FULL PAPER *Ethology*

Important Behavioral Traits for Predicting Guide Dog Qualification

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ABSTRACT. Guide dogs for the blind help blind people physically and mentally in their daily lives. Their qualifications are based on health, working performance and temperament; approximately 70% of dogs that fail to qualify are disqualified for behavioral reasons. In order to achieve early prediction of qualification, it would be essential as the first step to identify important temperament traits for guide dogs. Therefore, we administered a questionnaire consisting of 22 temperament items to experienced trainers to assess candidate dogs at the Japan Guide Dog Association after three months of training, which was at least three months prior to the final success (qualified as a guide dog) or failure (disqualified for behavioral reasons) judgment. Factor analyses of question items stably extracted three factors with high internal consistency, Distraction, Sensitivity and Docility. When we compared factor points between successful dogs and failed dogs, the successful dogs showed significantly and consistently lower Distraction points and higher Docility points. Additionally, Distraction points could predict qualification with 80.6% accuracy and detect 28.2% of the failed dogs that had higher Distraction points than any of the successful dogs. Of the nine question items not included in the three factors, two items ('Aggression' and 'Animal interest') were consistently associated with qualification. These results suggest that Distraction is stably assessable and has the strongest impact on success or failure judgment; therefore, it will be the first target to establish a behavioral test that may lead to early prediction of guide dog qualification.

KEY WORDS: behavior, canine, guide dog for the blind, questionnaire, temperament.

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Guide dogs for the blind are one type of working dog, helping blind people physically and mentally in their daily lives. Generally, candidate dogs are bred by guide dog associations, and reared by puppy-raisers from after weaning until the initiation of training. When candidate dogs are approximately one year old, they are trained in a guide dog training facility for about six months. After training, they are finally qualified as guide dogs, depending on their health, working performance and temperament. Although the number of guide dogs worldwide was estimated to exceed 25,000 in 2008, the number of applicants hoping to receive a guide dog is much larger, and they must wait about five months before obtaining a guide dog even in the UK, which has the highest prevalence rate of guide dogs [3]. The success rate of guide dog training varies among facilities, but the primary reason for disqualification is commonly reported to be behavioral problems, accounting for 77.3% of disqualified dogs in Australia [4], 65.5% in the US [14] and 69.5% in Japan (data from the Japan Guide Dog Association for 2003 to 2005). As an early prediction of guide dog qualification may save human and financial resources and improve the dogs' welfare by avoiding unnecessary training, establishment of reliable temperament assessment for predicting guide dog qualification is strongly desired.

Researchers have attempted to predict the future capabilities of candidate dogs and have conducted temperament assessments including questionnaire surveys and behavior tests. However, some studies have not mentioned the reproducibility of results [6, 14], and others have compared the behavioral or physiological responses between qualified and disqualified dogs [1, 10], despite the fact that judgment of qualification is considered to be subjective. In addition, each qualified/disqualified group may not be a uniform population, but may be a mixture of dogs with variable traits, such as fearfulness, aggression and distraction, which have been reported as reasons for disqualification [4, 14]. For early prediction of qualification, reliable temperament assessments with objective measurements are needed, but it is considered that the first step should be to identify behavioral traits that have consistently significant impacts on judgment of guide dog qualification; establishment of behavior tests might then be carried forward targeting the identified traits.

In this study, a questionnaire survey consisting of 22 temperament-related items regarding candidate dogs was administered; this was a 'rating of individual dogs' type survey that reflects overall information about an individual dog's behavior and history [9, 11]. In the questionnaire survey, experienced trainers were asked about dogs that had completed three months of training. We examined the association between temperament traits and a dog's ultimate qualification, which was determined more than three months after the questionnaire. We also examined the reproducibility of results and impacts of temperament traits on qualification predictability. In this manner, we hoped to reveal traits that might serve as targets for establishing

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behavior tests.

MATERIALS AND METHODS

Animals: The dogs used in this study were 144 Labrador retrievers (41 litters born from 26 dams and 17 sires); the animals were raised in the usual manner (as described in the introduction) and trained at the Kanagawa training center of the Japan Guide Dog Association (JGDA), which is one of the largest training facilities in Japan. The dogs were divided into two groups according to their date of training initiation; group A included dogs that started training between September 2005 and September 2006 (78 dogs: 46 males and 32 females), and group B included dogs that started training between January 2007 and January 2008 (66 dogs: 36 males and 30 females). At the time of the questionnaire, all of the dogs studied had been neutered.

