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HUMAN CHARACTERISTICS and HANDLING STRATEGIES:
THE EFFECTS ON THE BEHAVIORAL AND PHYSIOLOGICAL
RESPONSE OF PIGS TO STUDENT HANDLERS

presented by

Madonna Eva Gemus

has been accepted towards fulfillment
of the requirements for

Master of Science degree in Large Animal Clinical Sciences

Major professor
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Date May 15, 1998

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HUMAN CHARACTERISTICS and HANDLING STRATEGIES: THE EFFECTS ON THE BEHAVIORAL AND PHYSIOLOGICAL RESPONSE OF PIGS TO STUDENT HANDLERS

By

Madonna Eva Gemus

A THESIS

Submitted to
Michigan State University
in partial fulfillment of the requirements
for the degree of

MASTER OF SCIENCE

Department of Large Animal Clinical Sciences

1998

ABSTRACT

HUMAN CHARACTERISTICS and HANDLING STRATEGIES: THE EFFECTS ON THE BEHAVIORAL AND PHYSIOLOGICAL RESPONSE OF PIGS TO STUDENT HANDLERS.

By

Madonna Eva Gemus

Unpleasant handling of pigs can adversely affect the animal's physiological and behavioral response. The purpose of this study was to evaluate human characteristics that improve pig handling. University students completed a survey assessing interpersonal skills and were matched based on esteem score, gender and experience. Students (n=32), moved pigs through a circuit with typical on-farm obstacles. Human and pig behavior data, and time in the circuit was obtained from video recordings and observers. Salivary cortisol, monitored in pigs and handlers, was measured by radioimmunoassay. Linear regression analyses, was used for dependent variables time and cortisol. Human behavior "problemsolv" was associated with less time ($P \leq 0.01$), while "slapping" and "problemsolv" were associated with a higher human salivary cortisol ($P \leq 0.05$). Pig response "escape" tended to increase time ($P \leq 0.01$) and was strongly correlated with "turn" (r=0.78). Time in the circuit and a stress indicator were affected by the qualitative nature of the human-pig interaction.

It gives me great pleasure to dedicate this work
to Scott Benjamin,
and to my father and my mother,
Gerald and Madonna Gemus,
for their unfailing love, support, and encouragement.

ACKNOWLEGMENTS

I would like to extend my thanks and gratitude to graduate committee members, Drs. Adroaldo J. Zanella, Raymond F. Nachreiner, Joel Aronoff and Frederik J. Derksen, for their guidance and assistance. I would especially like to extend my sincere and heartfelt gratitude to Dr. Adroaldo J. Zanella, my mentor and major professor, for his guidance, friendship, and assistance above and beyond the work entailed within this project.

I would also like to thank those in the Behavior Lab, the Swine Barn, and the PALE pavilion within the Department of Animal Science, especially Telmo Oleas, Amy Martin, Mandy Gendron, Scott Benjamin, and Elisette Rivera, Al Snedegar, Marshall Williams, and Gerri McCully.

In addition, Dr. Paul Bartlett was invaluable in his support and advice on statistical analysis, as were Dr. Susan Ewart, Dr. Loic Dejardin and Ms. Angela Corley for their advice in completing the Master of Science program and the manuscript.

Finally, I would like to thank Dr. Frederik Derksen for his confidence in the process of academic freedom and his encouragement during this project encompassing both human and animal ethology.

Partial funding for this project was provided by a grant through the Animal Health Diagnostic Lab.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

INTRODUCTION

The stockperson is the person most saliently identified with stewardship of livestock. However, the role of the stockperson has changed over the last 50 years from one of sole ownership of diverse independent family operations to that of an employee responsible for one particular aspect of an industrialized, specialized and management-oriented, production unit.

Attrition of hog farms has accelerated since 1980, reducing the total number of hog farms by almost 77% (Boehlje et al., 1998). This reduction has also resulted in a shift in pork production from the traditional farming regions of the Midwest to other parts of the nation and world. These recent dramatic changes within the swine industry have shifted the responsibilities of the stockperson from the owner-operator to that of the employee. A large majority of these employees, however, do not originate from traditional farm backgrounds (Martin, 1996) and oftentimes lack adequate pork production experience.

Traditionally, research targeting the pig industry has investigated disease control, optimal pig space, nutrition, environment and genetics. However, to improve production efficiency and animal welfare, technologies are best captured when incorporated by good stockpeople. In support of this observation there is a growing amount of scientific data on the factors that may influence the relationship between humans and animals (Seabrook, 1994; Hemsworth et al., 1986; 1992; 1994). Knowledge of this interaction may have considerable implication on the welfare status of farm animals, and subsequently their productivity. Seabrook (1984) determines that the stockperson, when handling the pig, should give their livestock charges favorable stimuli and use negative stimuli only when adopting the "boss" animal position. Positive handling, as defined by Seabrook (1984), included touching and patting when handled, hand feeding and verbal communication.

Moving pigs prior to shipping improves overall willingness to move during the handling process, whereas animals are more reluctant to leave a pen when left for long periods of time within a barren environment (Abbott, 1997). In the smaller and conventional systems, pigs move from the hot nursery to a cold nursery to a grower barn and then finally into the finishing unit. Contrary to what we might expect, the specialization of the industry has increased the time a pig will spend in the same pen. Pigs are moved into combination "nursery-grower-finisher" units and remain in that pen for up to 180 days before being handled again, increasing the fear response and likelihood that pigs will be reluctant to leave the pens.

Communication between the sender and the receiver is not restricted between members of the same species. Auditory, olfactory and visual signals are used when pigs communicate and respond to humans (Grandin, 1993; van Putten, 1980). Therefore a vital part of animal husbandry is to understand the behavioral patterns used by pigs. Thus problem solving must be considered a necessary skill of all effective modern stockpersons.

