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# Training of transport drivers improves their handling of pigs during loading for transport to slaughter

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ABSTRACT

Pig transport drivers' (**TD**s') handling actions are of great importance as these drivers handle a large number of finishing pigs during stressful situations. Poor handling techniques can have negative consequences for working conditions, pig welfare and meat quality. We studied the effects of a training intervention on Swedish TDs' attitudes towards pigs and their handling actions during loading for transport to slaughter. Twenty TDs working with commercial pig transportation in Sweden were recruited and completed an attitude questionnaire. Ten of them were observed during one loading of pigs before training, and one or two loadings after training (49–265 pigs per loading), and eight of them completed the attitude questionnaire again 50–160 days after training. The cognitive-behavioural training program ProHand Pigs® was adapted and delivered to the ten TDs during a group session, followed by individual meetings. TDs' handling actions were video recorded and summarised as binary variables per 5-s interval. Factor analysis, principal component analysis and paired *t*-test were conducted to investigate the effects of the training intervention on TDs' attitudes, and mixed-effects logistic models were used to examine effects on negative and positive handling actions. Training tended to decrease TDs' beliefs that it is important to move pigs quickly ($P = 0.095$). Training decreased the odds of a 'moderately to strongly negative' action by 55% ($P = 0.0013$) and increased the odds of a 'positive' action by 97% ($P < 0.0001$). This study provides valuable insights into the possibilities to improve TDs' handling actions, and implications for pig welfare during slaughter transport. The study supports previous findings that the attitudes and behaviour of handlers can be improved by cognitive-behavioural training. While our previous research has shown reciprocal relationships between TDs' actions and pig behaviour, further research on TDs' attitudes towards handling that underlie the nature of their behaviour when handling pigs is necessary to fine-tune the cognitive-behavioural training program applied in the present study.



## Implications

Transport to slaughter and related handling are stressful events for finishing pigs, and the behaviour of pig transport drivers during handling can markedly affect the welfare of a large number of pigs. Following a cognitive-behavioural training program, transport drivers decreased negative and increased positive handling actions during the loading of pigs. This indicates that training of transport drivers offers an opportunity to reduce pig stress during loading. Further research is required to better understand the relationships between pig transport drivers' attitudes and handling actions.

## Introduction

Consolidation of the meat industry has led to larger and fewer farms and abattoirs with increased distances between them (Sørensen et al., 2006). In Sweden, there are approximately 940 farms producing 2.6 million finishing pigs annually, and 20 slaughterhouses of which only a handful slaughter the majority of all pigs (Swedish Board of Agriculture, 2023). At approximately 6 months of age, the pigs are collected from farms by professional pig transport drivers (**TDs**) with specialised trucks, each carrying 200–300 pigs. The TDs are legally responsible for the welfare of the pigs during loading, driving and unloading, and transportation is governed by regulations regarding, for example, maximum journey duration (EU Council Regulation No. 1/2005). In Sweden, approximately 100 TDs are working with the commercial transportation of pigs to slaughter (pers. comm., A. Falk., Swedish Association of Road

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Transport Companies, 18 June 2020). TDs are required to have a certificate of competence (European Regulation 1/2005), and practical training in handling of pigs is generally provided by the haulage company.

As a professional group, TDs have previously received limited scientific attention, even though their handling actions can markedly affect the welfare of a large number of finishing pigs (Correa et al., 2010). The loading of pigs for transport to slaughter, including the related handling, is a stressful event for finishing pigs, with a high risk of compromised animal welfare (Bench et al., 2008; McGlone et al., 2014). Appropriate design of loading facilities and appropriate handling are important to reduce the risk of preslaughter stress (Faucitano and Goumon, 2018). We recently found loading of pigs to be stressful also for TDs due to time limitations, a complex set of regulations, poor design of loading areas and conflicts between stakeholders due to a lack of information from farmers regarding injured or sick pigs and inconsistent assessment of fitness of pigs between official veterinarians at abattoirs (Wilhelmsson et al., 2021). Previous research on the transport of pigs to slaughter has focused mainly on the effects of different driving tools (Correa et al., 2010), animal fitness for transportation (Thodberg et al., 2020) and the impact of preslaughter stress on meat quality (Dokmanović et al., 2014; Terlouw et al., 2021). According to The European Food Safety Authority, inadequate staff skills and poorly designed facilities are identified as hazards for poor pig welfare after the arrival of pigs at the abattoir, and the lack of skills and training of staff is considered to be a serious animal welfare concern (EFSA, 2022).

Research in the pig and dairy industries has shown that stockpeoples' attitudes toward pigs influence their handling behaviour, which in turn affects animal fear and thus pig welfare (reviewed in Hemsworth and Coleman, 2011; Hemsworth et al., 2018). Previous research in the pig industry based on the theories of reasoned action and planned behaviour (Ajzen and Fishbein, 1980) has found relationships between stockperson attitudes and behaviours towards pigs and the level of fear of humans in pigs (Hemsworth et al., 1994b; Coleman et al., 1998). Aversive handling increases stress and fear of humans in pigs which in the long term may reduce growth and reproductive performance (Hemsworth and Barnett, 1991; Hemsworth et al., 1994a) as well as meat quality at slaughter (Hemsworth et al., 2002a). Similar evidence is available for dairy stockpeople (Breuer et al., 2000; Hemsworth et al., 2000; Waiblinger et al., 2002). Aversive handling, as well as fear of humans in pigs, may also result in decreased work efficiency during loading (Hemsworth et al., 1994b; Wilhelmsson et al., 2022). Although previous research has mainly focused on stockpeople on farms, similar human attitude-handling relationships were found during short-term human-animal interactions at pig abattoirs (Coleman et al., 2003) and are therefore also likely to be relevant for TDs loading pigs. We recently investigated human-animal interactions during the loading of pigs for transport and found associations between handling of a negative nature and stress-related pig behaviours, and between handling of a positive nature and relaxed pig behaviour (Wilhelmsson et al., 2023).