Questionnaire survey: The questionnaire survey was carried out after the dogs had completed three months of training, when the dogs were about 1 year and 3 months old. Table 1 shows the 22 question items that appeared in the actual questionnaire sheet. The responses were provided on a scale of 1 to 5, with 5 being the highest degree of a given item. The same questionnaire has been used on the first day of a dog's training during a town walk session at the JGDA since 2002 and mainly originates from the Guide Dogs for the Blind Association of Queensland in Australia. For each dog, one primary experienced trainer familiar with the target dog completed the questionnaire based on observations of training and daily behaviors for three months. Ten trainers responded for group A, 13 trainers responded for group B and eight trainers responded for both groups. The number of dogs rated per trainer varied from 1 to 36.

Success or failure outcome: Final qualification was judged by several staff members and trainers (including the rating trainer) based on health, working performance and temperament after about six months of training, and this took place more than three months after the questionnaire was administered. We collected the records of the studied dogs in regard to whether or not they were qualified as guide dogs and the reasons of disqualification. All the dogs used in this study were either qualified as guide dogs (successful dogs) or disqualified because of behavioral problems (failed dogs). Breeding dogs and dogs with poor health were excluded.

Statistical analyses: All data analyses were performed using JMP 7.0.7 (SAS Institute). The two-tailed significance level was set at 0.05 for all the statistical tests. To avoid Type I errors from multiple statistical tests, a Bonferroni correction was adopted [2].

Factor analysis of question items: Factor analysis was performed using 19 question items with high response rates (over 95%; Table 2) for each group; the principal factor method was used for factor extraction, and the Varimax rotation was used for orthogonal transformation. Extracted factors were determined by the eigenvalue criterion (the

Table 1. 22 question items included in the questionnaire

Items	Description
Steadiness	Retains stable behavior in spite of external stimuli under a habituated situation
Initiative	Heads towards objects (step, corner, etc.) independent of the handler's instruction
Willingness	High reaction to pleasant stimuli and calling of "good" and behaves to be called "good"
Adaptability	Understands new situations and calms down quickly even if he responded once
Learning ability	Learns commands and works in a short time
Dominance	Shows disobedience or tries to gain the favor of dogs and humans
Aggression*†	Shows aggressive behavior (growl or bite, etc.) toward dogs or humans
Maturity	Does not act like a puppy and does not get excited when he should calm down
Body sensitivity	Reaction when he is touched or put into a harness, and how close he cannot walk along walls
Hearing sensitivity	Reaction toward voice of the handler who instructs him
Sound sensitivity	Reaction toward environmental sounds (construction, motor, train, etc.)
Mental sensitivity	Overall reaction toward stimuli by humans or environment
Dog interest	Motivation toward other dogs, and how much it exceeds the handler's attention
Animal interest*	Motivation toward other animals (cats and birds)
Human interest	Motivation toward people in general, especially when someone is approaching
Food interest*	Motivation toward food on the ground or in supermarkets and eating places
Scent interest	Motivation for sniffing of a certain spot
Self interest	Overall motivation toward surroundings and low concentration on the handler
Excitability	Degree of excitement and the time taken to calm down
Sudden movements	Reflexive behavior, which usually originates from interest or anxiety
Suspicion	Cautious of a specific object and reacts by barking, threatening, or being scared
Anxiety	Anxious about changes in environment

Question items are listed according to the order in the actual questionnaire sheet.

*: Question items with a response rate less than 95% in group A and that were excluded from the factor analysis (Aggression, 60.3%; Animal interest, 82.1%; Food interest, 93.6%).

†: Because some trainers answered 0 or 'no', meaning no aggression observed or reported, the response rate was 60.3% in group A and 'Aggression' was excluded from the factor analysis. However, these invalid responses were easily correctable by instructing the trainers again about the evaluation method, and the response rate increased to 92.4% in group B.