At present there is little scientific research identifying characteristics of experienced and inexperienced stockpeople. Based on our current knowledge of the swine industry and our present understanding of human behavior, the purposes of the present study are threefold. The primary aim is to qualitatively evaluate human characteristics, self-esteem and gender, and human behavior that improve the handling of pigs. Beyond that, the study is designed to document human-pig interaction during handling in a simulated "on-farm" environment. The final aim is to provide a quantitative foundation for the establishment of criteria for selecting effective stockpeople.

LITERATURE REVIEW

The purpose of this review is to present research on the personality and behavioral characteristics of the stockperson. The review and integration of relevant literature in personality and social psychology is followed by a presentation of a traits that offer a general framework for prediction of human behavior. The review also explores pig behavior, indications of stress in both humans and pigs and ways in which the behavior and productivity of livestock is interconnected with of action and handling ability of the stockperson.

Handler Characteristics

The Foundation of Personality

Gordon (1963) defined personality as the enduring characteristics of the traits that temper the individual behavior throughout their lives. Personality traits are defined "as a characteristic of an individual that exerts pervasive influence on a broad range of trait relevant responses" (Ajzen, 1986). Although humans are complex individuals, the research consensus is that most of the individual differences can be summarized in terms factors and a few examples of trait pairs that are representative of each of these factors (Norman, 1963; Digman and Inouye, 1986) are as follows:

Extrovert: talkative-silent, frank-secretive, adventurous-cautious, high esteem-low esteem.

1. *Emotional stability*: calm-anxious, poised-nervous, neurotic-secure.
2. *Agreeableness:* good natured-irritable; gentle-headstrong; cooperative- negativistic.
3. *Conscientiousness*: tidy-unkempt, responsible-irresponsible
4. *Openess*: imaginative-simple, intellectual-non-reflective

These personality factors are expected to be manifested in behavior (Ajzen, 1988). To use examples cited by Ajzen, people who are extroverted are expected to talk more openly; thus it is likely that the extrovert will speak more frequently in a group setting and ask others for advice or assistance more freely.

Personality and the Stockperson

Seabrook (1972) conducted one of the pioneer efforts utilizing personality scores as a basis for successful stockpersonship within the dairy industry. In this study, Seabrook followed twelve, single-operator, dairy herds of similar genotype, building design, and feeding program for a period of 6 years. Analysis of herd records revealed interesting information of the effect of different stockpeople, with similar resources, on milk production (liters/cow/day) and cow behavior. This study showed that substituting the stockman of high producing farms with another stockman might result in a drop in milk yield. Alternatively, changing the stockman of low producing farm usually resulted in a marked increase in milk yield. Cows managed by the stockmen of high producing farms came into the parlor more easily than those farms with lower production. When the stockmen were assessed, by various techniques, for personality traits, Seabrook found the stockman associated with high production yields and easily managed cows were confident in their vocation yet introverted. This early interpretation of the high achieving stockperson as "the confident introvert" suggests a correlation between the personality traits and the positive interaction of the person with their animals. In a later longitudinal study, Hemsworth et al., (1981a) evaluated the achievement of 12 different stockpeople from farms with similar resources. The results suggest that the behavioral response of sows to the presence of the human is positively associated with the reproductive efficiency of the sows. He concluded that successful stockpeople are conscientious, caring, eager to learn, humble and have good observational skills of pig behavior.

Further work (Gonyou et al., 1986; Seabrook, 1991) revealed characteristics common to good stockpeople including confidence, independence, consistency, low aggression and stability. In a more recent study using a 16-trait personality test, Ravel et al., (1996) performed a psychodemographic profile of 86 stockpeople from swine farms in Quebec. Demographic data were obtained through interviews. The study population were predominantly male and the participant criteria consisted of the stockperson solely responsible and working within farrowing units. In general terms, all stockpeople working in these farrowing units were high scoring on emotional stability, conformity, self-discipline, and introversion. Based on the aforementioned research (Gonyou et al., 1986; Seabrook, 1991; and Ravel et al., 1996), a personality composite of the stockperson may be characterized as introverted, emotionally stable, serious, conscientious, reserved and controlled.

Developing Personality and Behavior

Although evidence for genetic effects of behavior is available in lower animals (Lagerspetz, 1979), these effects are determined by controlling the environment and through selective breeding. Thus, due to ethical restraints, evidence determining genetic effects for human behavior is not plentiful. The exception to this is population research consisting of monozygous twins who share a common environment. Behavior between twins provides evidence for genetic variability in human behavior. One such investigation (Rushton et al. 1986) consisted of more than 500 pairs of monozygotic and dizygotic twins who completed a questionnaire that assessed five personality variables: altruism, empathy, nurturance, assertiveness and aggressiveness. Rushton et al., reported higher correlations for the monozygotic twins for each variable. Further analyses from this data indicated that approximately 50 percent of the variance for each variable was due to hereditary causes, presenting evidence that behavior was heritable.

Some behaviorists, however, would argue that behavior is acquired through experience, conditioning and learning. According to Hinde, (1987) there is a repertoire of behaviors that is established through learning and individuals emulate the behavior of other members of the society or subculture in which they live in attempt to gain social acceptance. Baumrind (1971) investigated personality traits of children under different parenting methods and determined that mother-child interactions, particularly maternal warmth and maternal control, were good predictors of acquired attributes such as social responsibility, independence, achievement orientation, vitality and energy level of the child. For example, authoritative parenting, which is high in warmth and values both autonomous self-will and disciplined conformity, resulted in children possessing attributes such as social responsibility, independence, achievement orientation, friendliness, and popularity. The attributes of independence and achievement orientation were discovered to continue well into adolescence (Baumrind, 1991). In contrast, children of authoritarian parental rearing, which values power and is lower in warmth, have been observed to be withdrawn, unhappy, anxious, insecure when interacting with peers, and obtained poorer grades in high school (Dornbusch et al., 1987).