Motivation, knowledge and training should be recognised as important for all stockpeople handling pigs, including TDs. Training programs targeting attitudes and behaviour of stockpeople have previously been proven successful, resulting in improved attitudes, handling behaviour and pig welfare (Hemsworth et al., 1994b; Coleman et al., 2000). Furthermore, stockpeoples' attitudes towards their interactions with the animals have been shown to affect work motivation, willingness to learn and job satisfaction (Coleman and Hemsworth, 2014). Our recent findings of a bidirectional feed-back loop between TDs' actions and pig behaviour (Wilhelmsson et al., 2023), and the previously found relationships between attitudes and handling actions of stockpeople, behavioural responses of pigs towards humans, and positive effects of stockperson training, altogether highlight the opportunities to improve the handling actions of TDs and subsequently pig welfare through training. The objective of the present study was to investigate the effects of a training intervention on attitudes and handling actions of pig transport drivers during on-farm loading of finishing pigs. We hypothesised that training would improve transport drivers' attitudes towards pigs and pig handling, and decrease negative handling actions such as forceful physical interactions and shouting, and increase positive handling actions such as stroking and calmly talking to the animals.

## Material and methods

### *Transport drivers, farms and pigs*

Data were collected, stored and processed in accordance with Regulation (EU) 2016/679 (General Data Protection Regulation). All human participation was voluntary. Participating haulier managers, TDs and farmers gave their informed consent before data collection. Ten TDs aged 20–54 years, from four haulier companies operating in the south, south-west and centre-north of Sweden, were observed during one loading of pigs before training and one or two loadings after training, in total 28 loadings, between August 2018 and March 2020. All TDs had at least 6 months of experience in transporting finishing pigs at the first recordings. The TDs were selected by asking large-scale pig abattoirs for contact details of their contracted haulier companies, and haulier managers to provide contact details of individual TDs. Four out of five abattoirs, all haulier companies and all TDs that were approached agreed to participate in the study. The pigs were of a three-breed cross and approximately 6 months old. The number of pigs per loading occasion was 49–265 (median 110). All farms applied conventional indoor rearing and were either specialised in finishing pig production or integrated with piglet production. Farmers were approached and asked to participate by either the haulier or a research technician on the day before the intended loading, as determined by the haulier's schedule. The first author (SW) took care to establish rapport with the TDs, to gain their trust and to increase the chances that they were relaxed and not threatened during the study (Oswald et al., 2014). Approximately 1 h of preparations directly prior to preloading observations (see Wilhelmsson et al., 2021 for details) allowed the TDs to familiarise themselves with all three technicians present during data collection.

Pretraining observations were performed 283–131 days before training and were part of full-day recordings of the TD's work (as reported in Wilhelmsson et al., 2021). Post-training recordings, initially planned to be conducted between 2 and 4 months after training to allow TDs with sufficient time to practise new handling techniques, were conducted 50–90 days after training for all TDs except one who was observed 160 days after training (median of 80 days). When feasible, one of the post-training loadings took place at the same farm as the pretraining loading of the same TD; this was possible for two of the TDs.

### *Attitudes*

The TDs were asked to answer a questionnaire (Supplementary Material S1) before and after training, including questions (n = 36) designed to assess the attitudes of TDs towards finishing pigs and working with them (behavioural beliefs) and their beliefs about the extent to which they have control over how they interact with and manage these animals (control beliefs). The questions were based on the theory of planned behaviour (Ajzen, 1985) and originated from a previously validated questionnaire (Hemsworth et al., 1994b; Coleman et al., 2012) modified to address the context in which TDs worked. The respondents were asked to score their level of agreement with statements about behavioural beliefs and control beliefs on a five-level Likert scale from 'strongly disagree' to 'strongly agree', later translated to numerical grades from 1 to 5. In total, 20 TDs completed the pretraining questionnaire (2018–2019), including the ten who participated in training of which eight responded to the questionnaire post-training (2019–2020).

*Handling actions*

The loadings were video-recorded using a camera (Hero 5 Black, GoPro, Inc., San Mateo, California, USA) attached to the side wall of the upper part of the ramp of the truck and directed towards the doorway through which the pigs exited the farm building, covering most of the loading area, i.e. the area between the doorway and the vehicle ramp, as well as a small part of the building's interior if this area was included in the TDs work area. Before the loading started, three research technicians measured the dimensions of the loading area and the slope of the vehicle ramp and mounted the video camera. During loading the technicians were positioned outside the loading area next to the side walls of the loading ramp, although they were in view, they took care to minimise disruption of the driver and pigs.

For each loading, coding of handling actions started when both the TD and one or more pigs were present in the loading area, and finished when the last pig entered the truck. Only actions that were directed towards pigs within a half-circle with a radius of 2 m in front of the TD, denoted by the term 'lot', were recorded. TDs' physical actions, except for contact with knees, were recorded by all occurrence sampling (Altmann, 1974). Auditory and visual interactions and physical contacts with knees were recorded with 1/0 sampling at 5-s intervals. TDs actions were divided into three categories: moderately to strongly negative, mildly negative and positive (Table 1), based on the nature of the behaviour and how the pigs would perceive the human behaviour (positively or negatively) (as reviewed by Hemsworth, 2019; Skuse et al., 2020). Each of the three action categories was represented by a composite variable, coded – for each 5-s interval – as 0 if none of the actions was observed in the interval, and as 1 if one or several of the actions were observed. An additional variable expressed whether farm staff was located in the loading area during recording or not. Two of the authors (JY or MA), blinded to TD's identities, coded all video recordings and divided them between themselves as they found convenient. To train the coders, improve their skills and secure reliability, a video of a TD loading pigs (material from a small pilot study, TD not included in the present study) was coded by both authors before the real coding started.

Each composite variable was complemented by two additional variables that expressed the values of the composite variables in the preceding interval and in the interval before that (lag1 and lag2 values). The number of pigs in the lot was recorded at each TD action. For remaining 5-s intervals, where no TD action was recorded, the number of pigs was calculated either as the mean number of all recordings in the interval or, if no recorded number was available, as the nearest preceding number from up to five ear-

**Table 1**
Handling actions of transport drivers (TDs) during truck loading of Swedish finishing pigs for transport to slaughter.

| Composite variable | Action | Definition |
|---|---|---|
| Moderately to strongly negative action | Paddle hard pig still | Tactile contact with rattle paddle on pig(s) that stands still; moderate to forceful contact that is audible to the TD |
| | Paddle hard pig walk vehicle | Tactile contact with rattle paddle on pig(s) that walks towards the vehicle; moderate to forceful contact that is audible to the TD |
| | Paddle hard pig walk other | Tactile contact with rattle paddle on pig(s) that walks in other direction than towards the vehicle; moderate to forceful contact that is audible to the TD |
| | Board hard pig still | Tactile contact with driving board on pig(s) that stands still; moderate to forceful contact that is audible to the TD |
| | Board hard pig walk vehicle | Tactile contact with driving board on pig(s) that walks towards the vehicle; moderate to forceful contact that is audible to the TD |
| | Board hard pig walk other | Tactile contact with driving board on pig(s) that walks in other direction than towards the vehicle; moderate to forceful contact that is audible to the TD |
| | Hand hard pig still | Tactile contact with hand on pig(s) that stands still; moderate to forceful contact that is audible to the TD |
| | Hand hard pig walk vehicle | Tactile contact with hand on pig(s) that walks towards the vehicle; moderate to forceful contact that is audible to the TD |
| | Hand hard pig walk other | Tactile contact with hand on pig(s) that walks in other direction than towards the vehicle; moderate to forceful contact that is audible to the TD |
| | Knee | Tactile contact with knee against pig(s) |
| | Loud sound | Shouting or whistling louder than conversational tone or making loud noise with tools; long or short duration |
| Mildly negative action | Paddle loose pig still | Tactile contact with rattle paddle on pig(s) that stands still; low force that is not audible to the TD |
| | Paddle loose pig walk vehicle | Tactile contact with rattle paddle on pig(s) that walks towards the vehicle; low force that is not audible to the TD |
| | Paddle loose pig walk other | Tactile contact with rattle paddle on pig(s) that walks towards the vehicle; low force that is not audible to the TD |
| | Board loose pig still | Tactile contact with driving board on one or several pigs that walks in other direction than towards the vehicle; low force that is not audible to the TD |
| | Board loose pig walk vehicle | Tactile contact with hand on pig(s) that walks towards the vehicle; low force that is not audible to the TD |
| | Board loose pig walk other | Tactile contact with driving board on pig(s) that walks in other direction than towards the vehicle; low force that is not audible to the TD |
| Positive action | Hand loose pig still | Tactile contact with hand on pig(s) that stands still; low force that is not audible to the TD |
| | Hand loose pig walk vehicle | Tactile contact with hand on pig(s) that walks towards the vehicle; low force that is not audible to the TD |
| | Hand loose pig walk other | Tactile contact with hand on one or several pigs that walk in other direction than towards the vehicle; low force that is not audible to the TD |
| | Soft sound | Talking or whistling calmly; conversational tone or lower, long or short duration |
| | Visual active | Visual contact with pigs during at least 3 s while moving body or tools, without touching pigs. |
| | Visual passive | Visual contact with pigs during at least 3 s without moving body or tools, without touching pigs. |

lier intervals in the same loading or, if no close preceding number was found, as the mean number for the complete loading.

*Training procedure*

The training consisted of a two-day group session (in June 2019) led by the first author (SW), with all participants in a classroom setting with tables and chairs distributed in groups to promote the exchange of ideas, reflections and experiences. The group training was later followed by individual sessions with the first author to evaluate each TD's handling methods and attitudes. The training procedure was developed based on information about the TDs' physical workload and psychosocial working environment (Wilhelmsson et al., 2021), pig handling methods gained in pretraining observations (Wilhelmsson et al., 2023) and the cognitive-behaviour training program ProHand Pigs® (an original concept developed by Australian Pork Limited and the Animal Welfare Science Centre in 1996) adapted to Swedish TDs. To improve the training material further and increase participant motivation and engagement, the TDs and haulier managers were contacted by telephone 3 months before training and asked about the desired training content. The most common spontaneous comment concerned pig handling.

On day 1 of the group session, issues related to working conditions and ergonomically correct working positions were addressed and short lectures were mixed with workshops and discussions about workload, working environment, legislation and various practical questions. An official veterinary inspector from the Swedish Food Agency with extensive experience in meat inspection gave a presentation about transport-related pig injuries and answered questions from the participants. On day 2, the 'ProHand'® training program was introduced by delivering short lectures, mixed with group discussions. The training program, previously successfully implemented in the Australian pig industry (Hemsworth et al., 1994b; Coleman et al., 2000), targets beliefs that underlie the behaviours (attitude) and the behaviours themselves, and how to maintain appropriate beliefs and behaviours (Hemsworth and Coleman, 2011; Coleman and Hemsworth, 2014). First, key information was presented and discussed, for example regarding pigs' sensitivity to forceful physical interactions, as well as their sensitivity to stressors in general, and the importance of appropriate pig handling. Adverse effects of negative handling actions on pig fear behaviours such as high pitch vocalisations, freezing and crowding were addressed. In addition to negative consequences of the negative handling behaviour on handling ease and welfare, the effects of positive handling behaviours that reduce fear of humans in pigs and improve ease of handling were considered. Attention was given to the challenges to change TDs behaviour, for example, pressure to conform with co-workers and incorrect beliefs about barriers to change, such as a lack of time. In a concluding workshop, the TDs and the first author (SW) jointly developed ten guidelines for professional handling of pigs at transport to slaughter (Supplementary Material S2).

The individual sessions were held 2 and 3 months after the group session and lasted for approximately 3 h per TD. The TDs were invited to share thoughts that had emerged after the group session, followed by a repetition of essential material. Thereafter, individual data from pretraining recordings, including physical workload and attitudes, were presented and short video clips of the TD during pig loading were shown. The TD was encouraged to reflect and comment on the displayed handling actions, and opportunities for improvements were discussed. Finally, the TD was handed a course certificate, a custom-designed cap and a pocket folder with the ten guidelines. Furthermore, to reinforce the information presented in the sessions, the first author (SW) contacted the TDs by telephone 2–4 weeks after the training to prompt an assessment by the TDs as to whether or not changes in their behaviour and that of their transported pigs were being achieved, and to remind them of the important aspects of the training. A similar telephone call was repeated 1.5 years after training.

*Statistical analysis*

*Attitudes*

Thirty-two questionnaire items reflecting attitudes or beliefs towards pig handling (13 items for different ways to move pigs, seven items for rapid pig movement and 12 items for the nature of pigs) were selected from the original questionnaire based on logical reasoning. In the provided responses, there were two missing values for different TDs and items, apparently occurring at random. Principal component analysis (**PCA**) was conducted to reduce the number of dimensions, utilising the 20 TDs' pretraining responses. The Kaiser-Meyer-Olkin measure of sampling adequacy and Bartlett's test of sphericity (Supplementary Material S3) were used to assess the suitability of the data for structure detection. Considering the limited sample size, the proportion of variation explained by underlying factors and the interrelationships between questions indicated by these tests (Table 2) justified the two PCAs of attitudes labelled "Ways to move pigs" and "Rapid pig movement", but not the "Nature of pigs". Consequently, the first two groups of items were separately subjected to PCA using SPSS 25 for Windows (IBM Corp., Armonk, New York, USA).

Missing values were handled by pairwise deletion, i.e. the PCAs were based on correlations using all available data. Oblimin rotation with Kaiser normalisation was applied to find a solution that maximised individual loadings and minimised cross-loadings of variables on multiple components. In both PCAs, three components had Eigenvalues above 1 and were extracted, explaining 28.0, 19.2 and 12.8% (ways to move) and 36.5, 23.2 and 15.5% (rapid pig movement) of the total variance. The loadings are given by pattern matrices in Table 3: loadings below 0.4 are not reported.

The separation of components was acceptable for all questions in the PCA for "Rapid pig movement". For "Ways to move pigs", items 13, 19, 20 and 21 loaded almost equally across two components, and was therefore removed from further analysis. Based on the semantic content of the items, components 1–3 of "Ways to move pigs" were subjectively labelled 'force' (for example including the item "Friendly interaction makes handling harder"), 'design' (for example including the item "Building designs makes handling harder") and 'fear' (for example including the item "Pigs are easily frightened by forceful handling"), and for "Rapid pig movement" they were labelled 'quick' (for example including the item "Best to move pigs quickly"), 'floor' (for example including the item "Slippery floors makes pigs unsure") and 'contact' (for example including the item "Physical contact is necessary to move pigs"), respectively.

Composite scores were calculated for each component as the sum of the item scores multiplied by the corresponding component coefficient, thus adding six new variables to the data, both before and after training. There were 20 observations before training

**Table 2**
Kaiser-Meyer-Olkin measure of sampling adequacy (KMO) and Bartlett's test of sphericity for factor analysis of attitudes towards ways to move finishing pigs, rapid pig movement and the nature of pigs. Questionnaire responses from 20 pig transport drivers in Sweden 2018–2019.

| Beliefs | KMO | Bartlett's test of sphericity | | |
|---|---|---|---|---|
| | | $\chi^2$ | df | *P* |
| Ways to move pigs | 0.465 | 96.21 | 78 | 0.079 |
| Rapid pig movement | 0.554 | 38.06 | 21 | 0.013 |
| Nature of pigs | 0.382 | 49.84 | 66 | 0.93 |

**Table 3**
Loadings of different items in the first three principal components (labels within brackets) of attitudes towards ways to move finishing pigs and rapid pig movement; loadings below 0.4 are not reported. Questionnaire responses from 20 pig transport drivers in Sweden 2018–2019.

| Items | Questions | Component 1 (force) | 2 (design) | 3 (fear) |
|---|---|---|---|---|
| Ways to move pigs: | | | | |
| 2 | Goad switched on makes handling harder | −0.820 | | |
| 5 | No physical contact makes handling harder | 0.733 | | |
| 6 | Physical contact makes handling harder | | | 0.626 |
| 8 | Handling does not affect pig behaviour | | 0.739 | |
| 12 | Friendly interaction makes handling harder | 0.619 | | |
| 13 | Forceful interaction makes handling harder | −0.505 | | 0.505 |
| 14 | Loud noises make handling easier | | | −0.658 |
| 18 | Poor handling by farm staff makes handling harder | | | −0.466 |
| 19 | Previous handling has most effect on ease of handling | | 0.506 | 0.550 |
| 20 | Building designs makes handling harder | −0.652 | 0.680 | |
| 21 | Large pigs are difficult to handle | 0.552 | 0.613 | |
| 22 | Animal smell makes handling harder | | −0.817 | |
| 27 | Pigs are easily frightened by forceful handling | | | 0.730 |
| Rapid pig movement: | | 1(quick) | 2(floor) | 3(contact) |
| 1 | Physical contact is necessary to move pigs | | | −0.740 |
| 3 | Best to move pigs quickly | 0.870 | | |
| 4 | Best to keep pigs moving quickly | 0.797 | | |
| 7 | Pig numbers determine the speed | | | −0.723 |
| 9 | Unruly pigs can be irritating | 0.771 | | |
| 16 | Slippery floors make pigs unsure | | 0.939 | |
| 17 | Tilting floors makes pigs unsure | | 0.914 | |

and eight after training, except for force and design which had seven observations each due to a missing value in item 21. Effects of training on the composite scores were analysed by paired *t*-test based on the TDs with data from both before and after training, using Stata/IC 15 for Windows (StataCorp LCC, College Station, Texas, USA).

*Handling actions*

Handling actions were analysed in Stata/IC 15. Three mixed-effects logistic models were used to investigate effects of the training intervention on moderately to strongly negative, mildly negative and positive handling actions. Five-second interval was the unit of analysis. Twenty-two independent variables representing TDs and environment characteristics were tested as fixed effects, possibly confounding the studied relationships. To facilitate modelling, continuous independent variables were categorised into three to five approximately equally sized categories: season (August–November; December–March), hour when loading started (0400–0559 h; 0600–0659 h; 0700–0859 h; 0900–1200 h; 1200–1659 h), weather conditions (calm; other), outdoor temperature (-4–+2; 3; 4–5; 6–12 °C), haulier company (A; B; C; D), TDs sex (male; female), TDs age (21–25; 26–29; 30–34; 35–55 years), number of pigs loaded (49–84; 85–109; 110–164; 165–265), average number of pigs in the lot (1.0; 1.1–2.0; 2.1–3.0; 3.0–10), rearing time in farm section (70–90; 91–103; 104–114; 115–127 days), sorting of pigs by farm staff before loading (no; yes); fasting time before loading (0–3; 5–8; 9–12 h), width of loading bay (60–139; 140–234; 235–319; 320–400 cm), length of loading bay (0–149; 150–184:185–322; 323–685 cm), corners in loading area (none; soft; sharp), floor surface in loading area (concrete; dirt; wood), ramp slope (4.0–9.2; 9.3–12.9; 13.0–16.6; 16.7–22.2 degrees), width of loading ramp (60–148; 149–169; 170–185; 186–235 cm), length of loading ramp (140–247; 248–269; 270–274; 275–347 cm), surface of loading ramp (metal; non-slip), use of rattle paddle on farm (no; yes) and recorder id (third author; fourth author). Rain, strong sunshine or strong wind was denoted as "other weather". Rearing time was used as a proxy for average pig size. In addition, the dichotomous variables representing the dependent variable in the two preceding intervals (lag1 and lag2) and a dichotomous variable expressing farm-staff interacting with pigs in loading area during recording in the current or two preceding intervals (no; yes) were considered for inclusion. The lag1 and lag2 variables were used to control for the possible influence of handling actions in preceding 5-s intervals on the same actions in the present interval.

Initially, random effects for both TD and loading were tested to account for clustering at different levels, and random loading was considered the most appropriate to use, resulting in two-level hierarchical models. However, in some models, the random effect was eliminated because the fixed effects accounted for virtually all variation between TDs and loadings, rendering random estimates impossible to obtain. Thus, the models were simplified by excluding unnecessary random effects, which changed the model estimates only marginally (to the 4th–8th decimal). The variances were partitioned at different data levels for empty models with random effects using the latent-class method and the intraclass correlation coefficients were calculated (Supplementary Material S3).

Training was maintained in the models. All potentially confounding TD- and environment-specific variables were tested one by one in univariable models, including the random loading effect, and only variables with $P \leq 0.20$ were considered as eligible for further modelling. Subsequently, models with all eligible variables were reduced by a manual stepwise procedure, in each step excluding the variable with the highest *P*-value and trying to re-enter one-by-one all the previously excluded variables, until all remaining variables were either significant at $P \leq 0.05$ or confounded one or several of the studied predictors, as judged by a change in regression coefficients by > 10% when the confounder was excluded (given that the changed coefficient was significant at $P \leq 0.10$ before or after the exclusion). Interactions between fixed effects were disregarded. The final models are specified in Supplementary Material S3.

Model diagnostics included the examination of Pearson residuals, the Pearson Chi-Square test, the Pregibon delta-beta influence statistic (Pregibon, 1981) and the area under the receiver operating characteristic curve as measures of goodness-of-fit and discriminative ability. Overdispersion was estimated by calculating the Pearson $\chi 2$ divided by its df. To check for the influence of overdispersion, the models were run with a generalised linear model framework, specifying a binomial distribution, a logit link function and a scale parameter set to the deviance divided by the residual df (using iterated, reweighted least-squares optimisation of the deviance). Details are found in Supplementary Material S3.

## Results

### Effects of training on attitudes

The overall mean ± SD of variables 'force', 'design', 'fear', 'quick', 'floor' and 'contact' were 3.29 ± 0.271, 3.39 ± 0.288, 3.78 ± 0.416, 3.25 ± 0.765, 4.50 ± 0.516 and 3.28 ± 0.752, respectively. A summary of results from the *t*-tests and regression models is found in Table 4, 'quick' was the only attitude variable where there was a tendency for a statistically significant effect of training; training reduced 'quick' by 0.42 units ($P = 0.095$).

### Reinforcement telephone calls

In the telephone calls made 2–4 weeks after the individual training, all ten TDs reported that they had been able to change their handling behaviour in some way, for example, by decreasing the use of the rattle paddle, handling fewer pigs at the same time or allowing the pigs more time to move. Nine TDs responded to the telephone calls 1.5 years after training, with four TDs reporting being calmer or more flexible when handling pigs and reflecting more on their handling behaviour than before training. Five were no longer working as TDs and four of these found the training useful in their new occupations, which also involved animals.

### Effects of training on handling actions

In total, 28 loadings were observed on 23 farms by 10 TDs from 4 hauliers. A total of 3 472 5-s intervals were used for modelling, 42 and 58% of the intervals (10 and 18 loadings) were recorded before and after training, respectively. The third author (MA) coded 78% of the intervals (24 loadings) and the fourth author (JY) 22% (4 loadings). The median study time per loading used in the analysis was 41.3 (minimum 16.1, maximum 114) minutes. The average number of pigs in the lot during an interval varied between loadings from 1.4 to 5.2 (median 2.2).

The percentage of intervals with a record of the different composite variables is shown in Table 5. Seven of the 28 loadings had no record of moderately to strongly negative TD actions. Farm-staff presence in the loading area was recorded in 2.2% of the intervals and 18% of the loadings. The percentage of intervals with recorded composite variables and most common TD actions before and after training, and the mean number of recorded actions in total are shown in Table 6. The distribution of intervals across different levels of composite variables and independent variables is provided in Supplementary Table S1.

**Table 4**
Results of paired *t*-tests of the effect of pig transport driver training on attitude variables: force, design, fear, quick, floor and contact.

| Variable | *t*-test | | |
|---|---|---|---|
| | n | Difference[1] | *P* |
| Force | 7 | 0.071 | 0.36 |
| Design | 7 | −0.086 | 0.59 |
| Fear | 8 | 0.021 | 0.91 |
| Quick | 8 | −0.417 | 0.095 |
| Floor | 8 | 0.125 | 0.52 |
| Contact | 8 | −0.438 | 0.21 |

[1] Mean difference from before to after training, unitless.

**Table 5**
Percentage of 5-s intervals with a record of different transport driver actions at truck loading of Swedish finishing pigs for transport to slaughter in 2018–2020; overall (n = 3 472) and mean, minimum and maximum per loading (n = 28).

| Composite variable[1] | Overall (%) | Per loading (%) | | |
|---|---|---|---|---|
| | | Mean | Minimum | Maximum |
| Moderately to strongly negative driver action | 20 | 15 | 0 | 56 |
| Mildly negative driver action | 32 | 30 | 2.1 | 66 |
| Positive driver action | 57 | 64 | 24 | 96 |

[1] Composite variables explained in Table 1.

There were 16–426 (mean 124) 5-s intervals per loading and 166–634 (mean 347) such intervals per TD. The intraclass correlation coefficient was 0.130, 0.143 and 0.063 at the TD level and 0.512, 0.304 and 0.286 at the loading level in the empty three-level models of moderately to strongly negative, mildly negative and positive TD handling actions, respectively. This indicated that the modelled handling actions were only slightly correlated within the same TD, but more strongly correlated within the same loading and TD. Hence, the random effect of loading, but not TD, was included in the final models of moderately to strongly negative and mildly negative TD action, while no random effect was included in the model of positive TD action. The intraclass correlation coefficients for loading were 0.495 and 0.311, respectively, in the first two models. Thus, it was estimated that the random effect of loading composed approximately 51 and 30% of the total variance of moderately to strongly and mildly negative TD action, respectively. The complete final models are presented in Supplementary Tables S2–S4. Training was estimated to decrease the odds of moderately to strongly negative TD handling action by 55% ($P = 0.0013$) and increase the odds of positive TD handling action by 97% ($P < 0.0001$), but could not be shown to influence the *P* of mildly negative TD actions significantly. Predictive margins of training are shown in Fig. 1.

The data were slightly overdispersed (Peason $\chi 2$/df = 1.57–1.98), some Pearson residuals were larger than 2 (absolute values), and the Pearson Chi-Square test indicated that the models did not fit the data well ($P \leq 0.0001$). Despite this, generalised linear models produced almost unchanged estimates compared with the models presented. The area under the receiver operating characteristic curve was between 0.78 and 0.88, which indicated a good to excellent model fit and discriminative ability.

## Discussion

Road transportation including animal handling is considered a stressful practice for pigs (Bench et al., 2008; McGlone et al., 2014). Even so, the work of TDs has received very little scientific attention and, to our knowledge, this is the first study of the effects of a training intervention on the attitudes and handling actions of farm animal TDs. Training has proven effective to improve stockpeople attitudes and pig handling on pig farms, where working conditions are rather stable and it is possible to evaluate behavioural responses of pigs to humans before and after staff training (Hemsworth and Coleman, 2011). However, TDs interact briefly with large numbers of pigs and have very little control over the external conditions such as the physical working environment and the often tight time schedules (Wilhelmsson et al., 2021).

The reduction in the use of moderately to strongly negative actions and the increase in positive actions of TDs following train-

**Table 6**
Percentage of 5-s intervals before (n = 1 468) and after (n = 2 004) training with a record of different handling actions; composite variables[1] and the four most common actions within each composite variable; 28 loadings of finishing pigs by 10 transport drivers in Sweden 2018–2020.

| Composite variable[1] | Before (%) | After (%) | Action | Before (%) | After (%) |
|---|---|---|---|---|---|
| Moderately to strongly negative driver action | 30 | 12 | Loud sound | 15 | 2.0 |
| | | | Board hard pig still | 10 | 3.9 |
| | | | Hand hard pig still | 6.3 | 2.3 |
| | | | Knee | 2.9 | 3.4 |
| Mildly negative driver action | 25 | 36 | Paddle loose pig still | 11 | 11 |
| | | | Board loose pig still | 4.4 | 12 |
| | | | Paddle loose pig walk vehicle | 6.7 | 8.1 |
| | | | Board loose pig walk vehicle | 5.0 | 8.3 |
| Positive driver action | 47 | 64 | Visual active | 21 | 23 |
| | | | Visual passive | 17 | 17 |
| | | | Soft sound | 11 | 19 |
| | | | Hand loose pig still | 6.2 | 14 |

[1] Composite variables explained in Table 1.

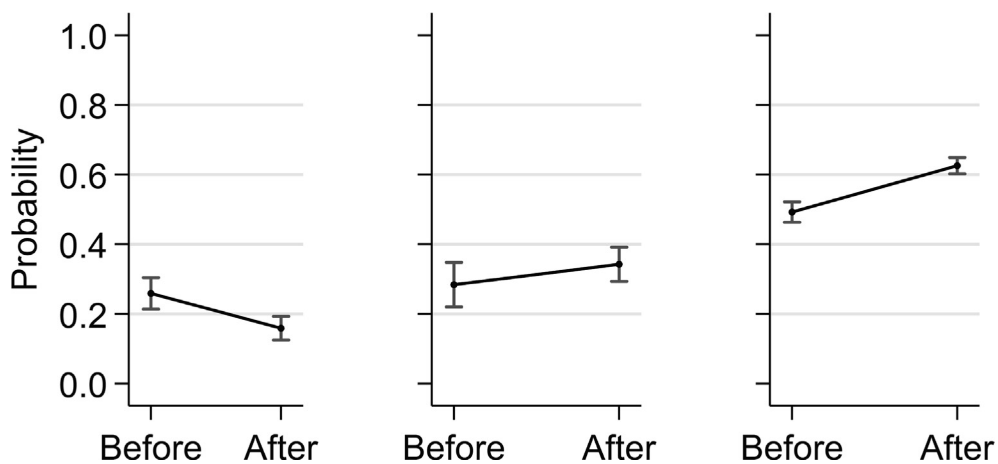


**Fig. 1.** Predictive margins of training (before; after) of pig transport drivers according to logistic models of moderately to strongly negative, mildly negative and positive handling actions (left, middle and right figures, respectively) (n = 3 472 5-s intervals). Error bars represent 95% confidence intervals.

ing in the present study is consistent with previous research using similar training interventions targeting attitudes and handling actions in pig stockpeople (Hemsworth et al., 1994b; Coleman et al., 2000) and dairy stockpeople (Hemsworth et al., 2002b). Although the hypothesis that training improves TDs' attitudes towards pigs was not confirmed, we found a tendency for training to reduce the attitude variable 'quick' (formed by the three questionnaire questions "Best to move pigs quickly", "Best to keep pigs moving quickly" and "Unruly pigs can be irritating"). The importance of allowing pigs more time to avoid stress-related behaviours that are time-consuming for TDs, such as crowding or freezing, especially if the pigs show fear responses towards humans, was discussed during training. In the reinforcement telephone calls, the TDs reported to have reduced the use of the rattle paddle and to allow the pigs more time, which possibly indicated that they had understood the messages and tried out new handling methods. Nevertheless, the small number of questionnaire respondents requires careful interpretation of the training effect on attitudes. Although about 20% of the total occupational group in Sweden (20 of approximately 100 TDs) completed the attitude questionnaire before training, a larger sample size would have improved the validity of the PCA. Attitude-behaviour relationships in pig stockpeople have been shown previously (Hemsworth et al., 1989; Coleman et al., 1998) and the tendency for improved TD attitudes towards pig handling found in the present study may underlie the observed changes in TD handling actions after training, such as the decrease in moderately to strongly negative use of the driving board or hand and the increase in talking calmly and gently placing a hand on a pig.

The sorting board has been suggested to be a more effective tool than the rattle paddle, with fewer pigs turning around and thus increasing time efficiency, in addition to creating a physical barrier between pigs and handler (McGlone et al., 2004). However, TDs who use the board to move pigs by vigorously pushing it with the knees potentially cause stress and even injury to the pigs as well as to themselves (Wilhelmsson et al., 2021). Findings in the current study of a decreased moderately to strongly negative use of the driving board indicate that, despite the sometimes physically demanding situation during loading, it is possible for TDs to use the board with less force to direct the pigs. Reducing negative and increasing positive handling actions in order to reduce pig stress (and the physical workload of the TD), and how this is connected to underlying beliefs about pigs and handling of pigs, were considered essential messages communicated and discussed during the training intervention. This information was partly based on the observed handling behaviour before training, and partly on previous research on the training of pig stockpeople (Hemsworth and Coleman, 2011). Although the results of this study and feedback from TDs on the training program suggest that the ProHand Pigs® training program was successfully adapted for TDs, providing personalised feedback to the TDs on their attitudes and behaviour, the animal welfare consequences of their handling actions and animal handling recommendations may have improved the efficacy of the training. Thus, further research to better understand the relationships between attitudes and handling behaviours of TDs is required. The most effective cognitive-behavioural technique would essentially involve re-training TDs by targeting the exact beliefs that underlie their behaviours, as well as the behaviours in question (Coleman and Hemsworth, 2014).

The observed changes in TDs' handling actions following training, with less negative and more positive interactions, most likely would have led to less stress in the handled pigs. For example, our previous findings suggest a reciprocal relationship between TDs' actions and pig behaviours (Wilhelmsson et al., 2023), with handling of a negative nature by TDs when loading pigs being associated with stress-related pig behaviour, and handling of a positive nature being associated with relaxed pig behaviour. Furthermore, cognitive-behavioural training of pig stockpeople has been shown to reduce fear of humans in commercial pigs (Hemsworth et al., 1994b; Coleman et al., 2000). Thus, the observed changes in both negative and positive TD handling actions after training indicate that cognitive-behaviour training of TDs offers an opportunity to reduce the handling stressors to which pigs are exposed at transport loading.

Variations in loading area design and pigs' fear of humans between study farms might have influenced TDs' behaviour, and more research on the consistency of TDs' handling actions at different loading locations is recommended. An increased number of recordings both before and after training would have improved the quality of the study. Only two TDs could be observed on the same farm both before and after training. Nevertheless, similar between-farm variation was present before and after training. It might be argued that a randomised experiment would have been a more robust way to demonstrate a causal effect of training (Glanville et al., 2020); however, using a treatment and a control group would have required an increased number of TDs and it would have been difficult to return to the same farms with the same TD. The TDs' lack of control of the working environment during on-farm loading regarding, for example, the design of the loading area, in combination with time pressure and perceived high decision demands, safety risks and economic risks (Wilhelmsson et al., 2021), could lead to TD stress, potentially impairing learning and decision making (Lupien et al., 2007; Porcelli and Delgado, 2017). Hence, conducting the study under commercial conditions probably increased the chances of a fair evaluation of the training effect, compared to a more controlled study. Also, practical considerations such as the need for informed consent of the slaughterhouses, hauliers, TDs and farmers, the limited number of Swedish pig TDs and their hectic work schedules limited the possibilities for a controlled trial.

Due to the lack of similar studies in this field, it was difficult to foresee the time required for pretraining recordings. The majority of refusals to participate in the study came from farmers, thereby directly affecting which loading occasions could be included. A shorter and less variable time between pretraining observations and training may have decreased the risk of changes in handling actions for reasons other than the training. The time to post-training recordings also varied, with one TD observed 160 days after training due to infrequent work with pig transport and a need to sufficient time to practice new handling methods. It was important to provide opportunities for all TDs to practice new handling techniques, because improvements observed by TDs in pig behaviour are likely to reinforce any improvements in their attitudes and behaviour achieved following training (Hemsworth and Coleman, 2011; Coleman and Hemsworth, 2014). Thus, although a decreased variation in time before and after training could have increased the quality of the study, it would also have required a similar frequency of transportation of finishing pigs in all TDs, which was not feasible.

All TDs were informed about the study aims, and during data collection the video camera and the three observers were clearly visible to the TDs, which may have influenced their behaviour; however, informed participant consent is the only ethically acceptable approach and it has also been applied in previous studies on pig farms (Hemsworth and Coleman, 2011). The first author (SW) participated in all stages of the study and used a non-judgemental and open approach to build good relationships, and establish rapport, with the TDs. All TDs were perceived by the first author to agree to the importance of the study aims throughout the study. Potentially, these measures made TDs more relaxed and limited the risk of the Hawthorn effect (that is the observer causing changes in the participants (Oswald et al., 2014)). The observed changes in TDs' actions after training indicate that the TDs, despite challenging working conditions, were in fact able to learn and adapt their behaviour. The chosen study setup allowed us to increase our understanding of the TDs' overall working environment and, prior to delivering the cognitive-behavioural training program, to address potential conflicts with official veterinarians and farmers (Wilhelmsson et al., 2021). This, together with involving the TDs in the planning of the training and the development of guidelines, may have helped decrease potential barriers to change. Furthermore, the two-way dialogue during the training group sessions is likely to have increased TD motivation to learn and willingness to implement results in practice (Benard et al., 2014; Fernandes et al., 2019). The laborious approach to training used, with two full days supplemented by individual training sessions, is hardly practical on a large scale. The existing training program ProHand Pigs® takes approximately 3 h for participants to complete, and future research is also needed to find equally efficient ways to deliver training to TDs.

The Swedish pork production is small compared to, for example, Denmark or Germany. Swedish TDs relatively often stop to load pigs at more than one farm to obtain a full truckload before going to the slaughter facility. This can be expected to increase TDs' physical workload (Wilhelmsson et al., 2021) as well as pig stress, and in turn alter pig behaviour and TDs' actions. Even so, previous findings of a reciprocal relationship between TDs actions and pig behaviour (Wilhelmsson et al., 2023), and the results found in the present study suggest that training programs similar to the one described here would be beneficial to implement on a large scale for TDs in other countries as well. The present study indicates that TDs' pig handling skills can be improved by a behaviour-change intervention, in that way decreasing negative and increasing positive handling actions, and potentially reducing pig stress, during the loading of finishing pigs for transport to slaughter.

## Supplementary material

Supplementary material to this article can be found online at https://doi.org/10.1016/j.animal.2024.101115.

## Ethics approval

The study was approved by the Regional Ethical Review Board of Gothenburg (ref. 070-18) for human research subjects, and by the Animal Ethics Committee of Gothenburg (ref. 5.8.18-12650/2018) for animal research.

## Data and model availability statement

The data/models were not deposited in an official repository. The data that support the paper findings are available upon request to the corresponding author.

## Declaration of Generative AI and AI-assisted technologies in the writing process

During the preparation of this work the author(s) did not use any AI and AI-assisted technologies.

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## Declaration of interest

None.

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