Table 2. Factor loadings of each question item in groups A and B

Question items	Group A					Group B				
	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
Dog interest	0.837					0.861				
Sudden movements	0.801					0.851				
Excitability	0.743					0.848				
Dominance	0.631					0.695				–0.536
Self interest	0.572					0.726				–0.536
Steadiness	–0.693		0.478			–0.572		0.574		
Anxiety	0.542			–0.428				–0.700		
Scent interest	0.495				0.410				0.625	
Sound sensitivity		0.861					0.849			
Hearing sensitivity		0.811					0.736			
Mental sensitivity		0.799					0.797			
Body sensitivity		0.791					0.794			
Willingness		0.607		0.493						0.762
Maturity			0.797			–0.495		0.561		
Learning ability			0.700					0.762		
Adaptability	–0.467		0.583					0.855		
Initiative				0.839				0.524		0.615
Suspicion	0.400			–0.471				–0.645		
Human interest					0.867				0.823	
Eigenvalue	4.890	3.527	1.782	1.419	1.135	6.904	3.288	1.719	1.215	1.053
Contribution ratio	0.257	0.186	0.094	0.075	0.060	0.363	0.173	0.090	0.064	0.055
Cronbach's alpha	0.847	0.839	0.767	0.502	–	0.912	0.821	0.872	–	0.799
Expected factor name	**Distraction**	**Sensitivity**	**Docility**			**Distraction**	**Sensitivity**	**Docility**		

No absolute values less than 0.4 are present in the table.
The underlined numbers are common between the two groups and were selected as composing items of each factor.

eigenvalue for the last extracted factor was greater than 1.0). To assess the internal consistency of the factors, we calculated Cronbach's alpha reliability coefficients for items that belonged to each factor.

Calculation of factor points and the association with success or failure outcome: By comparing factor structures of group A and B, items that were categorized to the same factor between two groups were selected as composing items (Table 2). We calculated factor points (Factor 1–3 points) by adding or subtracting the raw scores of composing items according to their positive or negative factor loadings; for example, Factor 1 points = 'Dog interest' + 'Sudden movements' + 'Excitability' – 'Steadiness' + 'Dominance' + 'Self interest'. Then, the factor points were compared between successful dogs and failed dogs (one-way ANOVA).

Impact of each factor on guide dog qualification: Concerning the practical use of factor points for success or failure judgments, the impact of each factor on guide dog qualification was also evaluated; the hitting ratio of predicting qualification and the detection power of distinctly unsuitable dogs were calculated for each factor. For the hitting ratio, we set the consecutive cut-off point for each factor that differentiates success or failure and calculated the hitting ratio (the percentage of dogs about which the judgment by cut-off point agreed with the actual outcome) as shown in Fig. 2. The *p* value for the hitting ratio was determined by a permutation test [15] in which the training outcomes of individual dogs were shuffled 10,000 times, maintaining the numbers of successful dogs and failed dogs.

The detection power of distinctly unsuitable dogs means the ability of the factor points to identify failed dogs without misjudging successful dogs as failure. We set "the essential number of points for success" to just above the highest point for successful dogs for Factor 1 (Fig. 2); failed dogs that scored equal to or higher than this point were regarded as distinctly unsuitable dogs (vice versa for Factors 2 and 3), and the number of those dogs was counted.

Question items not included in the factors: Nine of the 22 question items were not incorporated into the three factors because of low response rates (Table 1) or belonging to different factors (Table 2). However, as these characteristics are independent from the importance for qualification, associations between the nine items and success or failure outcomes were examined (one-way ANOVA) so that our analysis included as many potential temperament traits as possible. Dogs for which answers were not provided and those having scores that did not use the 1–5 point scale were excluded from the analysis.

RESULTS

Factor analysis of question items: Factor analysis of the question items resulted in extraction of five factors in both groups, which accounted for 67.2% and 74.5% of the common variance in groups A and B, respectively. Each of the 19 items belonged to one or more of the five factors as shown in Table 2. Factors 1–3 were considered to be con-

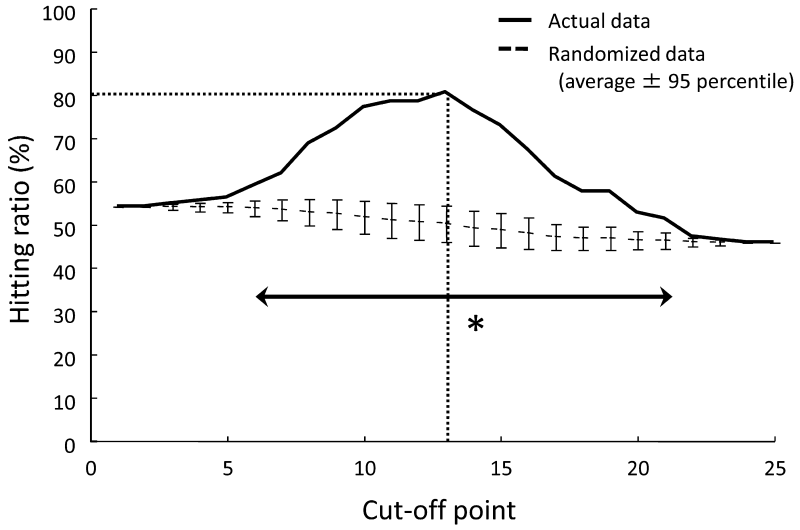

Fig. 1. Hitting ratio of qualification predictability using a cut-off point on Factor 1. The solid line is the actual hitting ratio obtained from this study. The dashed line is the average of the hitting ratios derived from 10,000 randomizations. When the cut-off point was set in the range of 6 to 21, the actual hitting ratio was significantly higher, as shown by the directional line (*: $p<0.05$). The maximum hitting ratio of 80.6% was obtained when the cut-off point was set to 13 (dotted line).

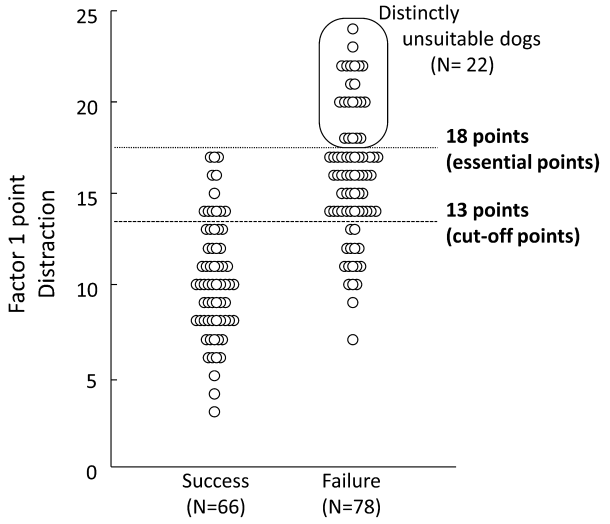

Fig. 2. Factor 1, Distraction, points for successful dogs and failed dogs. The small open circles show the Factor 1 points for individual dogs. When the cut-off point was set to 13 (dashed line), the maximum hitting ratio of 80.6% was obtained. As the highest (worst) number of points for the successful dogs was 17, the essential number of points for success was set to 18 (dotted line); therefore, 22 of the failed dogs were detected as being distinctly unsuitable (surrounded by a solid line).

served because common items were belonged to the same factors between the two groups; therefore, these factors were used for further analyses. According to the question items categorized into each factor, Factor 1 was named "Distraction", Factor 2 was named "Sensitivity" and Factor 3 was termed "Docility" (Table 2). All Cronbach's alpha reliability coefficients for these factors (Table 2) exceeded the generally accepted threshold (Cronbach's alpha ≥0.70) in both groups.

Association of factor points with success or failure outcomes: When factor points were compared between successful dogs and failed dogs, significant associations were seen for Factor 1, Distraction: successful dogs had significantly lower points compared with failed dogs ($F_{(1,142)} = 99.0$, $p=5.0 \times 10^{-18}$; Table 3). Factor 2, Sensitivity, and Factor 3, Docility, also showed significant associations with success or failure outcomes; successful dogs had higher points than failed dogs ($F_{(1,142)}=7.1$ and $p=8.8 \times 10^{-3}$ for Factor 2; $F_{(1,142)}=36.2$ and $p=1.4 \times 10^{-8}$ for Factor 3; Table 3). When the two groups were analyzed separately, Factors 1 and 3 showed the same significant associations in both groups after Bonferroni correction ($p<1.7 \times 10^{-2}$); however, Factor 2 showed a significant association in group A ($F_{(1, 76)}=6.6$, $p=0.012$) but not in group B ($F_{(1, 64)}=1.1$, $p=0.29$).

Impact of each factor on guide dog qualification: With regard to Factor 1, the hitting ratio for the actual data was significantly high ($p<0.05$) compared with those of randomized data when the cut-off point was set in the range of 6 to 21 (Fig. 1). A cut-off point of 13 led to the maximum hitting ratio of 80.6%; 54 dogs (81.8% of the successful dogs) were accurately judged as successes, and 62 dogs (79.5% of the failed dogs) were accurately judged as failures (Fig. 2). Regarding the detection power for distinctly unsuitable dogs, the highest point for successful dogs was 17, and the essential number of points for success was determined to be 18; consequently, 22 dogs (28.2% of failed dogs) were

Table 3. Associations between factor points and success or failure outcomes

		Factor 1 (Distraction)		Factor 2 (Sensitivity)		Factor 3 (Docility)	
	N	AVE	SE	AVE	SE	AVE	SE
Success	66	10.3	0.41	13.9	0.27	10.0	0.18
Failure	78	16.0	0.40	13.0	0.20	8.4	0.20
p value		5.0×10^{-18}*		8.8×10^{-3}*		1.4×10^{-8}*	
Hitting ratio		80.6 %		61.8 %		69.4 %	
Distinctly unsuitable dogs†		22 (28.2 %)		0 (0.0 %)		1 (1.3 %)	

N: number of dogs, AVE: average, SE: standard error.
Each *p* value was from one-way ANOVA.
*: Values that reached significance level ($p<1.7 \times 10^{-2}$) after Bonferroni correction.
†: The number of failed dogs whose points did not reach the number of essential points for success and that could be judged to have failed with accuracy.
Values in parentheses are the percentage of all failed dogs (N=78).

Table 4. Associations between non-composing items and success or failure outcomes

	Initiative			Willingness			Aggression			Animal interest			Human interest		
	N	AVE	SE	N	AVE	SE	N	AVE	SE	N	AVE	SE	N	AVE	SE
Success	66	3.2	0.08	66	3.6	0.09	46	1.1	0.05	59	2.9	0.09	66	3.0	0.09
Failure	78	2.8	0.08	78	3.3	0.08	62	2.2	0.17	71	3.8	0.10	78	3.0	0.08
p value	**2.2×10^{-3}***			0.058			**1.8×10^{-7}***			**3.5×10^{-9}***			0.76		

	Food interest			Scent interest			Suspicion			Anxiety		
	N	AVE	SE	N	AVE	SE	N	AVE	SE	N	AVE	SE
Success	65	2.7	0.06	66	2.8	0.08	66	2.8	0.10	66	3.1	0.10
Failure	74	3.1	0.06	78	3.2	0.97	78	3.4	0.10	78	3.4	0.10
p value	**1.2×10^{-4}***			**1.5×10^{-5}***			**2.8×10^{-5}***			**0.018**		

N: number of dogs, AVE: average, SE: standard error.
Each *p* value was from one-way ANOVA.
The *p* values less than 0.05 are in bold.
*: Values that reached significance level ($p<5.6 \times 10^{-3}$) after Bonferroni correction.

detected as distinctly unsuitable dogs (Fig. 2).

In the same way, the impacts of Factors 2 and 3 were estimated. For Factor 2, the hitting ratio of the actual data was significantly high ($p<0.05$) when the cut-off point was set in the range of 14 to 16, and the maximum hitting ratio of 61.8% was obtained when the cut-off point was 16. The essential number of points for success could not be determined because the minimum point for successful dogs was lower than in the failed dogs. For Factor 3, the hitting ratio of the actual data was significantly high ($p<0.05$) when the cut-off point was set in the range of 8 to 12, and the maximum hitting ratio of 69.4% was obtained when the cut-off point was 11. The essential number of points for success was set to 5, and only one dog (1.3% of failed dogs) could be regarded as distinctly unsuitable.

Question items not included in the factors: Of the 22 question items in the questionnaire survey, nine items were not incorporated into the factors; three items were not employed in the factor analysis (Table 1), and six items were not included in the composing items of the three factors (Table 2). Significant associations with guide dog qualification were shown for six of these items after Bonferroni correction. Successful dogs had higher scores for 'Initiative' ($F_{(1, 142)}=9.8$, $p=2.2 \times 10^{-3}$) and lower scores for 'Aggression' ($F_{(1, 106)}=31.2$, $p=1.8 \times 10^{-7}$), 'Animal interest' ($F_{(1, 128)}=40.3$, $p=3.5 \times 10^{-9}$), 'Food interest' ($F_{(1, 137)}=15.8$, $p=1.2 \times 10^{-4}$), 'Scent interest' ($F_{(1, 142)}=20.1$, $p=1.5 \times 10^{-5}$) and 'Suspicion' ($F_{(1, 142)}=18.7$, $p=2.8 \times 10^{-5}$) compared with failed dogs (Table 4). When the associations between item scores and success or failure outcomes were examined in groups A and B separately, only 'Aggression' and 'Animal interest' showed the same significant associations in both groups after Bonferroni correction ($p<5.6 \times 10^{-3}$).

DISCUSSION

In this study, three temperament factors, Distraction, Sensitivity and Docility could be assessed stably by the questionnaire survey and were identified as important behavioral traits that have significant associations with success or failure in guide dogs. The impact of each factor was estimated by a hitting ratio for qualification predictability and the

detection power of distinctly unsuitable dogs. It was concluded that Distraction was the most important temperament trait for predicting qualification, and this trait should become the first target for the establishment of a behavioral test. As shown in Table 4, other traits, including Initiative, Aggression, Animal interest, Food interest, Scent interest and Suspicion, were also found to be potentially important traits for guide dogs. Because these items were either rated with insufficient answers or their effects were not conserved throughout the factor analysis, their scores might have less certainty, and their associations with qualification remain potential. On the other hand, because we cannot conclude that the impacts of these traits are lower than the three factors identified in this study, they should be examined using improved questionnaires.

Among the three factors (Distraction, Sensitivity and Docility) and the six items (Initiative, Aggression, Animal interest, Food interest, Scent interest and Suspicion), the results for Distraction, Aggression and Suspicion were in accordance with the results previously reported by Goddard and Beilharz (1983) at the Royal Guide Dogs for the Blind Association of Australia. They identified fearfulness, aggression, and distraction as behavioral traits associated with guide dog qualification using a system in which trainers rated 17 temperament items for each dog, and item scores were compared to the concurrent judgment of whether the candidate dogs would continue training or halt. The list of important traits in the present study is also supported by studies conducted in the US, in which the trait 'suspicious of people' was most frequently reported as the primary reason for disqualification at Seeing Eye Inc., in Morristown, NJ, U.S.A. [14], and the appearance of aggression during the first walk-out session was associated with failure at Guide Dogs for the Blind, Inc., in San Rafael, CA, U.S.A. [17]. The agreement between these studies strongly suggests that the results obtained in the present study have validity.

With regard to the Distraction and Docility factors and Aggression and Animal Interest items, associations with qualification were seen in both groups A and B, and the reproducibility was confirmed. Although reproducibility has not been mentioned much in canine temperament assessment [9], it might be valuable when the results are put into practical use. In particular, the association between Factor 1 points and guide dog qualification was so strong that it would be valuable to perform a behavioral test that could assess Distraction earlier and objectively. Because an appropriate behavioral test for Distraction has not yet been reported, we need to establish a new test. There is a tendency for the validity of an assessment to be considered less seriously when performing a behavioral test [9, 11]; therefore, careful evaluation is needed to determine if data from an established behavioral test truly reflects Distraction. One possible method would be to conduct a candidate behavioral test in conjunction with a questionnaire survey and examine the association between the behavioral test and the Distraction points, as has been done for 'fearfulness' in dogs [6] and 'anxiety' in horses [12, 13].

In conclusion, three factors were identified as important behavioral factors for guide dogs, and six traits were found to be potentially associated with guide dog qualification at the JGDA. Of these behavioral traits, Distraction had the strongest impact on success or failure outcomes; therefore, objective assessments of Distraction by behavioral tests would be extremely valuable. Once an effective behavioral test is developed, it would be useful to examine the consistency of behavioral traits to determine whether or not these traits can be influenced by environment. Additionally, these assessable traits are expected to play a role in canine behavioral genetics [8, 16], promoting the identification of temperament-associated genes [7, 17, 18] and contributing to the establishment of breeding protocols and the development of tailor-made training programs. By combining several assessments that focus on important behavioral traits and genetic information, it may be possible to provide an early and highly accurate prediction of guide dog qualification, which would help address the guide dog deficit.

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