Self-esteem

Self-esteem, the evaluation of oneself, consists of a range of extremes from the feeling of complete worthiness as a valuable member of society to the feeling of worthlessness and valueless (McMartin, 1995). According to Pope et al. (1988), self-esteem can be evaluated in several different areas such as: 1) social self: the person's feeling about himself as a friend to others, 2) academic self: the person's evaluation and standard of their performance as a student, 3) family self: a person's feelings about being valued and making contributions within the family unit and being secure in the love and respect received from parents and siblings, 4) body image: a combination of physical appearances and capabilities based on the satisfaction of both the way his body looks and performs, ie athletic ability, and finally 5) global self-esteem: a overall general appraisal of the entire self reflecting such feelings as "I'm a good person" or "I like most things about myself" (Rosenberg, 1965).

Generally, when a person experiences success or failure, he assesses that performance against an inner standard. Self-esteem is an evaluation of the information contained in the self-concept and is derived from a child's feelings about himself (Pope et al., 1988). When the perceived and the ideal selves are a good match, the self-esteem will be good (Higgins, 1987). Based upon this knowledge William James (1890) offered a simple, profound, well-established, formula for self-esteem: **Self-esteem = Successes/Pretensions**. Pretensions are the expectations we place upon ourselves. Therefore, when successes exceed expectations, higher self-esteem results. Notwithstanding, a person who does not excel in sports is not likely to feel unsuccessful if that person does not value athletic skill (Pope et al., 1988).

According to Hinde (1987), respect from others has become essential to the sense of self-esteem. The primary relationship within a group is highly significant in the development of humans. Closely related to this is a person's sense of belonging to or frustration within a larger group within which that person closely identifies. This identity to a group is an important contribution to one's self-esteem, whether the group is a nation, a tribe, a political entity (Campbell, 1965) or for our research, part of an animal handling class.

Human Behavior

The premise of behavior, based on ethology, is the idea that behavior is pre-programmed (Geen, 1990) and aggressive behavior such as butting, clawing, biting, kicking, and slapping, are motor patterns reacting to aggression stimulus (Lorenz, 1966).

A simplistic yet basic premise is that aggression is the result of two variables (Geen, 1990). One variable is the *state of the person* in which one is capable of aggressing and is ready to aggress. The other variable is that *the situation* elicits the aggressive behavior. As with behavior in general, the state of the person, may be a result of a biologically inherited aggressive temperament or a result of past learning. Lorenz (1966) maintains that the aggression drive in humans is still a "hereditary evil of mankind".

Montagu (1973) and others argue that aggression is instead a learned response. A review of studies investigating learned aggression in older children (Crowell, 1986) noted that the interaction in families with aggressive children was characterized by the exchange of negative, hostile behaviors whereas the interaction in families with non-aggressive children tended to be mutually positive and gratifying for the parents and children. Hinde (1991) explains that the individual is establishing a repertoire of behaviors to be used in various situations, providing general capabilities which can then be adapted by humans to further expand the repertoire of successful behaviors as new events arise. Regardless of the debate, both the biological make-up and learning explain behavior in humans and both play a role in creating the conditions for human behavior.

Problem Solving Behavior: The Human Endowment

Problem solving is defined as a generation of alternative responses and cognitive strategies as well as decision making and behavior to find a solution (Anderson, 1993; 1996). Bransford and Stein (1984) suggest five components to problem solving: identify, define, explore, act, and learn. The first component or step in problem solving is to identify that a problem exists. The effective learner tends to recognize a problem, and gathers more information while inhibiting the tendency to respond either on the first impulse or to do nothing. According to Anderson (1993), effective learners have greater confidence (self-esteem) in their ability to control their environment and view the act of identifying a problem as a good thing. Less effective learners and thus less successful problem solvers tend to be impatient, impulsive and quick to give up if a solution is not immediately apparent (Rotter, 1966).

Many problematic situations are ambiguous and inadequate in suggesting the proper strategy or direction. Therefore after the problem has been identified, the problem must be defined by thinking about all aspects of the situation, separating relevant from non-relevant information, and to identify goals and specify major issues (Bloom and Broder, 1950). Bransford et al. (1986), in a review of the literature, suggest that the successful problem solvers tended to translate the difficult and unfamiliar terms into simpler, more concrete terms, often substituting an illustration for a vague concept and then working with the problem in tangible terms. Less successful problem solvers tend to take less time to encode the initial problem information, accepting the vague concepts and ignoring the unfamiliar ones (Bloom and Broder, 1950).

The definition of the problem then leads to the exploration of possibilities, and the subsequent addition, deletion and modification of those possibilities. For example, the effective learners tend to use different strategies when trying to achieve goals and are further able to incorporate the appropriate "repair" strategies (Bransford et al., 1986).

After the problem has been identified and explored, the person must act on the deemed strategies and look at the results of those actions. For example, Moser and Levy-Leboyer (1985), observed people as they attempted to use a malfunctioned, coinoperated, telephone. In one condition, an instruction on retrieving lost money was provided, in another, no information was provided. The researchers observed that aggressive behavior i.e. hitting, kicking, and slamming the phone was greater among those with no information than those with information.

Measuring Personality, Self-Esteem and Problem-Solving Behavior.

Thus far this review has emphasized two theoretical perspectives that have implications for understanding stockperson characteristics and actions. One involves the role of the personality in predicting subsequent behavior and the second focuses on the behavior of the handler in unfamiliar and unpredictable settings.

Personality

When self-awareness is heightened, the consistency between self-evaluation of personality and overt behavior is increased (Ajzen 1988). In his text, Ajzen cites examples of how heightened awareness during evaluation of personality can improve the consistency between the overt behavior and the personality score. In one study, actual punishment behavior using administration of shocks and the attitudes scores toward punishment were highly predictive when a mirror was present during the actual administration of shocks (correlation of 0.57 and 0.58 in repeated studies). In contrast, respondents filing self-reports may unknowingly or knowingly misreport their behavior and attitudes in a positive bias, especially in cases of socially desirable behaviors such as high self-esteem.

Self-esteem

Rosenberg (1965) developed a ten-item self-report scale as a measure of global attitudes toward the self among adolescents. This scale, the reliability and validity of which was examined based upon a normal distribution, was found to be a useful unidimensional measure of attitude toward self (Carmines and Zeller, 1979) within populations of similar age. If however, age varied substantially, this measure became multidimensional and less reliable. Another hypothesis explained by Ajzen (1988) is that consistency in behavior is greater when the situation exceeds the level of competence. In one particular study, behaviors reflecting aggressiveness and withdrawal were observed within emotionally challenged children. The participants were challenged with situations that were either within their competency or exceeded their competency. Consistency of behavior was higher when challenged beyond competency, suggesting that under stress, humans are more likely to resort to a known, familiar repertoire of behavior.

Problem solving

In evaluating problem solving research has not yet discovered a conclusive evaluation that easily distinguishes the differences between effective from less effective problem solvers. Bransford et al. (1986), however, did discover that less effective learners frequently experienced difficulties with each of the IDEAL components.

Behavior of the Stockperson

Earlier work on stockperson behavior in handling of pigs (Hemsworth and Brand et al., 1981a; Hemsworth and Barnett et al., 1981b; Hemsworth et al., 1986; and Dryden et al., 1986) investigated those behaviors commonly used by stockpeople and classified these behaviors as non-aversive or aversive based upon the fear response of the pig. Fear response was defined by withdrawal of the pig from the human (Hemsworth and Brand et al., 1981a) or was measured based on the time required for the pig to approach and interact with the handler or the experimenter (Hemsworth and Barnett et al., 1981b). On farms where the sows were less fearful, the sows were also less restless, quieter, and when comparing production measures reared a larger number of piglets than sows housed in aversive conditions (Hemsworth and Brand et al., 1981a). Where aversive handling was used, breeding animals, both gilts and boars, approached humans less often, exhibited retarded maturation rates to sexual development, and possessed higher plasma corticosteriod levels (Hemsworth et al., 1986). Negative or aversive handling of pigs was represented by such aggressive behavior as slapping, kicking, pushing and use of an electric prod (Dryden et al, 1986).

Aggression levels, based on personal interviews and observation measures during handling of piglets, were assessed for stockpersons on a large, multiple site, swine unit (Seabrook, 1994). The aggression scores of 56 employees ranged from a low of 2.4 to a high aggression score of 7.6. A significant correlation was discovered between higher aggression scores and reports that working with pigs was frustrating or the feeling that present job responsibilities did not allow enough time to handle pigs in a pleasant manner. Comments made in this study, by the stockpeople with higher scores include: "*It is a highly frustrating job*", "*It's not easy being nice when they are going the wrong way.*", or "*The pressure is great so I lose my temper.*"

Whether a certain behavior is considered to be aggressive may depend on expression of pain, occurrence of injury, or the actual intention. Individuals that elicit aversive responses should not be defined as aggressive based solely on behavior indicators of pain or escape. Piglet castrations, which most stockpersons would not consider aversive, elicit pain responses such as vocalization and tail wagging (Noonan et al., 1994).

Pig Behavior in Response to the Handler

Stimuli from social interaction with conspecifics include the interacting forms of behavior such as submission and dominance, and these sign-stimuli are recognized by respective conspecifics (Gray, 1987).

Auditory communication

Vocal signals are an important means of communication in the pig, and can be simply divided into two main categories of low and high tonal vocalization. Fraser (1974) investigated the tone, length, and frequency of vocalization of juvenile pigs in response to an isolation treatment. The study reported that short (0.25 to 0.4 seconds) low-tonal grunts were associated with overall low frequency of vocalization. Moreover, long grunts (>0.4 seconds) and squeals were associated with greater overall vocalization and increased locomotor activity. At high levels of excitement, vocalization tend to be longer, louder and of higher tonality, and can be classified as high grunts and squeals (Kiley, 1972). According to the Canadian Council on Animal Care (1993), the squeal, a more intense and higher pitched vocalization, is described as one of the key signs of pain and distress in pigs.

Kiley (1972) recognized that pig communication is not easily categorized and suggests that vocalizations of pigs are part of a continuum of sound that functions as an analogue system reflecting the "level of excitement". Apparently, similar tonal vocalization can communicate both pleasure and distress in pigs. For humans understanding pig vocalization must include a combination of auditory cues and observed activity. Recent research (von Borell and Ladewig, 1992) concurring with the earlier results of Fraser et al., (1974) demonstrated that high-pitch vocalization and increased locomotor activity were correlated. Moreover, this study revealed that a greater frequency of grunts and squeals were often accompanied with escape attempts.

Olfactory communication

Olfaction in pigs is important in establishing social hierarchy, reproductive status, and individual recognition among pigs (Meese and Baldwin, 1975; Fraser and Broom, 1990). When pigs are first introduced to a novel environment, they nose and root inanimate objects. If the environment includes unacquainted pigs, they will initially push and touch the pigs until finally a fight ensues resulting in pigs standing face to face followed by attacks predominately to the ear (Fraser and Broom, 1990). Studies in olfactory communication (Meese and Baldwin, 1975) reveal that the pig can distinguish the urine of one pig from another and that aggressive interaction was reduced when pigs were deprived of their olfactory bulb. McClone and Morrow (1988) showed that when urine containing pheromones from a handled or stressed pig was sprayed on fighting pigs there was an increase in submissive behavior. This was confirmed by Vieuille-Thomas and Signoret (1992) in another study which determined that, at a feeder space, the presence of urine from a stressed animal would result in avoidance of that feeder space by other pigs.

Visual Acuity

Similar to olfactory cues, visual cues involved in social recognition (Ewbank et al., 1971), may also contribute to the formation of stable hierarchies and reduction of aggressive interactions. Pigs have been shown to possess color vision and are able to discriminate between wavelengths of light differing by only 25mμ (Klopfer, 1966). In a review article Grandin, (1988) states that pigs have a natural tendency to move toward an illuminated area but will balk if the light is cast into the pig's eyes or if there are shadows cast in the alley or chute. She also notes that pigs have visual depth perception, which can result in balking when approaching a puddle or a change in floor surface.

The flight zone of an animal is that space surrounding the animal that will elicit avoidance or escape behavior when physically encroached upon. If the stockperson stands within the flight zone, pigs will move away from the stockperson, whereas pigs will cease to flee when the stockperson retreats from the flight zone (Grandin, 1987). Results from Muira et al (1996) investigating the flight zone and withdrawal response of the pig to humans, showed that the blind spot of the pig is at an angle of 90°-105° behind the pig, leaving 255° to 270° of vision. According to Muira et al., no escape behavior was observed while the human kept beyond a distance of 1.2 m from the pig. It should be noted however, that animals may engage in forms of behavior, which are neither approach or avoidance behaviors.

Breed and Genetic Variability

Not all animals respond to the same stress or novel stimuli in a predictable manner. One study by von Borell and Ladewig (1992) demonstrated a high degree of behavioral variability between pigs, yet a consistent adrenal response to adrenocorticotropin hormone (ACTH) treatment within individual pigs over a 14-week testing period. Behaviorally, those individuals with a greater adrenal response were consistently more excitable with increased vocalization, locomotion, and escape attempts.

Individual differences, not environmentally determined, but showing a genetic relationship have been demonstrated in mice (Benus et al., 1991). Mice, raised in identical situations, were divided into those who cope in an active manner and those who cope in a passive manner. Active copers respond to social and non-social stressful situations using the sympathetic system, which is physiologically characterized by increased blood pressure and higher levels of catecholamines and corticosteriods. Conversely, the passive copers respond to similar stimuli predominately parasympathetically which is associated with low blood pressure, and lower levels of catecholamines and corticosteriods. The behavior of the active copers tends to be more aggressive, exhibiting a higher number of escape attempts and a predisposition to develop routines. In a similar study, Hessing et al. (1993) divided pigs into two groups, resisting and non-resisting, based on the piglets' compliance to being held on their backs. Resembling the active and passive coping strategies of mice, resisting pigs were more likely to be more aggressive and consistently showed more escape attempts over time. Yet Jensen and Forkman et al., (1995) have criticized this work stating that the distribution of escape attempts of resisting and non-resisting pigs tends to be unimodal with rather low consistency over time.

Breed of the pig also affects behavior during handling. One study showed that Yorkshire hogs required more time to load than Pietrain (Marshal-Nimis and Rempel, 1986) and it is thought that Landrace pigs with long ears often balk because they have difficulty seeing (Grandin, 1987).

Hemsworth and Barnett et al. (1990) determined fearfulness in gilts on the basis of avoidance behavior such as the flight response and whether or not the gilts physically interacted with the experimenter. Fear response in gilts was determined to be moderately heritable.

Handling of Pigs

Lambooij and van Putten, (1993) simulated handling for transport by placing pigs in a circuit containing various obstacles. Because social isolation is stressful for pigs, each test pig was accompanied by some of it's pen mates through the circuit containing obstacles such as ramps, darkened areas, single file runs, and funnel crowd pens. Pigs were also coaxed forward with an electric prod. Using an increased heart rate as an indicator of stress, ascending a ramp was determined to be more stressful than electric prodding or descending the ramps. At a loading ramp angle of 30° heart rates reached 220-240 beats per minute. Mayes and Jesse (1980) also found that heart rate was greater when a pig climbed a ramp compared to descending it. They also discovered that the pig will stop or lie down when their heart rates exceeds 220 beats per min. The difficulty seems to be primarily psychological for pigs inexperienced in climbing a ramp. The pig may perceive the ramp as a wall. The animals refuse to try to climb and will turn their bodies sideways to the ramp. By decreasing the ramp angle to 15°, loading became easier for inexperienced animals.

This same study by Mayes and Jesse (1980) revealed that when a pig was prodded it attempted to escape by moving forward or running back into the middle of a group of pigs. Pigs were often observed attempting to return to the pen they had most recently left. Pigs would also still turn back towards an opening, even if it was only 5 cm wide. In addition, pigs were observed balking and turning around when the handler attempted to drive them down an alley where people were visible ahead. They would often balk and refuse to enter a crowd pen or single-file race if people were seen standing next to it.

Pigs will follow other pigs and maintain both body and visual contact (van Putten and Elshof, 1978). While moved into the single file race and through the funnel, all pigs attempted to move at the same time. However, pigs moved more readily if the handler detected the animals closest to the single-file race entrance and moved that pig into the race opening first, instead of pushing a large group of pigs from behind.

Spatial Memory in Pigs

Although there is very little research dedicated to spatial memory in pigs, studies have investigated spatial memory in red deer and cattle. Rushen (1986) noted that deer were able to associate an aversive stimulus to one arm of a maze. In another study, cattle appeared to have difficulty in reversing a previously learnt spatial association between an aversive stimulus (Grandin et al. 1994). In a more recent experiment, Mendl et al. (1997)

determined that pigs were able to search for food sources and remember the location across 10 minute and 2 hour retention intervals.

Handler to Pig Vocal Interaction

Animals respond to human vocalization (McConnell, 1991), thus the use of the voice is a useful means of interaction with animals. According to Seabrook and Bartle (1992), talking to animals is a reflection of the stockperson's empathy toward pigs and stockpeople with less empathy and high aggression scores spent less than 15 minutes per day talking to the animals in their charge.

Handler Posture

Hemsworth et al. (1989) reported that a human standing in an erect posture was more threatening to breeding pigs than a human in a squatting posture. Muira et al., (1996), examined the influence of human posture and movement on the approach and escape behavior of weanling pigs. By measuring the time taken by the pig to approach a dummy in a standing position, stooping position, or lying face down, this research determined that the pigs spent significantly more time in close proximity of the dummy lying down than in the standing erect posture.

Stress Response in Humans and Pigs

Stress is generally considered the physical and psychological state in response to emotional or environmental stimuli. When humans and animals are confronted with an environmental change, adaptation involves a range of behavioral and physiological responses that function to maintain homeostasis. Therefore the individual's perception of whether the experience or environment is stressful may vary.

Physiological Response to Stress

Animals confronted with a challenging situation due to increased physiological or psychological demands, respond to stress through the use of three major biological systems: autonomic systems, neuroendocrine systems and behavior (Moberg, 1987).

Response of the autonomic nervous system is part of Cannon's (1929) proposed flight or fight response to stress. The emergency reaction is due to the sympathetic nervous system acting in conjunction with catecholamine hormones, norepinephrine and epinephrine, secreted from the adrenal medulla. The function is to alter biological systems (cardiovascular, gastrointestinal, musculo-skeletal and immune) such that there is increased heart and respiratory rate, shunting of blood supply from the viscera to the muscles and the brain and margination of lymphocytes to improve healing. The response of the autonomic system is so rapid, that plasma hormonal concentration return to basal levels very quickly, making adrenaline and noradrenaline difficult to interpret in a clinical setting.

The "general adaptation theory" as described by Selye (1952) states that after the fight or flight response there follows a stage of resistance during which resistance to the original stress increases but the resistance to new stress is lowered. If stress is prolonged, glucocorticoids are released from the adrenal cortex under the control of ACTH from the anterior pituitary gland. ACTH has received attention in stress research because it is released during a variety of stressful situations such as injury, social interaction, physical restraint and transportation and may modulate biological systems such as reproductive, growth and immune response (Guyton, 1996). ACTH secretion is largely controlled by corticotropin releasing hormone (CRH), and the presence of hormones, neurotransmitters and receptors common to the endocrine, immune and CNS. It is believed that these systems interact in a coordinated manner (Gray, 1987). CRH, identified in the limbic areas of the brain (hypothalamus, thalamic nuclei, amygdala, and hippocampus), plays a role in activating endocrine, physiological, neurochemical and behavioral responses typically observed in stress responses (Vale et al., 1981). CRH activates the hypothalamic-pituitary-adrenocortical (HPA) axis, sympathetic and adrenomedulary system (Brown and Fisher, 1985) stimulating synthesis and release of the adrenal glucocorticosteriods: corticosterone and cortisol.

The glucocorticoids promote the transformation of non-sugars into sugars (gluconeogenesis) and increased glycogen storage, providing easily mobilized sources of energy. Glucocorticoids are also anti-inflammatory agents, delaying the growth of new tissue, inhibiting formation of antibodies, lowering lymphocyte counts (Vining and McGinley 1986). Other stress induced changes include marked inhibition of body growth, reduced production of spermatozoa, reduced secretion of testosterone by the testis and delay or complete suppression of puberty. Chronic release of glucocorticoids results in disruption of menstrual in primate females or disruption of the heat cycle in non-primate mammals, decreased uterine weight and failure to ovulate or implantation of the fetus due to a negative feedback reducing the secretion of follicle stimulating hormone (FSH) (Guyton, 1996). Hemsworth et al. (1989) demonstrated lower reproductive efficiency in gilts and young boars subjected to aversive handling three times per week over a period of 12 weeks. The boars were slower to reach puberty, complete matings and had smaller testis, while the gilts exhibited lower fertility rates when compared to breeding stock handled in a pleasant manner.

Unlike the short half-life of catecholamines, corticosteriod levels in plasma and saliva, can have a half-life of approximately 20 minutes (Blackshaw and Blackshaw, 1989). While cortisol concentrations tend to be episodic in pigs, humans cortisol levels are less episodic (Guyton, 1996). In clinical studies using human subjects, it was noted that the response between individuals varies. Some people show a brisk increase in cortisol secretion whereas others show little or no response. Moreover, if an individual is again exposed to the same stressor, psychological distress may be reported but is not usually accompanied by continued endocrine change (Pollard, 1995). This relatively quick adaptation to initial stressors is widely acknowledged.

Physiological Indicators of Stress

Salivary Cortisol

Assessment of cortisol has frequently been used as an indicator of hypothalamic-pituitary adrenal (HPA) activity. Cortisol is a small, hydrophobic molecule present in all bodily fluids.

The stress of venipuncture has been shown to increase cortisol levels whereas saliva sampling has not (Vining and McGinley, 1986; Kirschbaum and Hellhammer, 1989). The limitations of various criteria used to assess welfare are widely recognized. The measurement of cortisol in saliva provides a reliable tool for investigation of hypothalamus-pituitary-adrenal axis activity. Cortisol is the main glucocorticoid hormone, in both humans and pigs, being produced by the adrenal cortex. It is released in response to various biochemical agents and pyschosocial stimuli (Kirschbaum and Hellhammer, 1989). Fortunately, saliva flow rate does not effect saliva cortisol levels (Hubert and de Jong-Meyer, 1989).

The reliability of using saliva instead of blood as a body fluid to determine the free fraction of low molecular weight hormones, such as steroids, has been well established (Walker, 1989). The measurement of cortisol in saliva offers several advantages over blood sampling: saliva is easily collected using non-invasive methods; it is non-stressful to collect; easy to perform; and plentiful in supply (Cooper et al., 1989; Kirschbaum and Hellhammer, 1989; Parrott and Misson, 1989; Cook et al 1996; Fenske, 1997).

Salivary cortisol indicates the free, biologically active concentration of this particular glucocorticoid and is positively correlated with plasma levels. Cook et al., (1996) compared efficacy of salivary cortisol analyses for assessment of the HPA response to exogenous ACTH stimulation as compared to serum cortisol measurement. Significant correlations were established between serum and salivary cortisol values. Moreover, salivary "free" cortisol may prove to be a better indicator of stress than "total" cortisol measured in blood samples due to lower variation of cortisol-binding globulin (CBG) found in salivary cortisol. Less than 90% of circulating plasma cortisol is bound to a major binding protein called CBG plasma proteins (Parrott and Mission, 1989). In humans, approximately 4.0 % of cortisol in humans is unbound. In pigs, the levels of cortisol in saliva are approximately 10% of the total plasma cortisol (Cook et al., 1996).

Since salivary cortisol is not bound to proteins, this concentration level was not altered when measuring cortisol in women using oral contraceptives (Walker, 1989).

Saliva is produced by three major groups of salivary glands: the parotid; glossopharyngeal, submandibular and sublingual glands; and several accessory glands distributed throughout the oral mucosa. The accessory glands secrete saliva continuously and are under local control. The major gland's secretion is mediated mainly by parasympathetic activity in response to physical, chemical and psychological stimuli.

How steroids enter in the saliva

Vining and McGinley (1986) reviewed two mechanisms which have been postulated for the transference of steroids from plasma to saliva: A) Intra-cellular diffusion, which takes place into the lipid-rich cell membranes of acinar cells or into the cells lining the gland as a result of lipid solubility of steroids; and B) Ultrafiltration, the process by which unbound steroid fractions may be carried by water which passes between the tight junctions between acinar cells. Both processes allow only the passage of unbound steroids.

Behavioral Response to Stress in Animals

The physiological response of an animal may be a coping strategy in stressful situations and not necessarily evidence of a harmful effect of the stimulus or an indication that the animal is experiencing distress (Moberg, 1987). Therefore, changes in adrenal cortical responses must be correlated with a change in coping strategies and animal behavior.

Behavioral response of stress in animals may include the occurrence of destructive, stereotypic, inactive, and escape behavior (Fraser and Broom, 1990). Despite the obvious indication, these behaviors are not necessarily harmful for the animal but may be helpful in enabling the animal to cope with stressors.

Conflict behavior in animals may include both destructive and normal behavior. Destructive behavior are those causing mutilation to other animals such as feather pecking in poultry or tail biting in pigs (Broom, 1993). Stereotypic behavior is behavior repeatedly performed by animals without apparent purpose including tail chasing in dogs and sham chewing in pigs. This displacement activity or coping behavior (Broom et al., 1995), may be a response to aversive situations. Displacement or redirected behavior performed in an abnormal frequency may also include such normal behavior as grooming, feeding and sleeping. Willingham (1956) found that in mice, a normal behavior such as grooming was one of the major responses to fear stimuli. Other "normal" behaviors such as lying down and massaging of penmates were increased for pigs kept in barren environments (van Putten, 1980). It is suggested that these strategies have been shaped by evolution as adaptive measures to fitness-threatening situations with which animals are confronted in their natural environment (Wechsler, 1995).

This may explain why there is little evidence to confirm a relationship between abnormal behavior and production performance (von Borell and Hurnik, 1991) or evidence that stereotypic behavior is detrimental to animal health status. Wiepkema et al., (1987) reported that veal calves housed individually and showing stereotypic behavior had a lower incidence of abomasal ulceration.

Animals use various strategies to counteract aversive situations. Hemsworth et al., (1996) showed that daily injection was not physiologically stressful to pigs, speculating that the pig's ability to physically withdraw from those injecting, enabled the animals to cope without activating the hypothalamic-pituitary-adrenal axis.

Environmental Enrichment

Environmental enrichment through the use of toys or other investigative materials may be another method used to maintain homeostasis during stressful situations. Dantzer et al., (1983) have shown that pigs able to chew a chain in a conflict situation have lower plasma corticosteriod concentrations. Pearce et al., (1989) found that pigs handled aggressively during rearing were significantly more fearful of humans than pigs handled in a positive manner. However, pigs housed in enriched pens reduced their fear regardless of the handling treatment. In the enriched environment, the positively handled pigs showed more exploratory behavior.

Human-Pig Interaction

Within pig production there are many opportunities for the stockperson to interact with the pig, particularly with the breeding stock and the young pig. Indications of a good stockperson are based upon the individual's knowledge and understanding of livestock behavior and physiology, application of pertinent skills, sensitivity and recognition of abnormal behavior and the ability to prioritize responsibilities based on animal welfare (English et al, 1988). Research indicates that the productivity of the animal is related to different, positive or negative, interactions used by stockpeople (Hemsworth et al., 1981a, 1986a, 1986b, 1987, Gonyou et al., 1986). There are specific human characteristics, such as personality and attitude, common to good stockpeople (Hemsworth et al., 1989, 1994, Seabrook 1990 and Ravel et al., 1996)

One of the first research studies in the area of interaction between pigs and the stockperson was a study of 12 one-person operated commercial sow herds under single ownership, which were similar in terms of location, buildings, genotype, herd size, feeding and management advice (Hemsworth et al., 1981b). Despite similarities, the reproductive performance between herds varied more than 20.0 percent. To explain the differences, sows from each herd were tested for their withdrawal response to an experimenter's hand reaching to touch the side of the sow's snout. The sows were also tested individually for time taken to approach the experimenter. In these tests, gilts and first parity sows were more cautious to interact with the experimenter. Using productivity records corrected for parity, researchers observed a significant correlation between increased avoidance behavior of sows with the experimenter to a lower number of total live born piglets per sow. Since the sows responded in a similar manner to the stockperson as the experimenter, the results from this study suggest that the reproductive performance of sows is associated with the relationship developed between the stockperson and the breeding stock.

Factors that may influence this response are the quantity and quality of animal handling by the stockperson. Handling may involve physical, visual, auditory and possibly olfactory contact between the stockperson and the livestock.

Quantity and quality of handling

Studies in poultry demonstrate that regular handling by humans increased approach to humans (Jones and Faure, 1981), improved growth and feed efficiency (Gross and Siegel, 1979: Jones and Hughes 1981; Hemsworth et al., 1989), and increased resistance to pathogens (Gross and Siegel, 1990). In further studies, general fearfulness and fear of humans was negatively associated with production parameters in laying hens (Jones and Hughes, 1986). Regular handling, known to reduce chicken's fear of humans (Jones and Faure, 1981), has also been associated with improved feed conversion efficiency, resistance to infection and growth rate in young layer and broiler chickens (Gross and Siegel, 1979; Jones and Hughes, 1981; and Gross and Siegel, 1990). Conversely, Freeman and Manning (1979) found that regular handling depressed growth rate in layer chickens.

There is evidence that the mechanism responsible for the depression in performance is likely to be a chronic stress response (Hemsworth et al., 1992). A study to measure behavior and growth performance in growing pigs, Hemsworth et al., (1981a) demonstrated that a handling regime consisting of regular aversive treatments, which consisted of a brief shock using an electric prod, resulted in increased avoidance of pigs to the handler and reduced growth rate in juvenile pigs.

Even pigs that are subjected to daily husbandry procedures such as injection are likely to respond with a lower corticosteriod response when compared to those pigs treated in an aversive manner. Hemsworth et al., (1996) subjected pigs to 4 treatment groups daily for three weeks. One group was handled in a positive manner, patting and stroking, the second group was handled in a neutral manner with minimal handling, the third group was subjected to aversive handling such as an electric prod and the fourth group was injected intramuscularly with saline. Pigs aversively handled showed higher corticosteriod, ambulation and adrenal gland weights and had a higher number of escapes when compared to the injection group.

In a series of studies, juvenile pigs were exposed to two different treatments: a positive treatment involving the stroking of pigs as the pig approached the experimenter and a negative treatment involving forcing the pig away with either slapping or electrical shock whenever the pig approached the experimenter. The treatments were imposed three times per week from 11 to 22 weeks of age (Hemsworth et al., 1981a and 1987) and from 7 to 13 weeks age (Gonyou et al., 1986). In all three experiments, the unpleasantly treated pigs showed a fear response to the handler, had higher glucocorticoid levels, and exhibited significantly slower growth rates than pigs treated positively.

Handling of pigs early in life reduced the fear of humans in pigs at a later age (Hemsworth et al., 1986a). However, there are inconsistencies in the handling of pigs throughout the lifespan of the pig. Hemsworth and Barnett (1992) showed that the initial effects of early human contact on subsequent behavior may disappear with time or that the effects of present human handling may outweigh earlier handling.

Other work measured the behavioral and physiological response in juvenile pigs to three treatments (Hemsworth et al., 1987). In this study, the treatments consisted of the positive treatment of stroking the pig's head, the negative or unpleasant treatment of slapping the pig or an electrical shock as the pig approached the experimenter. The third, an inconsistent treatment, was a combination of positive to negative treatments imposed at a ratio of 1:5. The three treatments were imposed for three minutes each, three times per week from 7 to 13 weeks of age. Unpleasant and inconsistent handling treatments resulted in an overall lower growth rate and feed conversion (P <0.05), higher corticosteriod levels and less approach behavior when compared to those pigs in the exclusively positive treatment group.

Hemsworth et al. (1994) investigated stimulus generalization in pigs to humans, testing the pig's ability to discriminate between handlers. In this study, two handlers of different height and body weight used varied handling regimes. Handler #1, a male of 1.7 m and 65 kg, used predominantly negative behavior at a ratio of negative to positive interactions of 4:1, while handler #2, a female of 1.55 m and 59 kg, used a predominately positive to negative interaction ratio of 4:1. A third handler who had little previous exposure to either group of pigs later moved the pigs down a corridor. The pigs of the negative handling group were most difficult to move by the third handler, as measured by the number of balks by pigs and number of negative interactions required to move pigs through. This study proposed that in situations where pigs were handled in two markedly different manners, the behavioral response to the negative manner will extend to other humans.

Summary

The view of the stockperson is most saliently identified with stewardship of the livestock. However, it is only in the last ten years that the interconnection of the stockperson with animal welfare and productivity has received scientific attention in an effort to provide quantitative information. This review describes the ways in which human pyschosocial and physiological characteristics and behavior might influence the physiology and behavior of livestock.

Much of the behavior of the stockperson toward domestic animals is based on both human personality traits, innate and learned behavior. A personality composite of the stockperson may be characterized as introverted, emotionally stable, serious, and conscientious.

A compilation of such traits can be found in those with good self-esteem. Self-esteem enables people better able to tolerate uncertainty, incongruity, ambiguity, or inconsistency with new experiences and more readily solve encountered problems, which in turn reduces frustration and anxiety.

When a problem solver reaches a state in which no adequate problem-solving information available, the problem solver will revert to a repertoire of information that will produce success, provide positive reinforcement and facilitate effective behavior, thereby increasing self-esteem. Self-esteem is a variable studied within human ethology and has been a useful tool in predicting human behavior.

Investigations of those behaviors commonly used by stockpeople were classified as non-aversive or aversive based on the fear response of the pig. Animals use various strategies to counteract aversive situations.

The response of pigs during handling may provide the stockperson with important information of pig welfare and stress. Vocal signals, simply divided into two main categories of low and high tonal pitches, are important means of communication in the pig. Low pitched vocalization is generally associated with less locomotion and thereby less stress, while high pitched vocalization such as squealing, is associated with increased locomotion and stress of the pig. Olfaction in pigs is important in establishing social hierarchy, reproductive status, and individual recognition among pigs. Investigation behavior that includes nosing and rooting and avoidance of an area also provides an indicator to the handler of the novelty or environmental stressor.

When moving pigs, the stockperson can use the pig's vision to establish a flight zone to elicit avoidance response of the pigs when physically encroached upon. