Dairy veterinarians' skills in motivational interviewing are linked to client verbal behavior

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Communication skills affect client verbal behavior

Abstract

Veterinarians often give advice in a persuasive form, a style that has been shown to evoke resistance to change in clients experiencing psychological ambivalence (i.e. those who see both advantages and disadvantages to changing). With this style of communication, veterinarians run the risk of counteracting their purpose to encourage clients to follow recommendations. Motivational Interviewing **(MI)** is a client-centered communication methodology that aims to facilitate clients' internal motivation to change. In MI, *Change Talk* represents clients' own statements expressing consideration of, motivation for or commitment to behavior change, and has been shown to be strongly correlated to behavior change. *Sustain Talk* is corresponding statements related to maintaining the *status quo*. The aim of this exploratory study was to evaluate the potential of MI to facilitate behavior change in veterinary herd health management **(VHHM)** by investigating the effect of dairy cattle veterinarians' MI skills on client *Change* and *Sustain Talk*. We recorded VHHM consultancies on 170 Swedish cattle farms performed by 36 veterinarians, randomly distributed into two groups; MI veterinarians (n=18) had received 6-months training in MI and control veterinarians (n=18) had not received any training. Veterinarians' MI skills were assessed using the Motivational Interviewing Treatment Integrity coding system 4.2.1, and categorized as poor_untrained, poor_trained, near moderate and moderate. Client communication was coded using the Client Language Easy Rating coding system. The effect of MI skills on *Change Talk, Sustain Talk* and *Proportion of Change Talk (Change Talk* divided by the sum of *Sustain Talk* plus *Change Talk)* was investigated using cross-classified regression models with random intercepts for veterinarian and client (farm). The models also included additional explanatory variables (e.g. type of veterinarian and client's satisfaction with the consultation). The veterinarian's MI skills were associated with the client's *Change Talk,* but results regarding *Sustain Talk* or

Proportion of Change Talk were inconclusive. Clients of veterinarians reaching the highest (i.e. moderate) MI skills expressed 1.5 times more *Change Talk* than clients of untrained veterinarians. Clients of general large animal practitioners expressed less *Sustain Talk* than clients of animal health veterinarians and had higher *Proportion of Change Talk.* Results indicate that learning to practice MI may be one means to improve adherence to veterinary recommendations and to improve efficiency in VHHM services.

Keywords: veterinarian-client communication; change talk; herd health management; cattle; client language easy rating

Implications

We investigated communication between clients and veterinarians with different skills in the client-centered communication methodology motivational interviewing. Clients of veterinarians with the highest skills in motivational interviewing (from among the sampled veterinarians) spoke most favorably about behavior change. Such communication (in favor of change) previously has been shown to be correlated to clients later changing behavior. This finding therefore indicates that learning motivational interviewing may be a means by which veterinarians can inspire farms to implement preventive measures to improve animal health. Herd health advisory services should be revised so that veterinarians give further attention to client motivation and perspectives.

Introduction

Communication skills are increasingly being acknowledged as important in the veterinary profession (Cake *et al*., 2016; Ritter *et al*., 2019). Veterinary herd health management **(VHHM)** services constitute an increasing proportion of work for cattle veterinarians and often focus on changing management routines (i.e. behavior change). In these types of services, change-orientated communication skills therefore may be of special importance. A shared power elicited by relationship-oriented communication and use of a high proportion of empathy statements has been demonstrated to be positively associated with behavior change (Kanji *et al.,* 2012; Moyers and Miller, 2013). However, veterinarians working in VHHM have been found to show very few of these behaviors (Bard *et al.,* 2017; Ritter *et al.,* 2018; Svensson *et al.,* 2019a). Instead their conversations were dominated by information gathering, questions and persuasion (Bard *et al.,* 2017; Svensson *et al.,* 2019a). Ritter *et al.* (2019) recently demonstrated that dominance in the veterinarian and a high use of information gathering in consultations was associated with a lower stated likelihood by farmers to implement veterinary advice. In a similar vein, persuasion and confrontation are behaviors that have been shown to be negatively associated with behavior change in consultancies (Miller and Moyers, 2017). Hence, veterinarians speaking in this way run the risk of counteracting their purpose to encourage clients to follow veterinary recommendations.

One change-orientated evidence-based communication methodology being increasingly implemented across numerous sectors is Motivational Interviewing (**MI**; Miller and Moyers, 2017). This methodology was developed in alcohol abuse consultations and has successfully been used to reduce tobacco and drug use and to promote positive lifestyle changes (Hettema *et al.,* 2005; Lundahl *et al.,* 2010). Lately the MI methodology has also been found to be a helpful tool in enforcement situations

for food safety, health safety, and environmental inspectors (Forsberg *et al.,* 2014; Wickström *et al.,* 2017), and was rated by cattle veterinarians as highly relevant to their profession (Svensson *et al.,* 2020).

For veterinarians to continue to be effective and valued consultants in animal health, efficiency in their services is of importance. Given the weaknesses demonstrated in veterinarians' communications skills, adopting a client-centered communication methodology such as MI may be one means to increase efficiency in VHHM services, as suggested by Bard *et al.* (2017) and Svensson *et al.* (2019a). VHHM services involve complex consultancies and little is known about the communication style best suited for veterinarians to be efficient. To estimate the potential of MI to facilitate clients' implementation of preventive measures in VHHM, studies that objectively measure the effect of the methodology on these client behaviors are warranted.

In MI, *Change Talk* is defined as the client's own statements expressing consideration of, motivation for or commitment to behavior change. MI research uses the amount of *Change Talk* expressed by the client as an outcome measure of communication skills, because it has been shown to be strongly correlated to clients later adopting the behavior change in question (Apodaca and Longabaugh, 2009). Several instruments have been developed to assess client verbal responses in consultations. However, the most valid are time consuming and therefore costly (Martin *et al.,* 2005). A more practical and economically reasonable instrument is the Client Language Easy Rating **(CLEAR)** coding system (Hagen and Moyers, 2012). CLEAR assesses and summarizes clients' responses in three categories: *Change Talk*, *Sustain Talk* (i.e. corresponding statements related to the *status quo)* and *Neutral Talk*. When the amount of *Change Talk* and *Sustain Talk* in a session is all that is of interest,

CLEAR is believed to represent an appropriate and efficient way to characterize these types of client language (Hagen and Moyers, 2012).

The aim of the present study was to evaluate the potential of MI to facilitate client behavior change in VHHM by investigating the effect of dairy cattle veterinarians' MI skills on client *Change Talk* and *Sustain Talk* during VHHM visits. More specifically, the study aimed to test the hypothesis that clients conversing with veterinarians who had greater MI skills would express more *Change Talk* and less *Sustain Talk* than clients conversing with veterinarians who had a lower level of MI skills. Preliminary results from the present study have previously been published in abstract form (Svensson *et al.*, 2019c).

Materials and methods

In total, 36 cattle veterinarians audio-recorded VHHM consultancies on 170 Swedish cattle farms (164 dairy, four cow-calf beef, two specialized beef) using digital voice recorders. Recordings were made between June 2016 and January 2017 (n=18) or between June 2017 and January 2018 (n=18). Veterinarians wore voice recorders and uploaded recordings to a webpage at the coding laboratory MIC Lab AB, Stockholm (www.miclab.se). Professional coders at MIC Lab AB coded the clients' *Change Talk* and *Sustain Talk* using the CLEAR coding system. The quality of the recordings varied and were sometimes reduced by sounds from cows, machinery and interrupting telephone calls. The quality, however, was generally acceptable for coding. Each veterinarian was requested to record five consultancies; details about these consultancies have been reported by Svensson *et al.* (2019b).

Half of the veterinarians (n=18) had participated in a 6-month MI training program between September 2016 and March 2017(before they recorded their conversations); the rest were untrained. Before the consultancies took place, we assessed veterinarians' MI skills from role-play conversations with professional actors. At the start of the project, the veterinarians had filled in a web questionnaire (https://www.netigate.net/sv/) about their characteristics (Svensson *et al.,* 2019a), from which we received information about their gender and experience in VHHM. Veterinarians had also filled in a web questionnaire about 1) the conditions of their farm visit, 2) their view about the consultation, and 3) the outcomes of the consultation. From Part 1) of this questionnaire we retrieved information about type of visit (pre-defined categories) and the number of participants from the farm; from Part 2) we received information about whether veterinarians felt that they and the client, respectively, had allocated sufficient time to the consultation (Likert scale 1-6). After the consultations, clients were interviewed via telephone and data about their age, gender, education, role on the farm, satisfaction with the consultation and if they felt that they and the veterinarian, respectively, had allocated sufficient time to the consultation were collected. The telephone interviews have been further described by Svensson *et al.* (2019b). The study design is outlined in Figure 1.

Participating veterinarians and farms

The selection of participating veterinarians has been described previously by Svensson *et al.* (2019a). In short, volunteers were selected by the two largest employers of Swedish dairy cattle veterinarians - the District Veterinary Organization (Swedish Board of Agriculture) and the regional dairy associations – or among self-employed dairy cattle practitioners involved in the main Swedish VHHM network. Out

of the total number of Swedish dairy cattle veterinarians involved in VHHM (n=97; 56 employed by District Veterinary Organization, 23 by dairy associations and 18 self-employed), 42 veterinarians participated in the project and were randomly distributed into two groups (trained MI group and untrained control group). The training, described in detail by Svensson *et al.* (2020), consisted of six workshops with theoretical lectures and practical training. During the time between workshops, participants were to read and reflect on chapters in the main MI handbook by Miller and Rollnick (2012) and to practice their skills. Due to lack of time, four veterinarians terminated their participation in the project before they started their training, one never finished the training and one never recorded any consultancies. Out of the 36 veterinarians included in the present study, there were two men and 34 women. Eighteen were District veterinarians, 13 were animal health veterinarians from the regional dairy associations and five were self-employed veterinarians. Veterinarians were stationed all over the country, in both intensive farming areas as well as in woodland areas. All 36 veterinarians received MI training without any cost as part of the project. Control veterinarians received training from September 2017 to March 2018 (i.e. after they had finished all their recordings for the present study).

The selection of participating farms has been described previously by Svensson *et al.* (2019b). In short, a convenience sample of farms chosen by the veterinarians from among their clients was included and farmers were informed by the veterinarians about the purpose and design of the project. Clients received no compensation to participate in the study. We asked veterinarians in both groups (trained MI group and untrained control group) to provide the same information about the communication training in the project so that farms would be blinded to whether the veterinarian had received MI training or not. Six farms were visited by two

different veterinarians. One farm was visited in the same year by two different veterinarians who were both trained in MI. Recommendations from these two veterinarians dealt with totally different areas (biosecurity and udder health); the biosecurity conversation was considered to have negligible impact on the response talk in the udder health conversation and *vice versa*. Both observations therefore remained in the study. The other five farms were first visited by a control veterinarian and one year later by a veterinarian trained in MI.

Assessing motivational interviewing skills

Each veterinarian conducted three role-play conversations reflecting '*telephone consultations with a client whom the veterinarian previously had met on the farm when the time had been restricted and an agreement therefore had been made to continue and finish the discussion over the telephone'*. The role-plays were designed to provide controlled conditions for veterinarians to demonstrate relevant MI skills. For reference, veterinarians' MI skills were also assessed from the 170 audio-recorded on-farm VHHM consultancies mentioned above. Veterinarians' MI skills were assessed using the Motivational Interviewing Treatment Integrity coding system 4.2.1 (**MITI**; Moyers *et al.*, 2014). The MITI identifies frequency counts of 10 verbal behaviors as well as assessments of four global scores on a Likert scale ranging from 1 ("low") to 5 ("high") based on 20 minutes of a conversation. The coding manual also specifies six summary measurements derived from the 14 original variables (Moyers *et al.*, 2014). The role-plays and MITI codings (coded by MIC Lab AB) have previously been described in detail by Svensson *et al.* (2019a, 2020).

