a minimum distance of 50 centimetres, so that the dog can approach and sniff the doll. When the dog is already tightening the leash, the doll will be moved towards the dog as far as possible, so that the dog can sniff the doll. The dog must be able to sniff the doll, then the doll will be quickly pulled back from the dog.

- The dog reacts with threat behaviour: …..
- Threat behaviour, namely ….. and then bite behaviour / falling out on the following manner:
- The dog bites / falls out without any prior visible threat behaviour
- The bite is a:
    - Short bite, and the dog lets go directly
    - Hard bite, and the dog lets go directly
    - Hard bite, and the dog does not let go directly
    - Hard bite with tearing / shaking
- No threat behaviour, no falling out / biting
- The dog reacts scared:…..
- The dog
    - Approaches the doll
    - Ignores the doll
    - Keeps a distance from the doll
    - Sniffs with a distance from the doll
    - Licks hands/face of the doll
- Socially positive approach:
    - Tries to provocate play behaviour
    - Quiet tail wagging
    - Licking lips
    - Approaching
    - Trying to find support
- Different:…..

Subtest 9b: Doll Roxanne (doll on a stick). The test person takes the second doll and approaches, with the feet of the doll over the ground, until a distance of 50 cms and then let's the dog approach the doll. When the leash is already tight, the doll will be moved towards the doll until the dog is able to sniff the doll. Then the tester pushes the doll repeatedly against the dog (like a pushy child) with a maximum duration of 20 seconds.

Then the doll will be quickly pulled from and pushed to the dog, to test chase behaviour.

- The dog reacts with threat behaviour: …..
- Threat behaviour, namely ….. and then bite behaviour / falling out on the following manner:
- The dog bites / falls out without any prior visible threat behaviour
- The bite is a:
    - Short bite, and the dog lets go directly
    - Hard bite, and the dog lets go directly
    - Hard bite, and the dog does not let go directly
    - Hard bite with tearing / shaking
- No threat behaviour, no falling out / biting
- The dog reacts scared:…..
- The dog
    - Approaches the doll
    - Ignores the doll
    - Keeps a distance from the doll
    - Sniffs with a distance from the doll
    - Licks hands/face of the doll
- Socially positive approach:
    - Tries to provocate play behaviour
    - Quiet tail wagging
    - Licking lips
    - Approaching
    - Trying to find support

Different:…..

Subtest 9c: Dark doll. The test person takes the second doll and approaches, with the feet of the doll over the ground, until a distance of 50 centimetres and then let's the dog approach the doll. When the leash is already tight, the doll will be moved towards the doll until the dog is able to sniff the doll. Then the tester pushes the doll repeatedly against the dog (like a pushy child) with a maximum duration of 20 seconds.
Then the doll will be quickly pulled from and pushed to the dog, to test chase behaviour.

- The dog reacts with threat behaviour: …..
- Threat behaviour, namely ….. and then bite behaviour / falling out on the following manner:
- The dog bites / falls out without any prior visible threat behaviour
- The bite is a:
    - Short bite, and the dog lets go directly
    - Hard bite, and the dog lets go directly
    - Hard bite, and the dog does not let go directly
    - Hard bite with tearing / shaking
- No threat behaviour, no falling out / biting
- The dog reacts scared:…..
- The dog
    - Approaches the doll
    - Ignores the doll
    - Keeps a distance from the doll
    - Sniffs with a distance from the doll
    - Licks hands/face of the doll
- Socially positive approach:
    - Tries to provocate play behaviour
    - Quiet tail wagging
    - Licking lips
    - Approaching
    - Trying to find support

Different:…..

Subtest 10: Umbrella test. The closed umbrella is held next to the leg of the test person. The test person approaches the dog frontally from a distance of 5 meter to a distance of 1 meter of the dog (not within the

safety circle). On this distance the umbrella will be opened once towards the dog and the umbrella will be dropped just on the outside of the safety circle, so that the dog cannot reach but can sniff the umbrella. Then the umbrella is picked up and closed and held next to the test person, who stands still and turned away for 10 seconds (recovery time).

- The dog is scared, but recovers within 1 second
- The dog is scared and recovers not within 10 seconds
- The dog scares and there is nog recovery within the subtest duration
- The dog reacts scared: ….
- The dog reacts with threat behaviour: …..
- Threat behaviour, namely ….. and then bite behaviour / falling out on the following manner:
- The dog bites / falls out without any prior visible threat behaviour
- The bite is a:
    - Short bite, and the dog lets go directly
    - Hard bite, and the dog lets go directly
    - Hard bite, and the dog does not let go directly
    - Hard bite with tearing / shaking
- No threat behaviour, no falling out / biting
- The dog reacts scared:…..
- The dog
    - Approaches the umbrella
    - Ignores the umbrella
    - Keeps a distance from the umbrella
    - Sniffs with a distance from the umbrella
    - Licks hands/face of the umbrella
- Socially positive approach:
    - Tries to provocate play behaviour
    - Quiet tail wagging
    - Licking lips
    - Approaching
    - Trying to find support
- Different:…..

Subtest 11 Horn test. The test person approaches the dog with a distance of 2 meters and pulls the horn in the direction of the dog. 5 times and each time 5 seconds. The dog should be able to sniff the horn. Then the test persons stands still and turned away for 10 seconds (recovery time).

- The dog is scared, but recovers within 1 second
- The dog is scared and recovers not within 10 seconds
- The dog scares and there is nog recovery within the subtest duration
- The dog reacts scared: ….
- The dog reacts with threat behaviour: …..
- Threat behaviour, namely ….. and then bite behaviour / falling out on the following manner:
- The dog bites / falls out without any prior visible threat behaviour
- The bite is a:
    - Short bite, and the dog lets go directly
    - Hard bite, and the dog lets go directly
    - Hard bite, and the dog does not let go directly
    - Hard bite with tearing / shaking
- No threat behaviour, no falling out / biting
- The dog reacts scared:…..
- The dog
    - Approaches the horn
    - Ignores the horn
    - Keeps a distance from the horn
    - Sniffs with a distance from the horn

- Licks hands/face of the horn

- Socially positive approach:
  - Tries to provocate play behaviour
  - Quiet tail wagging
  - Licking lips
  - Approaching
  - Trying to find support

Different:…..

Subtest 12: Taking away the feed bowl. The feed bowl is taken away, a small amount of pet food is put in, the test person places the bowl in front of the dog, just within the safety circle. If the dog is eating, the test persons tries to pet the dog with a fake hand and then tries 3 times slowly to pull the bowl away for a maximum duration of 20 seconds. If the dog is not eating, sausage will be added and the test well be repeated.

- The dog is scared, but recovers within 1 second
- The dog is scared and recovers not within 10 seconds
- The dog scares and there is nog recovery within the subtest duration
- The dog reacts scared: ….
- The dog reacts with threat behaviour: …..
- Threat behaviour, namely ….. and then bite behaviour / falling out on the following manner:
- The dog bites / falls out without any prior visible threat behaviour
- The bite is a:
  - Short bite, and the dog lets go directly
  - Hard bite, and the dog lets go directly
  - Hard bite, and the dog does not let go directly
  - Hard bite with tearing / shaking
- No threat behaviour, no falling out / biting
- The dog reacts scared:…..
- The dog
  - Approaches the food bowl
  - Ignores the food bowl
  - Keeps a distance from the food bowl
  - Sniffs with a distance from the food bowl
  - Licks hands/face of the food bowl

- Socially positive approach:
  - Tries to provocate play behaviour
  - Quiet tail wagging
  - Licking lips
  - Approaching
  - Trying to find support

Different:…..

Subtest 13a Real large dog test: A gently real large dog, preferably a dog of the same sex, is leashed and walks slowly beyond the tested dog. The tested dog is fixated safely to make sure the dogs cannot reach each other. Then the test person stands still with the stimulus dog for 5 seconds with a minimal distance. Then the stimulus dog walks back beyond the tested dog and is brought back to his cage.

- The dog is scared, but recovers within 1 second
- The dog is scared and recovers not within 10 seconds
- The dog scares and there is nog recovery within the subtest duration
- The dog reacts scared: ….
- The dog reacts with threat behaviour: …..
- Threat behaviour, namely ….. and then bite behaviour / falling out on the following manner:
- The dog bites / falls out without any prior visible threat behaviour
- The bite is a:
  - Short bite, and the dog lets go directly

- Hard bite, and the dog lets go directly
- Hard bite, and the dog does not let go directly
- Hard bite with tearing / shaking

- No threat behaviour, no falling out / biting
- The dog reacts scared:…..
- The dog
  - Approaches the dog
  - Ignores the dog
  - Keeps a distance from the dog
  - Sniffs with a distance from the dog
  - Licks hands/face of the dog

- Socially positive approach:
  - Tries to provocate play behaviour
  - Quiet tail wagging
  - Licking lips
  - Approaching
  - Trying to find support

Different:…..

Subtest 13b Real small dog test: A gently real small dog, preferably a dog of the same sex, is leashed and walks slowly beyond the tested dog. The tested dog is fixated safely to make sure the dogs cannot reach each other. Then the test person stands still with the stimulus dog for 5 seconds with a minimal distance. Then the stimulus dog walks back beyond the tested dog and is brought back to his cage.

- The dog is scared, but recovers within 1 second
- The dog is scared and recovers not within 10 seconds
- The dog scares and there is nog recovery within the subtest duration
- The dog reacts scared: ….
- The dog reacts with threat behaviour: …..
- Threat behaviour, namely ….. and then bite behaviour / falling out on the following manner:
- The dog bites / falls out without any prior visible threat behaviour
- The bite is a:
  - Short bite, and the dog lets go directly
  - Hard bite, and the dog lets go directly
  - Hard bite, and the dog does not let go directly
  - Hard bite with tearing / shaking
- No threat behaviour, no falling out / biting
- The dog reacts scared:…..
- The dog
  - Approaches the dog
  - Ignores the dog
  - Keeps a distance from the dog
  - Sniffs with a distance from the dog
  - Licks hands/face of the dog

- Socially positive approach:
  - Tries to provocate play behaviour
  - Quiet tail wagging
  - Licking lips
  - Approaching
  - Trying to find support

Different:…..

Subtest 14 Jogging test: A test person passes the dog while he/she is jogging, but does not come into the safety circle. On the side of the dog the jogger keeps the fake hand, which has to come into the safety circle while passing the dog. In total the test person has to pass the dog four times and the fake hand has to be held close to the dog each time. This can be repeated twice when the pattern of desensitisation / sensitisation is not clear of

when it is suspected that the dog is fixating on the fake hand instead of the person who is jogging. When this is the case, the dog will be passed another two times without a fake hand. The dog can be passed to a maximum of 6 times. When the dog reacts to a passage with a fake hand, then the dog will be passed again twice without a fake hand.

- The dog reacts with threat behaviour: …..
- Threat behaviour, namely ….. and then bite behaviour / falling out on the following manner:
- The dog bites / falls out without any prior visible threat behaviour
- The bite is a:
    - Short bite, and the dog lets go directly
    - Hard bite, and the dog lets go directly
    - Hard bite, and the dog does not let go directly
    - Hard bite with tearing / shaking
- No threat behaviour, no falling out / biting
- The dog reacts scared:…..
- Excited
    - Quick tail wag
    - Panting
    - Quick locomotion
    - Barking
    - Squeaking
- Socially positive approach:
    - Tries to provocate play behaviour
    - Quiet tail wagging
    - Licking lips
    - Approaching
    - Trying to find support
- Runs with jogger
    - Passage 1
    - Passage 2
    - Passage 3
    - Passage 4
- Falls out / bites during
    - Passage 1
    - Passage 2
    - Passage 3
    - Passage 4

Different:…..

Subtest 15 Surrounding test: The dog is being surrounded by 3 persons. These persons enlarge themselves (stretching their arms) and quickly walk towards the dog from a distance of 5 meters, towards the safety circle and they stand there for 5 seconds while they spread their arms and look at the dog while they bend forwards towards the dog. Then they walk backwards.

- The dog reacts with threat behaviour: …..
- Threat behaviour, namely ….. and then bite behaviour / falling out on the following manner:
- The dog bites / falls out without any prior visible threat behaviour
- No threat behaviour, no falling out / biting
- The dog reacts scared:…..
- Excited
    - Quick tail wag
    - Panting
    - Quick locomotion
    - Barking
    - Squeaking
- Socially positive approach:

- Tries to provocate play behaviour
- Quiet tail wagging
- Licking lips
- Approaching
- Trying to find support

- Different….

Subtest 16 Dog keeper test: The dog keeper is being threat by the test person. The test person walks from a distance of 5 meter towards the dog keeper and threatens him/her with yelling to him/her and holding him/her during 20 seconds. The test person is holding a fake hand which is within the reach of the dog, so that this dog could bite into it. The dog keeper plays along and also holds the test persons and yells that the test person.

- The dog reacts with threat behaviour: …..
- Threat behaviour, namely ….. and then bite behaviour / falling out on the following manner:
- The dog bites / falls out without any prior visible threat behaviour
- No threat behaviour, no falling out / biting
- The dog reacts scared:…..
- Excited
  - Quick tail wag
  - Panting
  - Quick locomotion
  - Barking
  - Squeaking
- Socially positive approach:
  - Tries to provocate play behaviour
  - Quiet tail wagging
  - Licking lips
  - Approaching
  - Trying to find support
- Different….

APPENDIX 5

Description of each subtest.

Subtest	Description
1	**Cage test:** The dog stays in his cage and the test-person tries to make contact with the dog in a friendly way. Then the test-persons fixates his/her eyes on the dogs' eyes for five seconds. Then the test-persons runs back and forth past the cage for three times.
2	**Leashing and transport:** Leashing and transport. Dog keeper leashes the dog in the cage. The dog is brought to a secluded part of the terrain and secured on a safe fixation place with two leashes.
3	**Commands:** The dog keeper tries the dog to perform the next 3 commands: come, sit and down. Each command will at most be tried for three times.
4	**Petting with a fake hand:** The dog is being petted over the head, and if possible over the flanks and hind limbs, with a fake hand during 20 seconds.
5	**Playing.** The tester tries to play with the dog using a toy. Duration maximum of 1 minute**.**
6	**Pulling game:** If the dog holds the toy of test 5, the test persons tries to play a pull play with the dog. Duration: 20 seconds.
7	**Being threatened by a male person:** The dog, fixated with two leashes, is being approached by a test person (male) who stares at the dog for 5 seconds, from a distance of 2 meters. Then the person makes one step forwards and makes a movement with his arms as if he is trying to hit the dog. Then the persons keeps standing in front of the dog for 5 seconds, while staring at the dog; the test person then turns around and does not look at the dog for 10 seconds (recover time).
8	**Being threatened by a female person (the same way as in test 7)**
9	**Confrontation with different dolls:** **A. Large doll:** A large doll is being held from a 5 meter distance and is moved towards the dog to a minimum distance of 50 centimetres, so that the dog can approach and sniff the doll. When the dog is already tightening the leash, the doll will be moved towards the dog as far as possible, so that the dog can sniff the doll. The dog must be able to sniff the doll, then the doll will be quickly pulled back from the dog. **B. Doll Roxanne (doll on a stick):** The test person takes the second doll and approaches, with the feet of the doll over the ground, until a distance of 50 cms and then let's the dog approach the doll. When the leash is already tight, the doll will be moved towards the doll until the dog is able to sniff the doll. Then the tester pushes the doll repeatedly against the dog (like a pushy child) with a maximum duration of 20 seconds. Then the doll will be quickly pulled from and pushed to the dog, to test chase behaviour. **C. Dark doll:** The test person takes the second doll and approaches, with the feet of the doll over the ground, until a distance of 50 centimetres and then let's the dog approach the doll. When the leash is already tight, the doll will be moved towards the doll until the dog is able to sniff the doll. Then the tester pushes the doll repeatedly against the dog (like a pushy child) with a maximum duration of 20 seconds. Then the doll will be quickly pulled from and pushed to the dog, to test chase behaviour.
10	**Umbrella test:** The closed umbrella is held next to the leg of the test person. The test person approaches the dog frontally from a distance of 5 meter to a distance of 1 meter of the dog (not within the safety circle). On this distance the umbrella will be opened once towards the dog and the umbrella will be dropped just on the outside of the safety circle, so that the dog cannot reach but can sniff the umbrella. Then the umbrella is picked up and closed and held next to the test person, who stands still and turned away for 10 seconds (recovery time).
11	**Horn test:** The test person approaches the dog with a distance of 2 meters and pulls the horn in the direction of the dog. 5 times and each time 5 seconds. The dog should be able to sniff the horn. Then the test persons stands still and turned away for 10 seconds (recovery time).

12	**Taking away the feed bowl:** The feed bowl is taken away, a small amount of pet food is put in, the test person places the bowl in front of the dog, just within the safety circle. If the dog is eating, the test persons tries to pet the dog with a fake hand and then tries 3 times slowly to pull the bowl away for a maximum duration of 20 seconds. If the dog is not eating, sausage will be added and the test well be repeated.
13	**Confrontation with real dogs:** **A. Real large dog test:** A gently real large dog, preferably a dog of the same sex, is leashed and walks slowly beyond the tested dog. The tested dog is fixated safely to make sure the dogs cannot reach each other. Then the test person stands still with the stimulus dog for 5 seconds with a minimal distance. Then the stimulus dog walks back beyond the tested dog and is brought back to his cage. **B. Real small dog test:** A gently real small dog, preferably a dog of the same sex, is leashed and walks slowly beyond the tested dog. The tested dog is fixated safely to make sure the dogs cannot reach each other. Then the test person stands still with the stimulus dog for 5 seconds with a minimal distance. Then the stimulus dog walks back beyond the tested dog and is brought back to his cage.
14	**Jogging test:** A test person passes the dog while he/she is jogging, but does not come into the safety circle. On the side of the dog the jogger keeps the fake hand, which has to come into the safety circle while passing the dog. In total the test person has to pass the dog four times and the fake hand has to be held close to the dog each time. This can be repeated twice when the pattern of desensitisation / sensitisation is not clear of when it is suspected that the dog is fixating on the fake hand instead of the person who is jogging. When this is the case, the dog will be passed another two times without a fake hand. The dog can be passed to a maximum of 6 times. When the dog reacts to a passage with a fake hand, then the dog will be passed again twice without a fake hand.
15	**Surrounding test:** The dog is being surrounded by 3 persons. These persons enlarge themselves (stretching their arms) and quickly walk towards the dog from a distance of 5 meters, towards the safety circle and they stand there for 5 seconds while they spread their arms and look at the dog while they bend forwards towards the dog. Then they walk backwards.
16	**Dog keeper test**: The dog keeper is being threat by the test person. The test person walks from a distance of 5 meter towards the dog keeper and threatens him/her with yelling to him/her and holding him/her during 20 seconds. The test person is holding a fake hand which is within the reach of the dog, so that this dog could bite into it. The dog keeper plays along and also holds the test persons and yells that the test person.