Based on the MITI coding results, we categorized veterinarians' MI skills as 'poor', 'near moderate' and 'moderate'. We further subcategorized 'poor' skills into 'poor_untrained' and 'poor_trained', because differences between untrained and trained veterinarians in MI skills other than those expressed by the MITI variables could not be excluded. In order to categorize in this way, we used the summary MITI variables *Relational* and *MI-non-adherent behaviors* and the original MITI variable *Cultivating Change Talk*. The MITI variable *Relational* was calculated as (*Partnership* + *Empathy*) / 2, where *Partnership* expressed the extent to which the advisor actively fostered collaboration and power sharing with the client, and *Empathy* was how the advisor understood or made an active effort to grasp the client's perspective and experience. *MI-non-adherent behaviors* were *Persuade* (overt attempts to change a client's opinions, attitudes or behaviors using tools such as logic, compelling arguments, self-disclosure, facts, biased information, advice, suggestions, tips, opinions, or solutions to problems) and *Confront* (directly and unambiguously disagreeing, arguing, correcting, shaming, blaming, criticizing, labeling, warning, moralizing, ridiculing or questioning a client's honesty). *Cultivating Change Talk* expressed the extent to which the advisor actively encouraged the client's own language in favor of the behavior change goal as well as the client's confidence to make the change. Because information about client ambivalence was lacking for the on-farm VHHM consultancies, we did not use *MI-non-adherent behaviors* in the reference categorization based on the on-farm recordings, but used only *Relational* and *Cultivating Change Talk.*

We used the following thresholds to define the veterinarians who reached 'near moderate' and 'moderate' competency: 'moderate' competency – *Relational* ≥3.5, *Cultivating Change Talk* ≥3, and *MI-non-adherent behaviors* ≤2; 'near moderate'

competency - *Relational* ≥3.5, *Cultivating Change Talk* ≥2.7, and *MI-non-adherent behaviors* <4. Veterinarians who did not reach these thresholds were categorized as 'poor´. In the reference categorization based on the on-farm recordings, thresholds were: 'moderate' competency - *Relational* or *Empathy* ≥3 and *Cultivating Change Talk* ≥2; 'poor' competency - *Relationa*l or *Empathy* ≤2 or *Cultivating Change Talk* ≤1.2. Veterinarians who did not meet these thresholds were categorized as 'near moderate'. Thresholds were chosen based on MI literature and experience of MITI coding of conversations in different contexts. *Relational* ≥3.5 and *Cultivating Change Talk* ≥3 are thresholds suggested in the MITI manual (Moyers *et al*., 2014). We deleted one veterinarian who only had one recorded VHHM visit from the reference categorization based on on-farm recordings, as one recording was not considered sufficient to give a reliable measurement.

Assessing client change talk

Three coders performed all CLEAR codings of the 170 audio recordings from on-farm VHHM consultations according to the CLEAR manual, translated to Swedish (Hagen and Moyers, 2012). The professional coders at MIC Lab AB perform MITI codings continuously and had been trained in CLEAR coding before the present study. To sustain coders' competence, coders at MIC Lab AB participate in a quality assurance program. The program comprises weekly training sessions based on independently coded recordings. Coders also discuss especially difficult coding sessions between themselves regularly. Further information about the quality assurance program is provided in Supplementary Material S1. The CLEAR manual specifies frequency counts of two main categories of client talk, *Change Talk* and *Sustain Talk*, each comprising seven sub-categories. *Change Talk* comprises the sub-categories *Desire*

to change, Ability to change, Reason to change, Need to change, Commitment to change, Taking steps towards change and *Other Change Talk*. The seven sub-categories of *Sustain Talk* are *Desire not to change, Ability not to change, Reason not to change, Need to not change, Commitment not to change, Taking steps away from change and Other Sustain Talk*. We summarized client responses as *Change Talk* and *Sustain Talk*. We also calculated another outcome variable, *Proportion of Change Talk*, defined as *Change Talk* frequency over the sum of *Change Talk* frequency plus *Sustain Talk* frequency (%*Change Talk* = *Change Talk* /(*Change Talk* + *Sustain Talk*)).

Coders started CLEAR coding the on-farm VHHM recordings when all veterinarians (from both groups) had recorded all consultancies. The order in which coders coded the recordings was randomized so that consultancies from both MI-trained veterinarians and untrained control veterinarians were coded in parallel. Consultations were encrypted during uploading to the web page and registered in a database at a protected server. Coders did not know the identities of veterinarians nor their group. For reliability reasons the MITI recommends to code 20 minutes of each consultation. Because recordings were used both for MITI and CLEAR coding, we coded 20 minutes of each consultation. Veterinarians were instructed to record a minimum of 20 minutes consultation on each farm, and to select the time period during which they were consulting the client about any behavior change (i.e. implementation of preventive measures). However, 21 recordings (all included in the present study) were shorter (10-17 minutes). If veterinarians recorded longer consultations, we coded those parts indicated by the veterinarians to be about behavior change. When veterinarians had indicated longer sequences than 20 minutes as relevant, we chose random sequences of 20 minutes to code. Veterinarians were not specifically informed that the audio-recordings would be subjected to CLEAR coding.

Data editing and statistical analyses

Descriptive statistics of *Change Talk* and *Sustain Talk* were calculated using Microsoft Excel (Microsoft Corp., Redmond, WA). The frequencies of *Change* and *Sustain Talk* for conversations shorter than 20 minutes were adjusted to 20 minutes by multiplying the frequency with 20/(number of minutes of the recordings).We investigated the effect of MI skills on client response talk using three cross-classified regression models. Two Poisson regression models, with random intercepts for veterinarian and client (farm) and offset for number of minutes of the recordings, were estimated in the statistical software R (Version 3.5.3., R Core Team 2019, https://www.R-project.org/) using the package glmmTMB (R package version 0.2.3. Brooks *et al.,* 2017) for the two response variables *Change Talk* and *Sustain Talk*. The offset in models standardizes the response variable to the length of the recording, thus, in our case, making the rate of the different types of client speech the modeled response. A logistic regression model with the same random intercepts but with the response variable *Proportion of Change Talk* was also estimated using the same package. The effects of the following extra explanatory variables were assessed: gender, VHHM experience and type of veterinarian, age, education and role of the client, if both client and veterinarian felt that the time allocated for the consultancy was sufficient, if the gender of the client and veterinarian were the same (gender concordance), number of participants from the farm, visit type and the client's satisfaction with the consultation. Interactions and sequence of veterinarians' visits (time within veterinarian) were not investigated because of the limited number of observations. The R code is provided in Supplementary Material S2. All extra explanatory variables except age of the veterinarian were categorical; categories of

each variable are shown in Table 1. Animal health veterinarians worked with preventive medicine only, whereas general large animal practitioners also made treatment visits. Lower education was defined as primary or secondary level of education and higher education as tertiary level education. The variable *Sufficient time* was created from the responses (Likert scale 1-6) by the veterinarian in the web questionnaire (own and the client's time) and by the client in the telephone interview (own and veterinarian's time) so that *Sufficient time* was classified as 'no' when either the veterinarian or the client rated a time variable below four and as 'yes' in all other cases. The client was denoted as satisfied with the consultation if she or he had rated the satisfaction with both the veterinarian's behavior and competency (Likert scale 1-6) as more than three or the sum of the two ratings was eight or more.

For **each** model, randomized quantile residuals were obtained by the R package DHARMa (R package version 0.2.4. https://CRAN.R-project.org/package=DHARMa) and assessed graphically and with tests of residual distribution, together with tests of under- and over-dispersion and zero inflation. None of the models showed any clear visual deviation for the residual distribution from the assumed error distribution, and none of the tests of deviations from typical model misspecifications indicated any problems. Multicollinearity was assessed for each model with generalized variance inflation factor, due to the presence of categorical explanatory variables. No evidence of multicollinearity was found, with a rule of thumb threshold at three which corresponded to an ordinary variance inflation factor of nine. Results from the model validation are shown in Supplementary Material S3.

Results

The frequency count of *Change Talk* per 20 minutes ranged from 0 to 18 (median; interquartile range: 6; 4-8) and of *Sustain Talk* from 0 to 13 (median; interquartile range: 2; 1-4). Distribution of characteristics of veterinarians, clients and consultancies are shown in Table 1. The age of clients ranged from 20 to 74 (median; interquartile range: 49; 38-56) years; 91 were men and 64 were women, whereas both genders were represented in 15 of the conversations with multiple clients. Clients were overall highly satisfied with their veterinarians. On the 170 farms, all but ten (94%) clients scored satisfaction with the veterinarian's attitude at 5 or 6 (range; median; interquartile range: 3-6; 6; 5-6) and all but 14 (92%) stated their satisfaction with the veterinarian's competency to be 5 or 6 (range; median; interquartile range: 1-6; 5; 5-6). None of the untrained control veterinarians reached MI skills comparable to the thresholds set to categorize 'near moderate' competency (i.e. the MI skills of all untrained veterinarians were categorized as poor_untrained). Of the trained veterinarians six reached 'moderate' skill, six 'near moderate' skills, and six were categorized as having 'poor' skills (Table 1). Before training, none of the trained veterinarians had reached 'near moderate' skills.

Table 1 also presents the results from the cross-classified model investigating associations with *Change Talk*. The veterinarian's MI skills were associated with the client's *Change Talk*, with clients speaking to veterinarians that had reached 'moderate' skills expressing 1.6 times more *Change Talk* (P=0.008) than clients speaking to untrained veterinarians. Results regarding *Sustain Talk* and *Proportion of Change Talk* were inconclusive (Tables 2 and 3). Clients of animal health veterinarians expressed more *Sustain Talk* (P=0.003; Table 2) and a lower *Proportion of Change Talk* (P=0.01; Table 3) than clients of general large animal practitioners. There was 1.2 times more *Change Talk* in conversations with clients of the same gender as the

veterinarian compared to conversations without gender concordance, but the confidence interval **(CI)** was 0.98-1.50. The multiplicative effects of *Change Talk* in conversations from visits regarding herd health problems or visits of other types (as compared to strategic visits) were 0.69 and 0.81, but CIs were 0.50-0.95 and 0.63-1.00, respectively (Table 1). The odds ratio for the *Proportion of Change* Talk for clients satisfied with the conversation (as compared to for unsatisfied clients) was 2.8, but CI was 0.95-8.40 (Table 3). Using the veterinarian's MI skills based on on-farm conversations rather than on role-play conversations in the multivariable analyses gave the same results (results not shown).

Discussion

Veterinarians' MI skills were associated with client *Change Talk,* but results regarding *Sustain Talk* and *Proportion of Change Talk* were inconclusive. Previous studies have demonstrated associations between MI skills and all three variables. Magill *et al.* (2018) reported from a meta-analysis of 36 studies that MI skills of non-veterinary consultants in interventions targeting a range of behavioral outcomes (alcohol use, drug use, gambling, diet, exercise and medical adherence) were positively associated with both *Change Talk* and *Sustain Talk*. However, on average, improved MI skills were associated with more *Change Talk* rather than *Sustain Talk*. This is consistent with the method of MI, which explores ambivalence and, as the conversation continues, helps the client to resolve this ambivalence into commitment to change (Miller and Rollnick, 2012). A link between *Change Talk* and behavior change at follow-up has been demonstrated in several studies *(*Amrhein *et al.,* 2003*;* Moyers *et al.,* 2009; Pirlott *et al.,* 2012), and a systematic review of studies found that *Change Talk* was consistently related to positive client outcome (Romano and

Peters, 2016). This highlights the importance of the findings in the present study and demonstrates an indirect link to outcome of VHHM consultancies suggesting that learning to practice MI may be one means to increase efficiency of veterinary services.

It is unclear what level of MI fidelity is 'good enough' to facilitate change within particular contexts and thus the level of MI skills a veterinarian should have to get results. In the present study, we categorized veterinarians' MI skills based on both relational and technical skills (the MITI variables *Relational*, *MI-non-adherent behaviors* and *Cultivating Change Talk*). These variables were chosen because the skill of empathy has been positively associated and *MI-non-adherent behaviors* negatively associated with outcome. The technical skill *Cultivating Change Talk* has been positively associated with *Change Talk* (Lindqvist *et al.,* 2017). For role-play conversations, the thresholds for *Relational* and *Cultivating Change Talk* were based on those suggested to represent 'fair competency' in the MITI manual (Moyers *et al.,* 2014). Although firm suggestions are lacking with regards to MI-non-adherent behaviors, it is generally recognized that this type of speech should ideally not occur in MI consultations. Coding is difficult, and because the veterinary context was new to the coders before we trained them for the present study, they may have misinterpreted some situations and miscoded speech as MI-non-adherent. To account for this, we chose ≤ 2 as a threshold for 'moderate' skills for this variable. Thresholds for 'near moderate' skills in role-play conversations and for the on-farm conversations were chosen based on experience of MITI coding of conversations in different contexts. In the on-farm conversations, none of the veterinarians reached the threshold used for the role-play conversations. Although previous studies have demonstrated associations between MI skills and outcome, research has not yet

been able to specify clear thresholds (Magill *et al.,* 2018). A definition of ‘moderate’ MI skills was associated with *Change Talk,* but results regarding ‘near moderate’ or ‘poor’ skills were inconclusive. This may indicate that a certain level of MI skills is needed to have an impact. Further studies are needed to explore the most suitable thresholds to define various levels of MI skills in the veterinary profession.

Svensson *et al.* (2020) demonstrated that cattle veterinarians were able to reach ‘moderate’ MI skills from a 6-month training program consisting of 6 days of workshops separated by period of literature studies and practical training of their new skills. However, the majority of participating veterinarians in this study did not reach this level of skills, highlighting the challenges of teaching MI methodology and the need for sufficient practice. MI takes time to learn and to maintain and it may not be possible to fit sufficient practice into the every-day-work of a cattle practitioner.

There was a higher rate of *Sustain Talk* and lower *Proportion of Change Talk* in consultations with animal health veterinarians compared to in those with a general large animal practitioner. This finding is difficult to explain but may be due to animal health veterinarians being more tempted to use their expertise and suggest actions to their clients (MITI variable *Persuade*). Animal health veterinarians generally have larger volumes of VHHM services in their work compared to general large animal practitioners and may have been more confident in their advisory role. Confidence may be built both from longer experience as veterinarians or years in VHHM, but also from larger volumes of VHHM. Svensson *et al*. (2019a) found that veterinarians with more years in practice had lower *Relational* scores and expressed more persuasion than those with more recent veterinary degrees. In line with that finding, Svensson *et al*. (2020) reported that veterinarians with longer experience in VHHM did not improve in practicing *Cultivating Change Talk* after their MI training.

438 The variable with largest average effect on proportion *Change Talk* was client
439 satisfaction (Odds ratio: 2.8; CI: 0.95-8.40). Ritter *et al.* (2019) previously suggested
440 client satisfaction to be a proxy for farmers' preparedness to adopt veterinary advice.
441 Just as in the study by Ritter *et al.* (2019), clients in the present study were highly
442 satisfied with their veterinarian. In fact, only two clients stated they were unsatisfied;
443 hence these results should be interpreted with caution.

444 The results of the present study suggest that the association between *Change*
445 *Talk* and type of visit should be further evaluated in future studies. Strategic visits aim
446 to optimize animal health and production in a longer perspective, and it may be more
447 logical to discuss farm goals in this type of consultations compared to on VHHM visits
448 initiated as a consequence of specific herd health problems and other advisory visits.
449 The focus on farm goals may improve veterinarian-client relations and trust that in
450 turn may render clients to view their relationship with the veterinarian more positively
451 and to adopt veterinary advice, as indicated by findings by Svensson *et al.* (2019b)
452 and Bard *et al.* (2019).

453

454 ***Methodological considerations***

455 We chose to assess veterinarians' MI skills based on role-play with professional
456 actors. This approach was chosen as role-play methodology has shown promise in
457 comparison to using real clients (Imel *et al.,* 2014) and our previous work suggested
458 veterinarians' communication patterns between role-play and real contexts were
459 stylistically similar (Svensson *et al.* 2019a). Additionally, this approach standardized
460 the conditions for MI communication, allowing for reliable categorization of
461 veterinarians in terms of estimating their MI skills. The role-plays were designed and

the actors were trained to provide controlled conditions for participants to demonstrate all their relevant MI skills; consultations had clear behavior targets and actor clients had ambivalent perceptions. To ensure methodological validity, we also assessed how veterinarians would have been categorized based on performance within the same on-farm consultations from which client CLEAR coding data were drawn. Minor differences were found in overall skills categorization, but this method provided the same associations with outcome variables (results available on request) indicating the basis for categorization of MI skills was not critical to these results. Further research is needed to explore if more nuanced differences may exist between such sample groups.

Because of its exploratory nature, multiple testing issues have not been considered in the present study. Observed effects should be verified in future studies and until then interpreted with caution. The limited spread in MI skills among veterinarians (few veterinarians reached 'moderate' skills, and none reached higher levels of MI skills) may have reduced the power of this study, making it less possible to identify associations with client responses. Future research using samples with larger variation may be used to verify the present results and to find further associations between veterinarians' MI skills and client responses.

Also, we were unable to use one of the most accurate coding instruments, the Motivational Interviewing Sequential Code for Observing Process Exchanges (**SCOPE**; Martin *et al.,* 2005), to assess client response. The SCOPE requires that recorded consultations are transcribed and that coders go through the recordings twice to assess each client utterance against one of 16 client codes. In contrast, CLEAR coding does not require a transcript and the coder only needs to listen to the recorded conversation once. CLEAR does not code global ratings but only counts of

Change Talk, Sustain Talk and *Neutral Talk.* CLEAR coding is also not sequential, so behaviors are coded using only tallies. Future studies with larger budgets enabling more precise methods may reveal more associations. Futhermore, qualitative methodologies may complement quantitative efforts such as the present study, offering nuanced and in-depth insight into how veterinarians and farmers understand and experience these MI advisory consultations in the VHHM sphere.

Information about coder was not available and the effect of coder could not be included in the statistical models. However, to sustain coders' competence, coders at MIC Lab AB participated in a quality assurance program. Furthermore, codings were performed in a randomized order, which was likely to reduce further any effects of coder. It is therefore unlikely that the results were biased due to systematic differences between coders. We chose to include a random effect of client (farm) as multiple veterinarians occasionally visited the same farm. Inclusion of a random client (farm) effect even though most farms were only visited once is also a common remedy against so-called overdispersion (i.e. excess variation that is not described by the standard Poisson or logistic regression model). For all models, the variance of the random effect of client (farm) was substantially larger than the variance of the random effect of veterinarian, indicating a larger unexplained variation between clients (farms) than between veterinarians (see also Supplementary Material S4 and S5). A discussion on potential bias related to the veterinarians' selection of recordings for coding is presented in Supplementary Material S1.

Clients were a convenience sample selected by the veterinarians from among their customers. Many of the veterinarians had difficulty finding five farms where they could record a 20-minute advisory conversation for the study. However, when more farms were available, it is likely that clients perceived by the veterinarians as more

satisfied with their services would have had a higher chance of being selected. It is therefore not unlikely that the present study may have overestimated the level of satisfaction by clients and that this may have resulted in higher counts of *Change Talk*. A bias in the effect of MI skill on client response talk in these data is not anticipated because the same sampling method was used by all veterinarians to select clients.

The participating veterinarians were not from a random sample, but most likely represented cattle veterinarians most interested in communication and advisory services. Participants were randomized into the two groups and we also controlled for factors that may have been unequally distributed in spite of the randomization (type of veterinarian, gender, VHHM experience and type of visits) in the cross-classified analyses. Coders did not know the identity or the group of veterinarian, and codings for both groups (trained MI-veterinarians and untrained control veterinarians) were made in parallel and in a randomized order. Veterinarians from both groups were instructed to provide the same information to the farms so that clients would be unaware if their veterinarian was trained or untrained. This approach should merit valid comparisons.

Conclusions

To conclude, in this exploratory study we identified an association between veterinarians' MI skills and client *Change Talk*, a variable known to be correlated with clients' adopting of behavior change. The results suggest that MI may be a valuable methodology in VHHM as these services largely focus on changing management

routines on farms. Learning to practice MI may be one means to improve adherence to veterinary recommendations and to improve efficiency in VHHM services.

Acknowledgements

This study was funded by The Swedish Research Council for Environment, Agricultural Sciences and Spatial Planning. The authors thank the participating veterinarians for providing their time and efforts in the project and participating farmers for their time and effort for the interviews and for their kindness to allow recordings of their conversations with the veterinarians. Distriktsveterinärerna (Jönköping), Växa Sverige (Stockholm) and Skånesemin (Hörby) are acknowledged for their cooperation. The authors are grateful to Åsa Karlin, Nanny Nilsson, Emilia Roosmann, Daniel Ohlsson and Martin Preisler at MIC Lab AB (Stockholm) for their role-play acting performances and to Mahlena Wiveson, Helena Chaomar, and Marie Illerbrand at MIC Lab AB (Stockholm) for coding the recordings. Johan Glimskog (MIC Lab AB, Stockholm) is acknowledged for data retrieval.

Declaration of interests

Lars Forsberg is a partner at MIC Lab AB and Hans Wickström a partner at MeetMe Psykologkonsult AB. Research results demonstrating positive effects of MI on outcome in veterinary medicine may increase the market for codings for MIC Lab AB and the market for educational concepts in MI for MeetMe Psykologkonsult AB. Catarina Svensson, Ulf Emanuelson, Kristen Reyher, Alison Bard, Staffan Betnér and Claudia von Brömssen have no conflict of interest to report.

Ethics statement

The study was granted ethics approval by the Regional Ethical Review Board in Uppsala (reference number 2016/041), ensuring procedures met ethical guidelines for research with human participants. Participation in the study was voluntary both for farms and veterinarians. Veterinarians informed their clients about the purpose and methods of the study. Both veterinarians and farm owners and staff provided written consent for sharing data from recordings and questionnaires with the research team. Participants were assured that all information would be treated anonymously and that they could withdraw from the study at any time. They were also assured that data would be stored at the Swedish University of Agricultural Sciences and that no unauthorized person would be able to access the data.

Software and data repository resources

None of the data were deposited in an official repository.

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669 **Table 1** *Results from multivariable Poisson regression model[a] of the associations between veterinarians' (n=36) skills in Motivational*

670 *Interviewing (MI) and rate of client Change Talk in 170 veterinary herd health management (VHHM) consultations on Swedish cattle farms*

				Multiplicative effect		
Level of observation	Parameter	Level	Number	Estimate; 95% CI[b]	*P*	Overall *P*[c]
Veterinarian	MI skills	Poor_untrained	18	Ref		0.06
		Poor_trained	6	0.99; 0.70-1.40	0.97	
		Near moderate	6	1.07; 0.77-1.50	0.68	
		Moderate	6	1.55; 1.12-2.1	<0.01	
	Gender	Male	2	Ref		
		Female	32	0.91; 0.61-1.40	0.67	
	VHHM experience	≤ 5 years	22	Ref		

		>5 years	14	1.08; 0.85-1.40	0.53
	Vet type	Animal health vet	13	Ref	
		General practitioner	23	0.89; 0.69-1.10	0.35
	Gender concordance	No	124	Ref	
		Yes	46	1.20; 0.98-1.50	0.08
Consultancy	Sufficient time	No	34	Ref	
		Yes	136	1.04; 0.83-1.30	0.73

	Number of clients	One	150	Ref		
		Multiple	20	0.99; 0.72-1.30	0.94	
	Visit type	Strategic	38	Ref		0.06
		Herd health problem	30	0.69; 0.50-0.95	0.02	
		Other	102	0.81; 0.63-1.00	0.07	
Client	Age	Continuous (decades)		1.01; 0.93-1.10	0.79	
	Education	Lower	104	Ref		
		Higher	66	0.96; 0.79-1.20	0.64	

Role	Owner	133	Ref	
	Employee	37	1.00; 0.78-1.30	0.99
Satisfied with consultancy	No	2	Ref	
	Yes	168	1.73; 0.65-4.60	0.27

[a] standard deviation of random intercept of veterinarian: 0.21 (standard error (SE) : 0.079) and client (farm): 0.38 (SE: 0.052)

[b] 95% confidence interval [c] Overall *P*-value for Chi square test for variables with more than two categories

673 **Table 2** *Results from a multivariable Poisson regression model[a] of the associations between veterinarians' (n=36) skills in Motivational*

674 *Interviewing (MI) and rate of client Sustain Talk in 170 veterinary herd health management (VHHM) consultancies on Swedish cattle farms*

				Multiplicative effect		
Level of observation	Parameter	Level	Number	Estimate; 95% CI[b]	*P*	Overall *P*[c]
Veterinarian	MI skills	Poor_untrained	18	Ref		0.51
		Poor_trained	6	1.08; 0.71-1.60	0.73	
		Near moderate	6	1.05; 0.72-1.50	0.80	
		Moderate	6	1.35; 0.92-2.00	0.13	
	Gender	Male	2	Ref		Ref
		Female	32	1.18; 0.72-1.90	0.52	

	VHHM experience	≤ 5 years	22	Ref		Ref
		>5 years	14	1.17; 0.88-1.60	0.28	
	Vet type	Animal health vet	13	Ref		Ref
		General practitioner	23	0.64; 0.47-0.86	<0.01	
	Gender concordance	No	124	Ref		Ref
		Yes	46	1.20; 0.89-1.60	0.23	
Consultancy	Sufficient time	No	34	Ref		Ref

		Yes	136	0.84; 0.61-1.20	0.28	
	Number of clients	One	150	Ref		Ref
		Multiple	20	0.90; 0.59-1.40	0.62	
	Visit type	Strategic	38	Ref		0.22
		Herd health problem	30	0.67; 0.42-1.10	0.08	
		Other	102	0.84; 0.61-1.20	0.29	
Client	Age	Continuous (decades)		1.12; 0.98-1.30	0.09	

	Education	Lower	104	Ref		Ref
		Higher	66	1.15; 0.88-1.50	0.31	
	Role	Owner	133	Ref		Ref
		Employee	37	1.23; 0.87-1.80	0.24	
	Satisfied with consultancy	No	2	Ref		Ref
		Yes	168	0.65; 0.22-2.00	0.45	

675 [a] standard deviation of random intercept of veterinarian: 0.08 (SE: 0.26) and client (farm): 0.55 (SE: 0.078) [b] 95% confidence interval

676 [c] Overall *P*-value for Chi square test for variables with more than two categories

677 **Table 3** *Results from a multivariable logistic regression model[a] of the associations between veterinarians' (n=36) skills (n=36) in Motivational*

678 *Interviewing (MI) and Proportion Change Talk in 170 veterinary herd health management (VHHM) consultations on Swedish cattle farms*

				Proportion Change Talk		
				Odds ratio		
Level of observation	Parameter	Level	Number	Estimate; 95% CI[b]	*P*	Overall P[c]
Veterinarian	MI skills	Poor_untrained	18	Ref		0.88
		Poor_trained	6	0.93; 0.63-1.40	0.72	
		Near moderate	6	1.02; 0.79-1.40	0.93	
		Moderate	6	1.12; 0.79-1.60	0.51	
	Gender	Male	2			

	Female	32	0.90; 0.56-1.40	0.65
VHHM experience	≤ 5 years	22		
	>5 years	14	0.89; 0.68-1.20	0.38
Vet type	Animal health vet	13		
	General practitioner	23	1.44; 1.09-1.90	0.01
Gender concordance	No	124		
	Yes	46	1.02; 0.77-1.40	0.87

Consultancy	Sufficient time	No	34			
		Yes	136	1.26; 0.93-1.70	0.14	
	Number of clients	One	150			
		Multiple	20	1.03; 0.68-1.60	0.89	
	Visit type	Strategic	38	Ref		0.90
		Herd health problem	30	1.07; 0.69-1.70	0.75	
		Other	102	0.98; 0.73-1.30	0.88	
Client	Age	Continuous		0.89; 0.79-1.00	0.06	

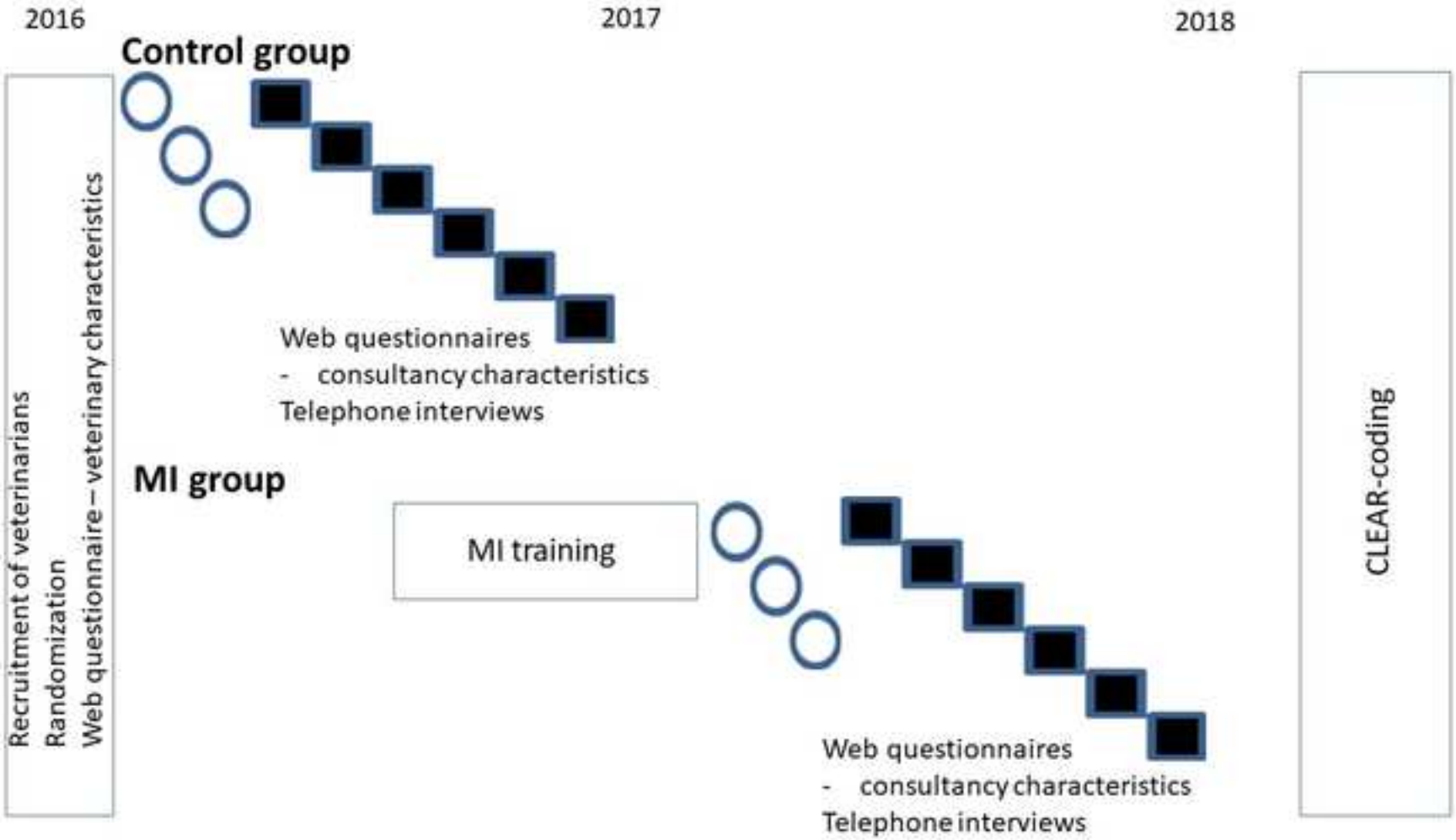
		(decades)			
	Education	Lower	104		
		Higher	66	0.86; 0.66-1.10	0.25
	Role	Owner	133		
		Employee	37	0.80; 0.58-1.10	0.18
	Satisfied with consultancy	No	2		
		Yes	168	2.82; 0.95-8.40	0.06

[a] standard deviation of random intercept of veterinarian: <0.001 (SE: 0.44) and client (farm): 0.24 (SE: 0.12) [b] 95% confidence interval

[c] Overall *P*-value for Chi square test for variables with more than two categories

Figure 1 Design of the study investigating effect of veterinary Motivational Interviewing (MI) skills on client responses in veterinary herd health management conversations on 170 Swedish cattle farms

Figure



Dairy veterinarians' skills in motivational interviewing are linked to client verbal behavior

C. Svensson, L. Forsberg, U. Emanuelson, K.K. Reyher, A.M. Bard, S. Betnér, C. von Brömssen, and H. Wickström

Animal journal

Supplementary Material S1 – Client Language Easy Rating coding

The MIC Lab AB quality assurance program involved coding using both the Motivational Interviewing Treatment Integrity coding system **(MITI)** and the Client Language Easy Rating coding system **(CLEAR).** Inter-rater reliability between coders regarding MITI codings were calculated and checked twice a year as part of the program; in June 2017 and June 2018, intra-class correlations of the different MITI variables were 0.61-0.97 and 0.52-0.93, respectively. Coders generally perform more MITI than CLEAR coding. Although CLEAR coding was done intensively during the course of this study (April and June 2018) and the quality assurance program dealt with both types of coding in a similar way, inter-rater reliability was never calculated for CLEAR codings.

It was crucial to this study that we coded the parts of the conversations when veterinarians were consulting clients about any behavior change (implementation of preventive measures). To instruct veterinarians to select these parts of the conversation for coding therefore seemed the most reasonable method. In theory, this approach may have allowed trained veterinarians to submit sections when their clients expressed the most *Change Talk*. However, we doubt that this occurred to any considerable extent in practice given:

i) we did not specifically inform participants that these audio-recordings were going to be CLEAR coded;
ii) to recognize and note when the client expressed the most amount of *Change Talk* would have required a very high level of multitasking when the veterinarians were occupied advising their clients;
iii) we know from other parts of the same project and general knowledge about veterinary work that many advisory conversations did not deal with implementation of preventive measures for very long periods, meaning veterinarians therefore often did not have more than one set of 20-minute conversations to choose from;
iv) if veterinarians indeed selected sections with the most *Change Talk*, all trained groups had the same opportunity to do so. Hence, if the observed effect was due to this selection procedure only, all trained groups should have performed better than the 'poor_untrained' group. This was not the case.

Supplementary Material S2 – R code for models

Change Talk Model

```
glmmTMB(data = dataset, formula = change_talk ~ offset(log(minutes)) + age + rp_mi_skills + concordance + vet_gender + education + role + sufficient_time + satisfaction + years_in_vhhm + vet_type + multiplepartner + visit_type + (1|farm)+(1|vet), family = poisson, REML = TRUE)
```

Sustain Talk Model

```
glmmTMB(data = dataset, formula = sustain_talk ~ offset(log(minutes)) + age + rp_mi_skills + concordance + vet_gender + education + role + sufficient_time + satisfaction + years_in_vhhm + vet_type + multiplepartner + visit_type + (1|farm)+(1|vet), family = poisson, REML = TRUE)
```

Proportion *Change Talk* Model

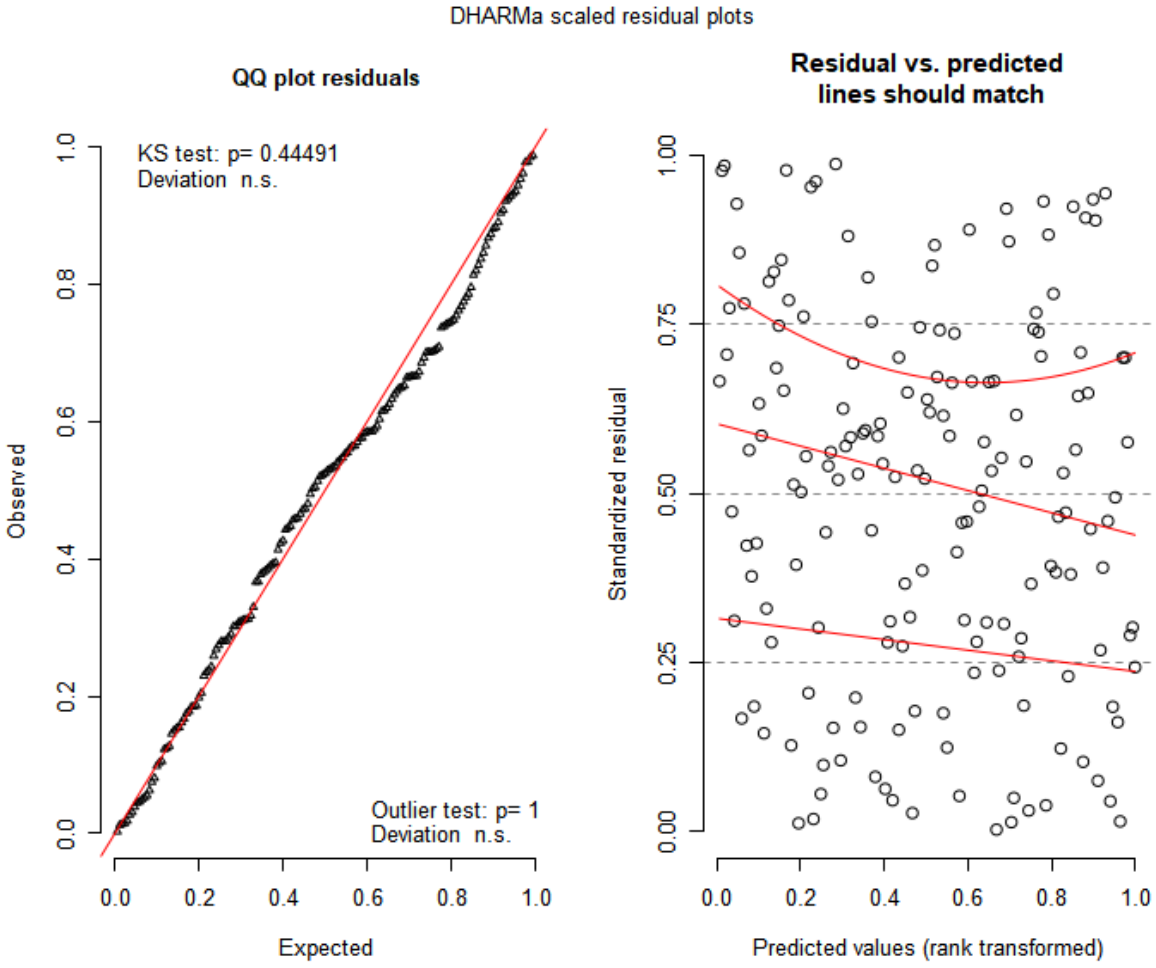
```
glmmTMB(data = dataset, formula = cbind(change_talk, sustain_talk) ~ age + rp_mi_skills + concordance + vet_gender + education + role + sufficient_time + satisfaction + years_in_vhhm + vet_type + multiplepartner + visit_type + (1|farm)+(1|vet), family = binomial, REML = TRUE)
```

rp_mi_skills = role play motivational interviewing skills
VHHM = veterinary herd health management
vet = veterinarian

Supplementary Material S3 – Results from model validation

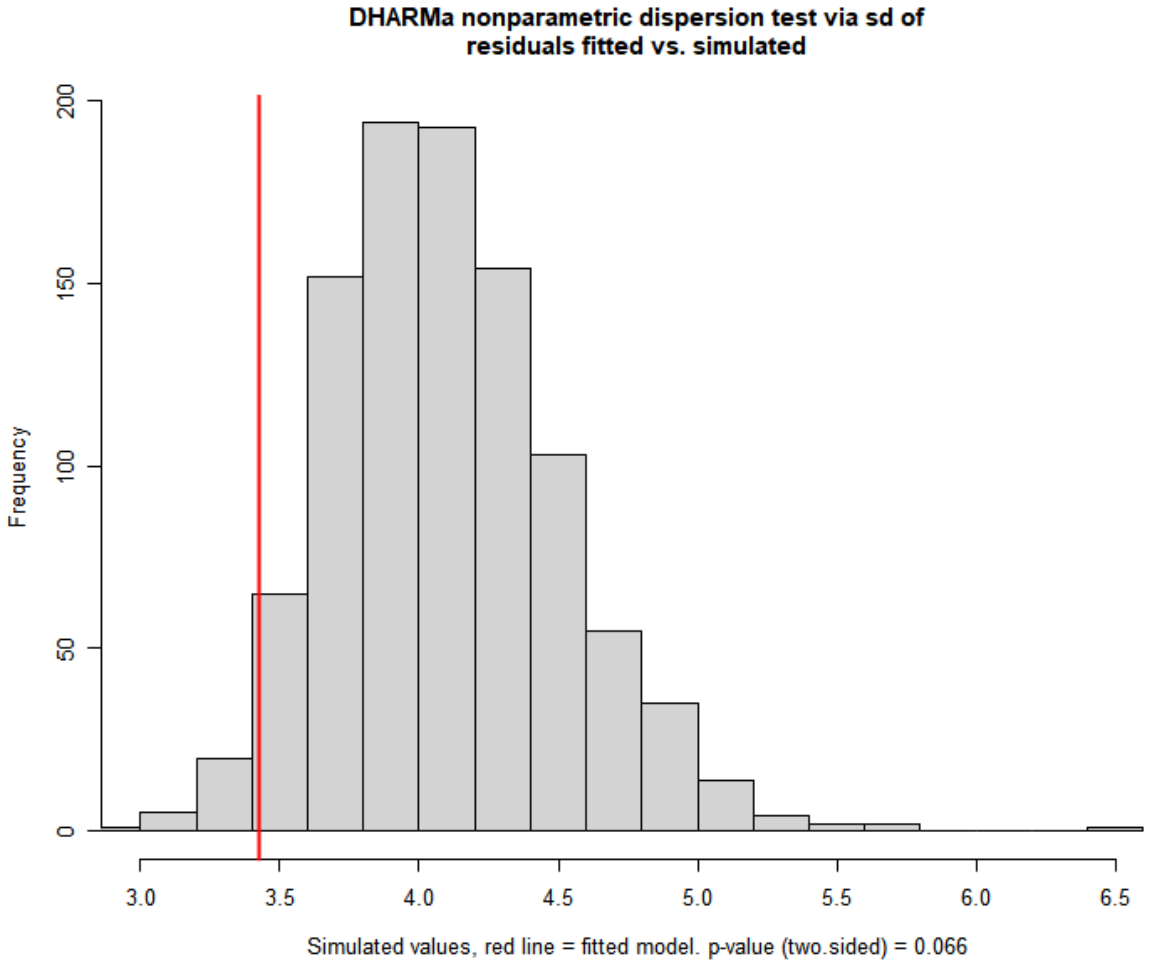
Change Talk Model

Quantile-quantile (**QQ)** plot and residual versus unconditional (on random effects) predictions plot



Dispersion test

Estimated dispersion: 0.84, p-value 0.066 (H_0: dispersion $= 1$, H_A: dispersion $\neq 1$)



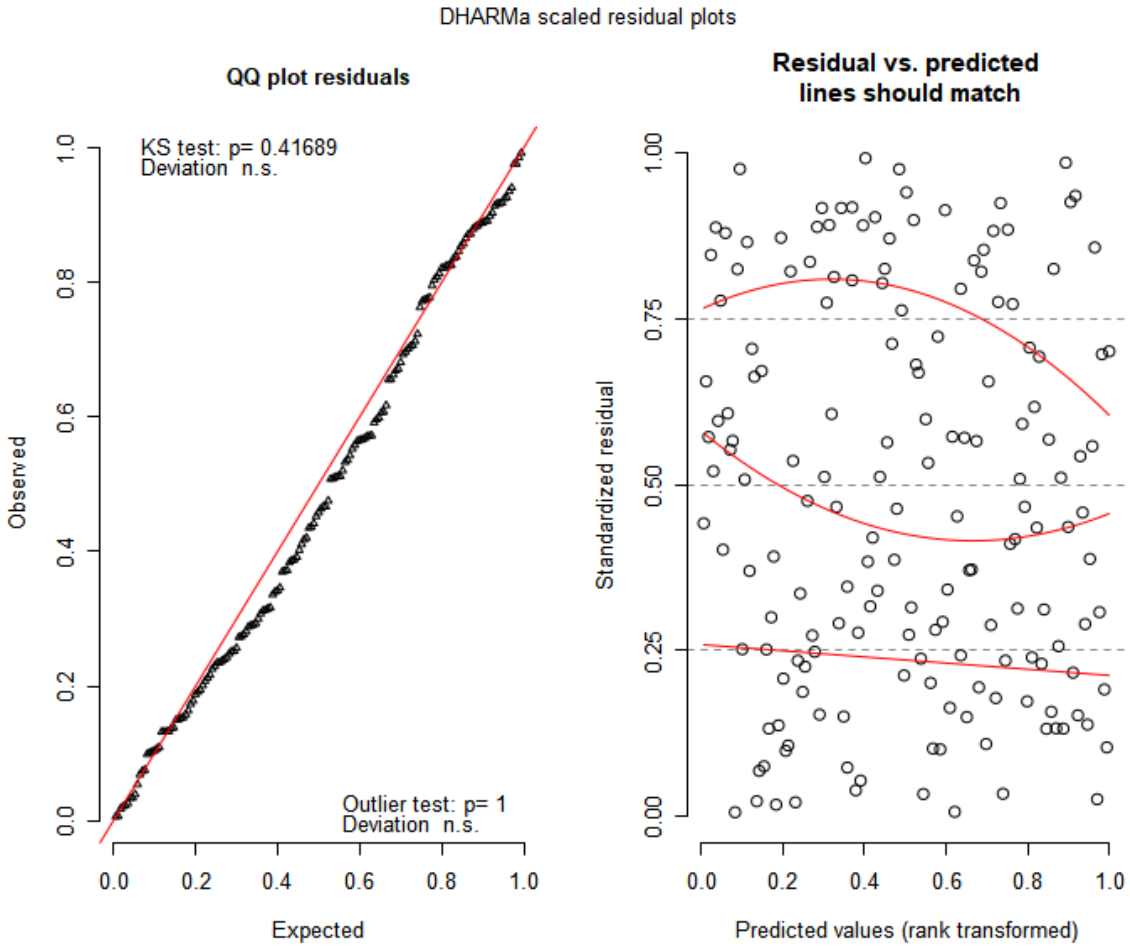
Generalized Variation Inflation Factor **(GVIF)**

Variable	GVIF	Df	$GVIF^{\frac{1}{2Df}}$
age	1.266	1	1.125
rp_mi_skills	1.713	3	1.094
concordance	1.361	1	1.166
vet_gender	1.255	1	1.121
education	1.141	1	1.068
role	1.395	1	1.181
sufficient_time	1.104	1	1.050
satisfaction	1.059	1	1.029
years_in_vhhm	1.164	1	1.079
vet_type	1.288	1	1.135
multiplepartner	1.151	1	1.073
visit_type	1.311	2	1.070

Df = degrees of freedom

***Sustain Talk* Model**

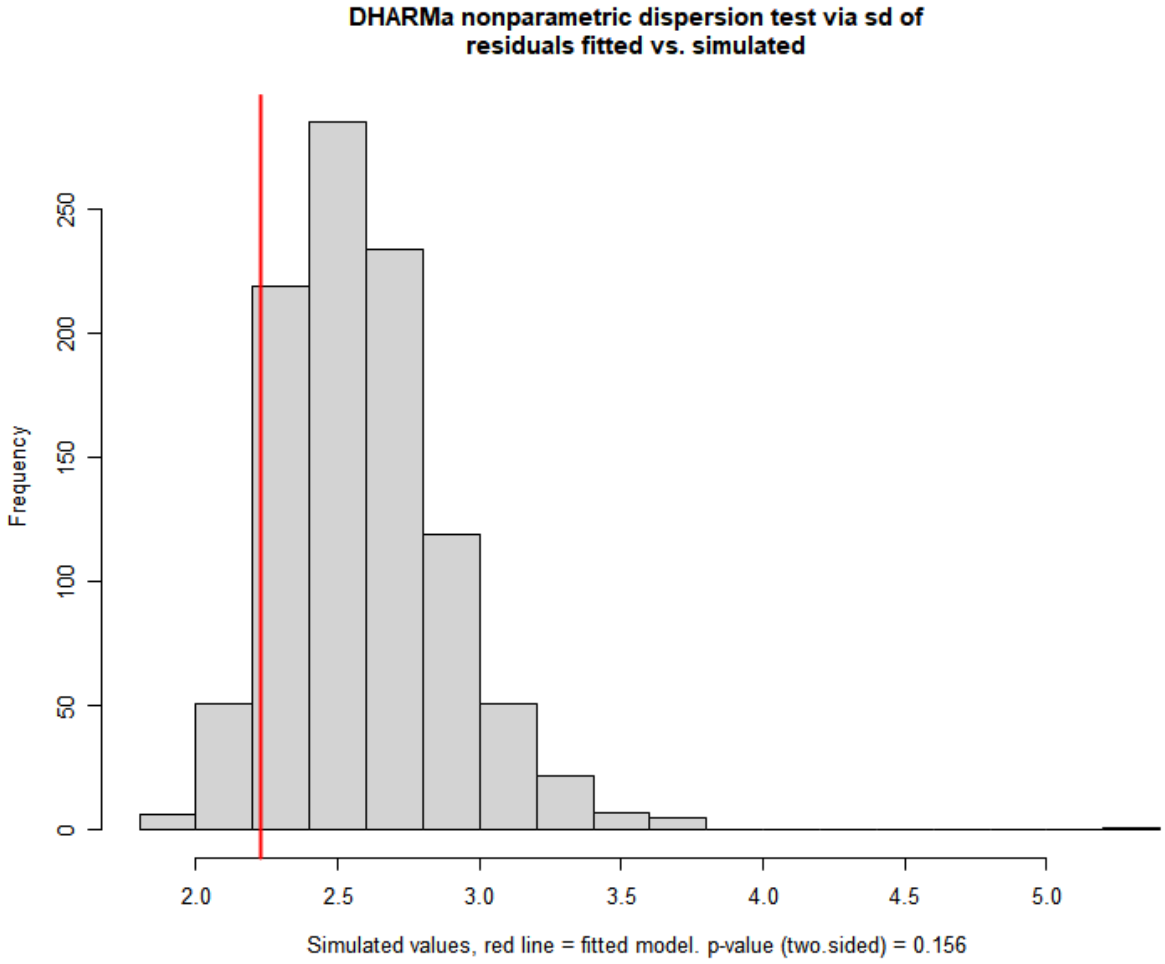
QQ plot and residual versus unconditional (on random effects) predictions plot



Kolmogorov-Smirnov **(KS)** test

Dispersion test

Estimated dispersion: 0.86, p-value 0.156 (H_0: dispersion $= 1$, H_A: dispersion $\neq 1$)

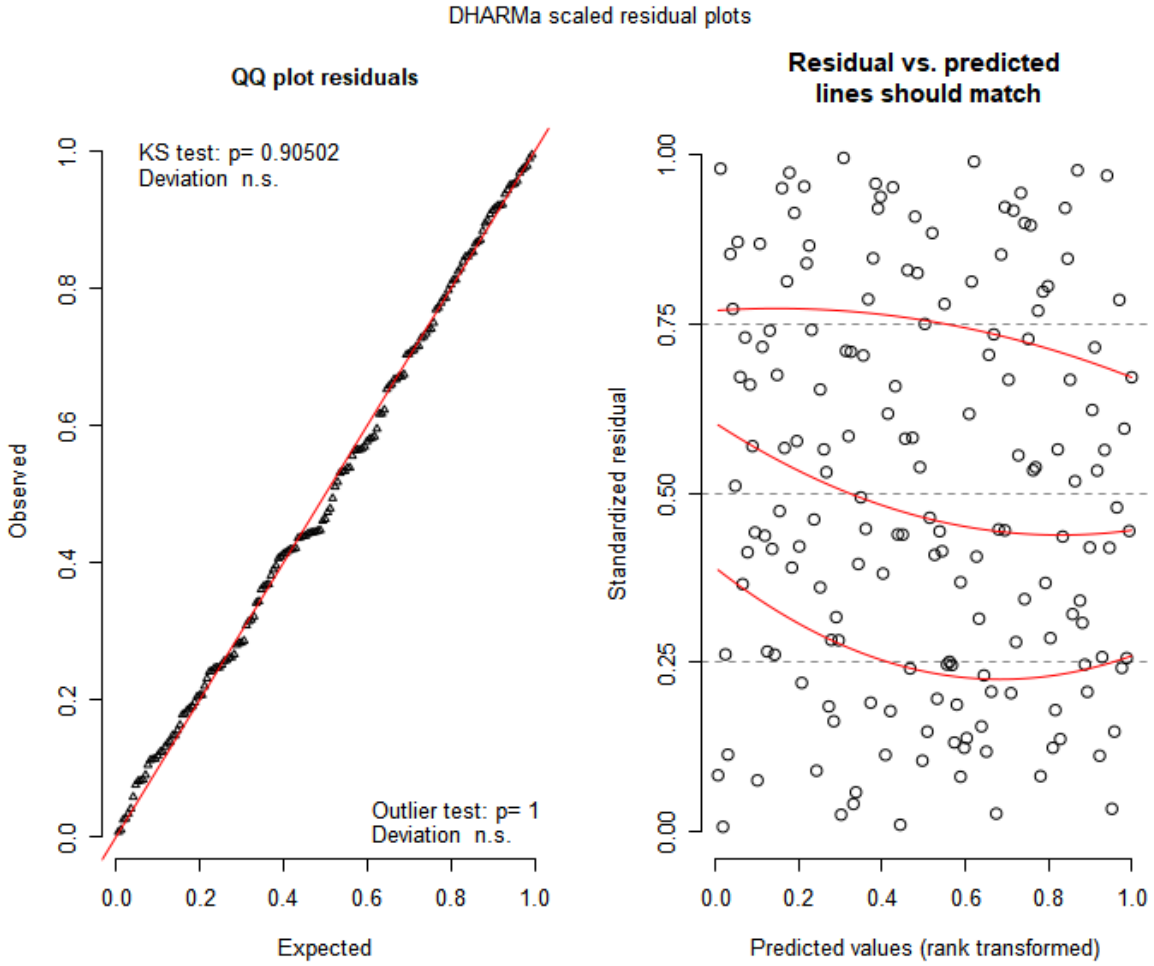


Generalized Variation Inflation Factor

Variable	GVIF	Df	$GVIF^{\frac{1}{2Df}}$
age	1.260	1	1.123
rp_mi_skills	1.755	3	1.098
concordance	1.379	1	1.174
vet_gender	1.264	1	1.124
education	1.139	1	1.067
role	1.384	1	1.176
sufficient_time	1.135	1	1.065
satisfaction	1.103	1	1.050
years_in_vhhm	1.159	1	1.077
vet_type	1.320	1	1.149
multiplepartner	1.169	1	1.081
visit_type	1.340	2	1.076

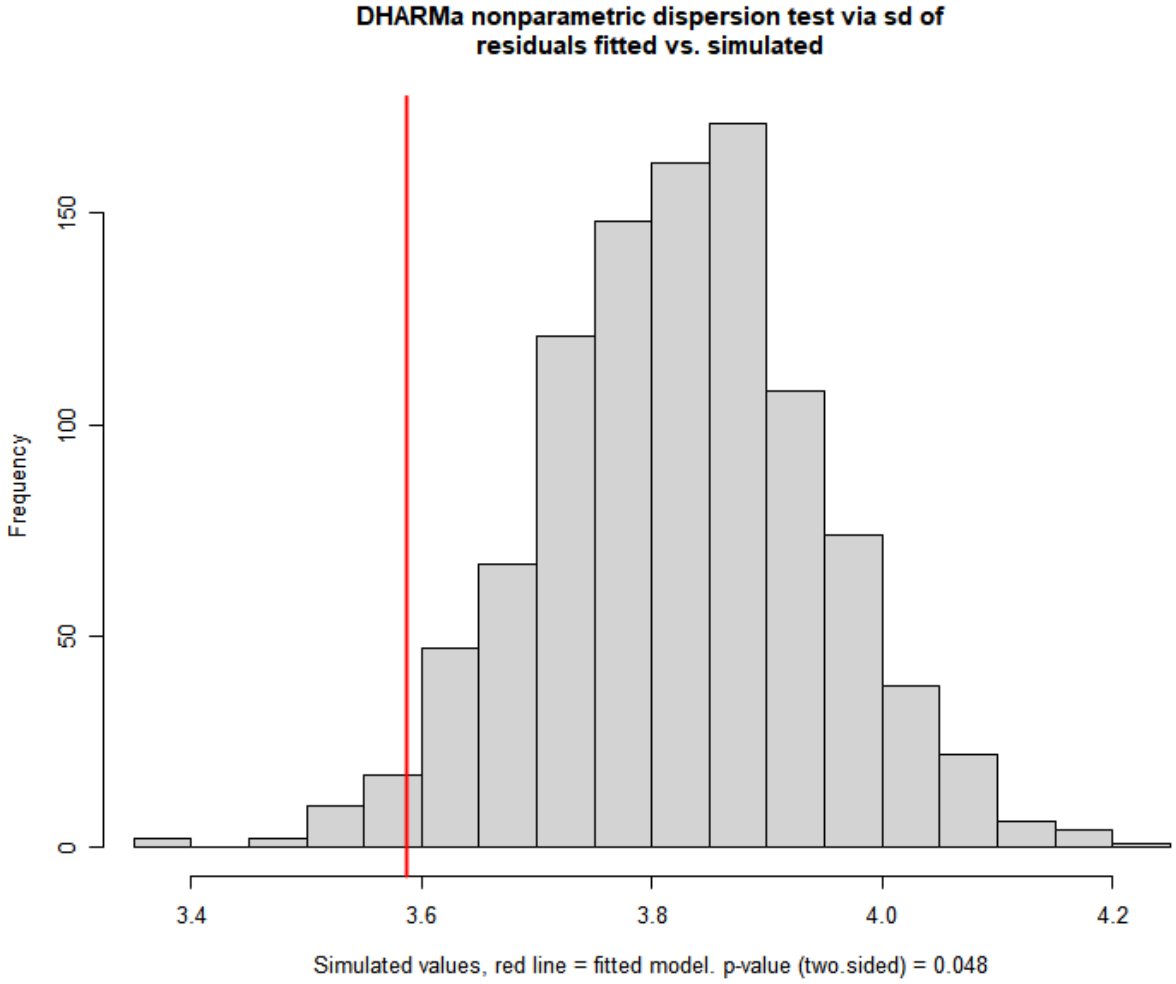
Proportion *Change Talk* Model

QQ plot and residual versus unconditional (on random effects) predictions plot



Dispersion test

Estimated dispersion: 0.94, p-value 0.048 (H_0: dispersion $= 1$, H_A: dispersion $\neq 1$)



Generalized Variation Inflation Factor (GVIF)

Variable	GVIF	Df	$GVIF^{\frac{1}{2Df}}$
age	1.266	1	1.125
rp_mi_skills	1.889	3	1.112
concordance	1.504	1	1.226
vet_gender	1.262	1	1.123
education	1.173	1	1.083
role	1.450	1	1.204
sufficient_time	1.185	1	1.088
satisfaction	1.093	1	1.045
years_in_vhhm	1.178	1	1.085
vet_type	1.399	1	1.183
multiplepartner	1.249	1	1.118
visit_type	1.399	2	1.088

Supplementary Material S4 – Random effect of client (farm)

The large unexplained client variance may potentially reflect a large between-client variability in inclination to change and potentially also reflects the large variability in preventive measures discussed in the conversations. To study these factors was outside the scope of this study, but would be an interesting topic for further research.

Supplementary Material S5 – Time within veterinarian

As described in Materials and methods, the effect of time within veterinarian was not investigated because of the limited number of observations. Another reason was that we did not anticipate any effect using this material. An effect of time was not anticipated in untrained veterinarians because *Years in VHHM* ($\leq$ 5 years; > 5 years) was not associated with outcome. Associations with time would correspond to an effect of an additional experience in VHHM of less than a year.

In the MI-trained veterinarians, increased communication skills post training would be highly unlikely without any coaching and feedback according to previous studies (*Schwalbe CS, Oh HY and Zweben A 2014. Sustaining motivational interviewing: a meta-analysis. Addiction 109, 1287-1294*).

Sustained skills (i.e. no effect of time) was considered a likely scenario because in the MI training in the present study, workshops were accompanied by sustained coaching and feedback throughout 6-7 months. Furthermore, participants were well aware of expectations to deliver MI consultancies during the study period encouraging preparations before consultations.

Eroding of skills post training would also be a likely scenario. However, according to previous studies skills would most likely have eroded already by 3-6 months post training, with no or only smaller changes later on, i.e. during the period when nearly all consultations were recorded. Such changes would be difficult to detect in our models, because within-veterinarian variation in communication performance is known to be substantial and many veterinarians performed their consultations within a relatively short period of time.

In a follow-up study with a larger number of veterinarians and with each veterinarian performing several consultations at e.g. 3 months intervals post training it would be interesting to investigate the effect of time post training on MI skills and thus possibly also on CLEAR results. One way to do this would be to include a fixed effect of time post training and the interaction Time*MI skills. Another possibility would be to perform repeated measures of MI skills, where each measure would consist of sets of at least 3 recordings from different role-play scenarios coded by MITI.

Dairy veterinarians' skills in motivational interviewing are linked to client verbal behavior

C. Svensson, L. Forsberg, U. Emanuelson, K.K. Reyher, A.M. Bard, S. Betnér, C. von Brömssen, and H. Wickström

Animal journal

Supplementary Material S1 – Client Language Easy Rating coding

The MIC Lab AB quality assurance program involved coding using both the Motivational Interviewing Treatment Integrity coding system **(MITI)** and the Client Language Easy Rating coding system **(CLEAR).** Inter-rater reliability between coders regarding MITI codings were calculated and checked twice a year as part of the program; in June 2017 and June 2018, intra-class correlations of the different MITI variables were 0.61-0.97 and 0.52-0.93, respectively. Coders generally perform more MITI than CLEAR coding. Although CLEAR coding was done intensively during the course of this study (April and June 2018) and the quality assurance program dealt with both types of coding in a similar way, inter-rater reliability was never calculated for CLEAR codings.

It was crucial to this study that we coded the parts of the conversations when veterinarians were consulting clients about any behavior change (implementation of preventive measures). To instruct veterinarians to select these parts of the conversation for coding therefore seemed the most reasonable method. In theory, this approach may have allowed trained veterinarians to submit sections when their clients expressed the most *Change Talk*. However, we doubt that this occurred to any considerable extent in practice given:

i) we did not specifically inform participants that these audio-recordings were going to be CLEAR coded;
ii) to recognize and note when the client expressed the most amount of *Change Talk* would have required a very high level of multitasking when the veterinarians were occupied advising their clients;
iii) we know from other parts of the same project and general knowledge about veterinary work that many advisory conversations did not deal with implementation of preventive measures for very long periods, meaning veterinarians therefore often did not have more than one set of 20-minute conversations to choose from;
iv) if veterinarians indeed selected sections with the most *Change Talk*, all trained groups had the same opportunity to do so. Hence, if the observed effect was due to this selection procedure only, all trained groups should have performed better than the 'poor_untrained' group. This was not the case.

Supplementary Material S2 – R code for models

Change Talk Model

```
glmmTMB(data = dataset, formula = change_talk ~ offset(log(minutes)) + age + rp_mi_skills + concordance + vet_gender + education + role + sufficient_time + satisfaction + years_in_vhhm + vet_type + multiplepartner + visit_type + (1|farm)+(1|vet), family = poisson, REML = TRUE)
```

Sustain Talk Model

```
glmmTMB(data = dataset, formula = sustain_talk ~ offset(log(minutes)) + age + rp_mi_skills + concordance + vet_gender + education + role + sufficient_time + satisfaction + years_in_vhhm + vet_type + multiplepartner + visit_type + (1|farm)+(1|vet), family = poisson, REML = TRUE)
```

Proportion *Change Talk* Model

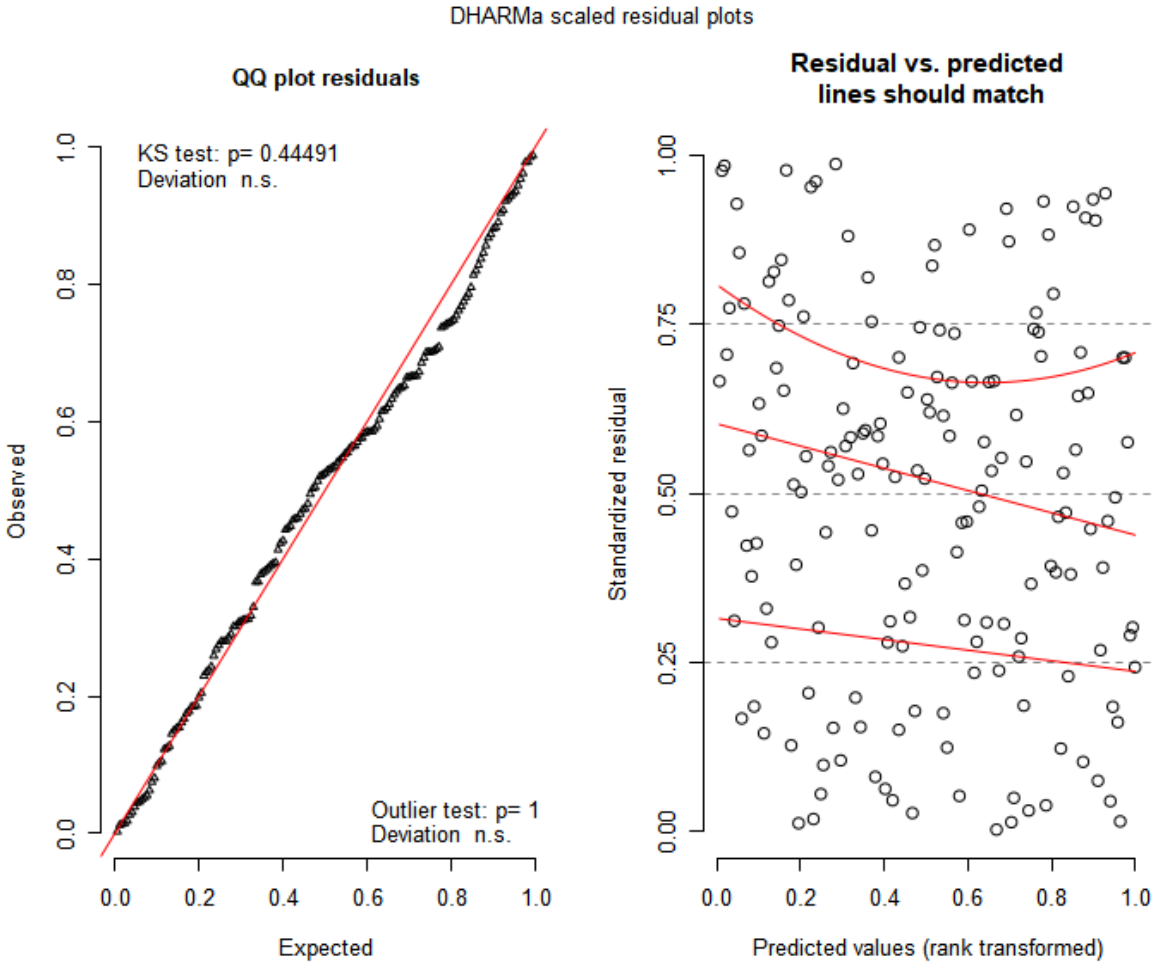
```
glmmTMB(data = dataset, formula = cbind(change_talk, sustain_talk) ~ age + rp_mi_skills + concordance + vet_gender + education + role + sufficient_time + satisfaction + years_in_vhhm + vet_type + multiplepartner + visit_type + (1|farm)+(1|vet), family = binomial, REML = TRUE)
```

rp_mi_skills = role play motivational interviewing skills
VHHM = veterinary herd health management
vet = veterinarian

Supplementary Material S3 – Results from model validation

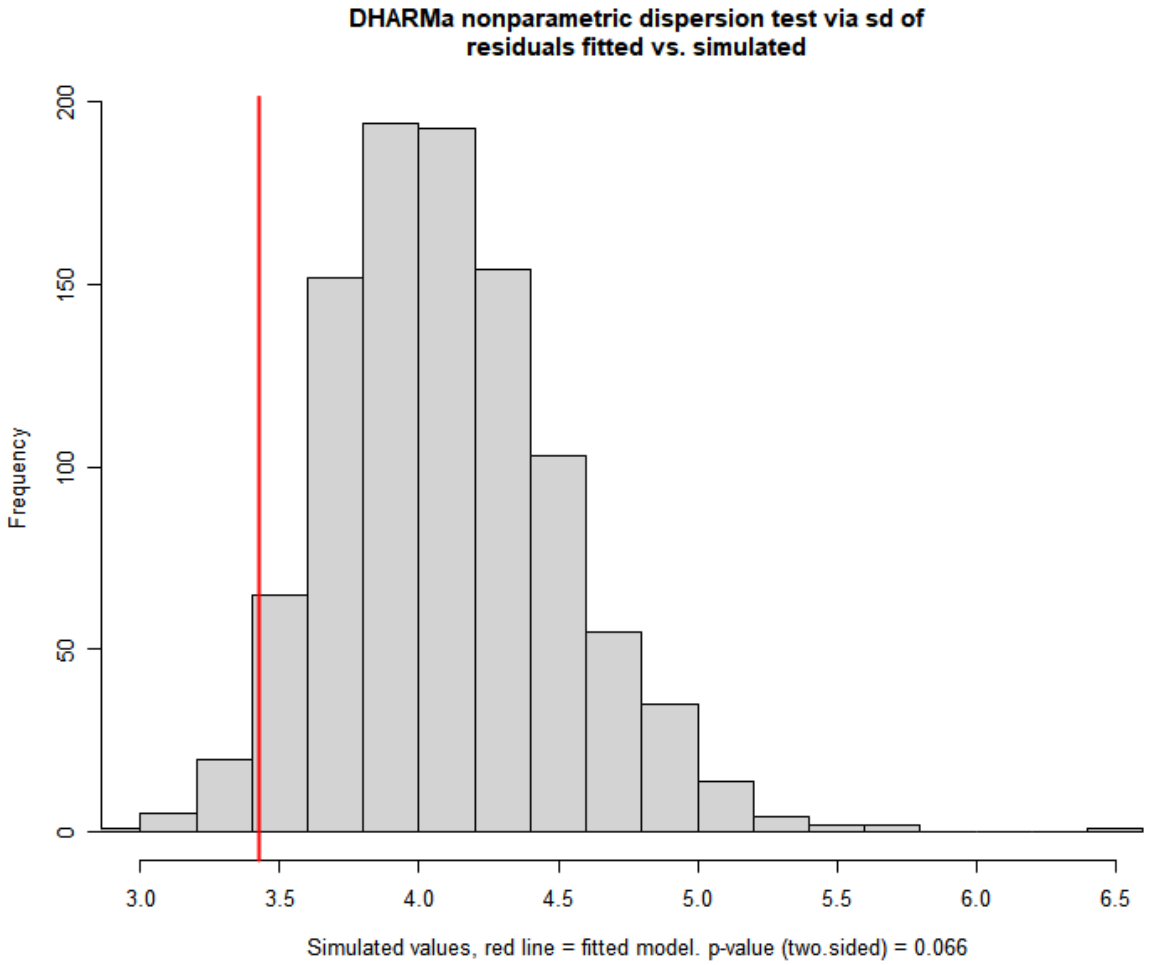
Change Talk Model

Quantile-quantile (**QQ)** plot and residual versus unconditional (on random effects) predictions plot



Dispersion test

Estimated dispersion: 0.84, p-value 0.066 (H_0: dispersion $= 1$, H_A: dispersion $\neq 1$)



Generalized Variation Inflation Factor **(GVIF)**

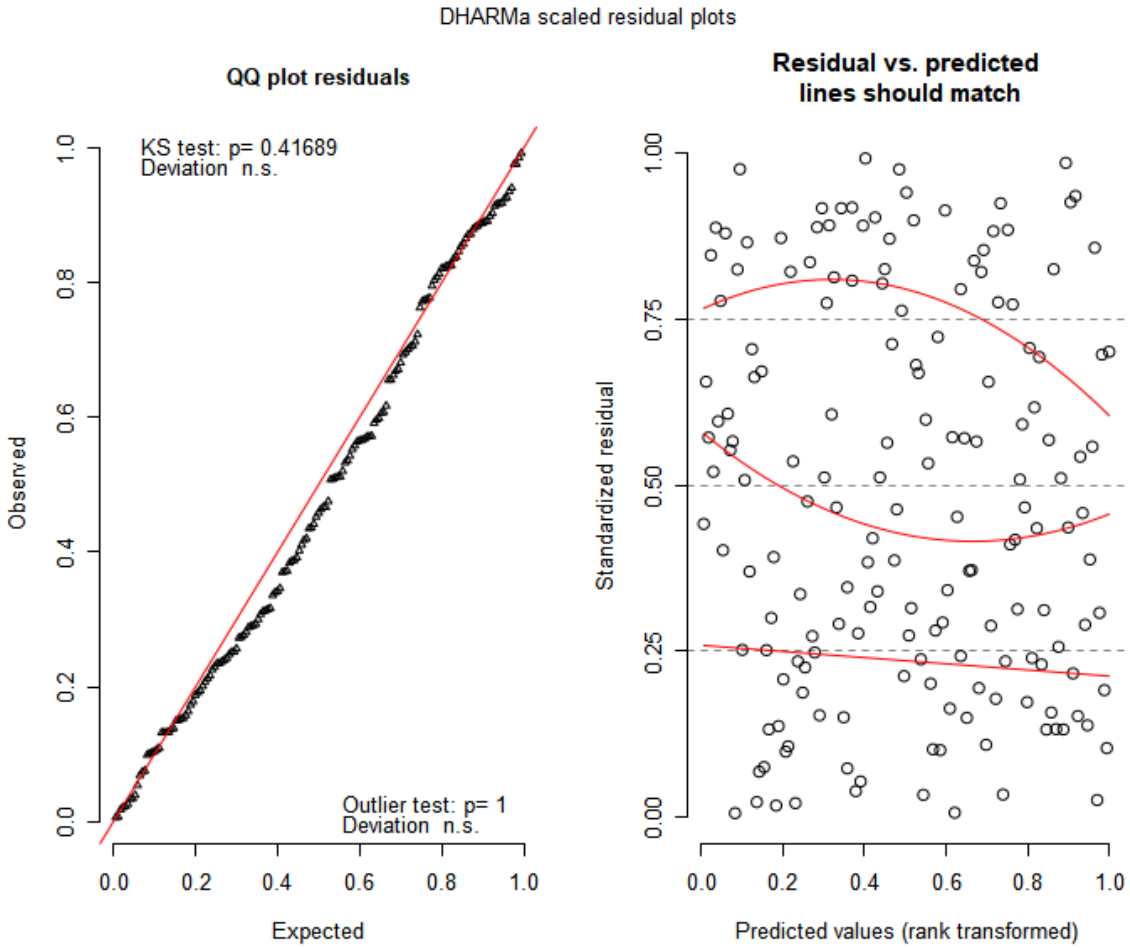
Variable	GVIF	Df	$GVIF^{\frac{1}{2Df}}$
age	1.266	1	1.125
rp_mi_skills	1.713	3	1.094
concordance	1.361	1	1.166
vet_gender	1.255	1	1.121
education	1.141	1	1.068
role	1.395	1	1.181
sufficient_time	1.104	1	1.050
satisfaction	1.059	1	1.029
years_in_vhhm	1.164	1	1.079
vet_type	1.288	1	1.135

multiplepartner	1.151	1	1.073
visit_type	1.311	2	1.070

Df = degrees of freedom

***Sustain Talk* Model**

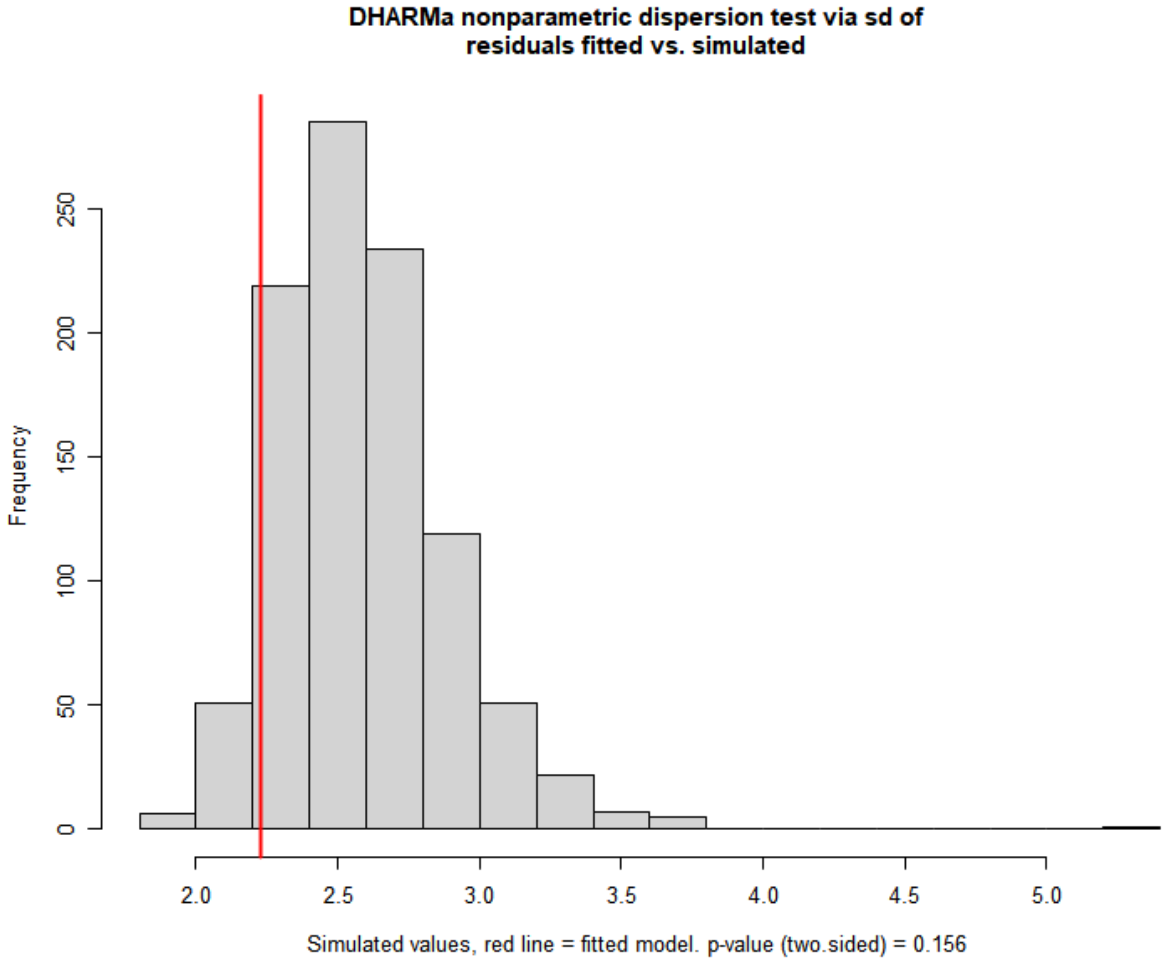
QQ plot and residual versus unconditional (on random effects) predictions plot



Kolmogorov-Smirnov **(KS)** test

Dispersion test

Estimated dispersion: 0.86, p-value 0.156 (H_0: dispersion $= 1$, H_A: dispersion $\neq 1$)



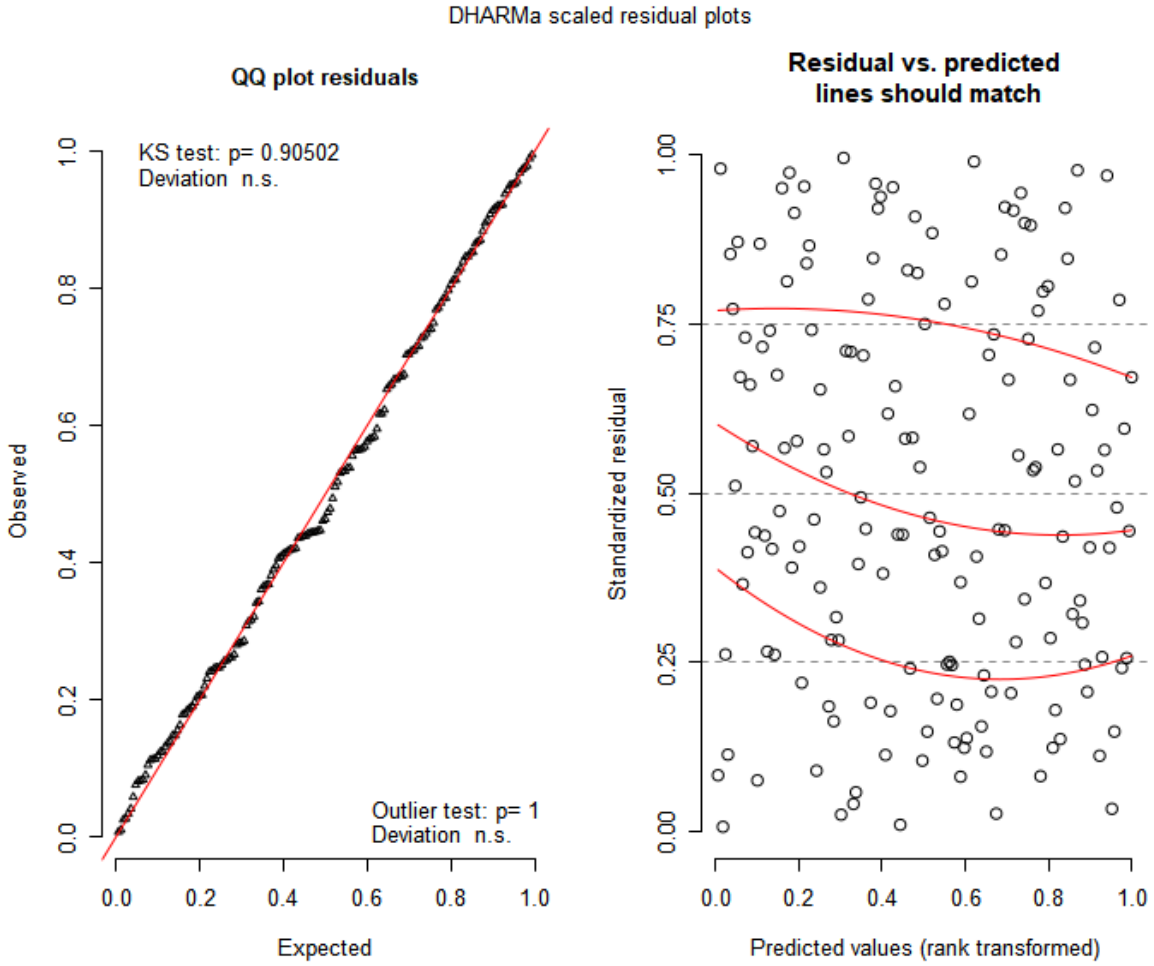
Generalized Variation Inflation Factor

Variable	GVIF	Df	$GVIF^{\frac{1}{2Df}}$
age	1.260	1	1.123
rp_mi_skills	1.755	3	1.098
concordance	1.379	1	1.174
vet_gender	1.264	1	1.124
education	1.139	1	1.067
role	1.384	1	1.176
sufficient_time	1.135	1	1.065
satisfaction	1.103	1	1.050
years_in_vhhm	1.159	1	1.077
vet_type	1.320	1	1.149

multiplepartner	1.169	1	1.081
visit_type	1.340	2	1.076

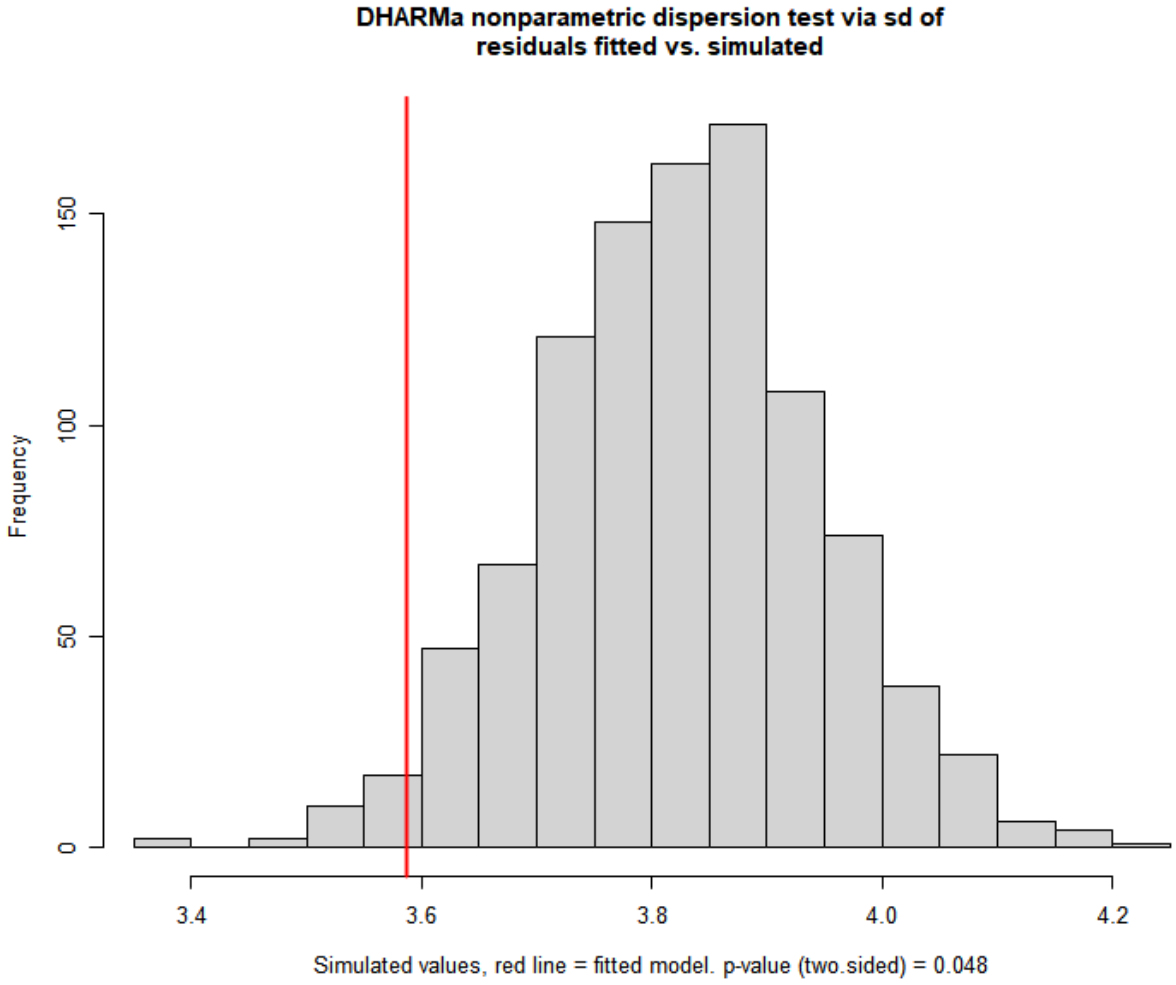
Proportion *Change Talk* Model

QQ plot and residual versus unconditional (on random effects) predictions plot



Dispersion test

Estimated dispersion: 0.94, p-value 0.048 (H_0: dispersion $= 1$, H_A: dispersion $\neq 1$)



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Additional Comments from Editor to Author:
I have some technical requests you need to handle with the editorial office (also to avoid excessive work with a resubmission). Read the text below carefully. Feel free to ask me for elaboration.

Comments to your responses and technical requirements:
I fully accept that you have " … clearly described the aims of this study: to investigate the potential of MI to facilitate client behavior change in VHHM by investigating the effect of dairy cattle veterinarians' MI skills on client response talk. …". With Figure 1 you describe the design of you study to investigate the effect of veterinarian. So it is plain wrong when you argue in item c that "…and a sampling plan that was not designed for this analysis. …'. In figure 1 TIME is specified as a component of your data collection so you must have expected TIME to be part of the effect (or at least a part of your tool to estimate the vet-effect) but you have not addressed the effect of TIME (within veterinarian) with a single word in your manuscript – the issue was raised in the first review).

AU: We have not addressed the effect of ***time within veterinarian*** *in the manuscript because it was not all a specified component of our data collection regarding client behaviour responses. We included TIME in Figure 1 simply to illustrate that the different research activities are described in chronological order if you move from left to right in the figure (one research activity being role-plays, another being MI training and another consultations and so on). In our first revision we also included further information about time aspects of the study design in response to a reviewer comment. We then explained that the recordings were made during two different years for the two groups (2016-2017 och 2017-2018) but within the same time period during those years (June to January) and that the MI training was made during September to March 2016/2017. We understand that the figure may be misleading and we have therefore revised it. We hope that the new figure and this explanation makes it clear that time within veterinarian was not a component of our sampling plan of client behaviour responses.*

In your response you argue with this statement: "…b) We cannot presume a linear slope and to estimate a non-linear slope would require more observations than we have in our dataset. ". That may be true, but with your current model, you presume a horizontal slope. That is, nothing happens during the study period (no 'skill development'). I believe that is a very strong assumption – and quite depressing from the perspective of developing competencies. And if there was a linear effect of TIME which was accounted for, your estimates of the fixed effects could be more precise. I still agree that your sample size is a major limiting factor but you have strength with your mixed model. It will cost one degree of freedom (DF) to include a fixed effect of TIME; two DF if you include TIME*Trained and TIME*Untrained. It will also cost one DF to include a random slope with the random intercept for vet. With this model specification, you have respected your sampling plan (study design). Inclusion of a random coefficient you might have contributed to an explanation of the weird vet-effect in Table 3 (=<0.001). Adding a quadratic term to the fixed effect also costs merely one DF.

In short, you may not have released the full potential of your data. That is up to you, but I want to make sure that a reader of Animal can see that the TIME aspect is not neglected or overlooked by our reviewers (and the editor). So, a pragmatic solution is as follows. We accept your submission but require technical changes as follows:
1) L307-308: '…Interactions were not investigated because of the limited number of observations. …'. Change to: '…Interactions and sequence of veterinarians' visits (time within veterinarian) were not investigated because of the limited number of observations. …'.

2) L499-502: '… For all models, the variance of the random effect of client (farm) was substantially larger than the variance of the random effect of veterinarian, indicating a larger unexplained variation between clients (farms) than between veterinarians (see also Supplementary Material S4). …'. Change to: '…between veterinarians (see also Supplementary Material S4 and S5). …'.
3) Add a section S5 to your Supplementary Material, where you explain why you have omitted TIME. The limited sample size is a plausible argument because you have used it to address the power issue and multiple testing. I also want you to outline how you could address the TIME-component in a follow-up study.
4) You seem to have missed this request: '… You should provide estimates of uncertainty linked to the random effects estimates….'. You must have at least SE-estimates to add to the footnotes in tables 1-3?

AU: Suggested changes have been made to the manuscript and a section S5 has been added in the Supplemental material.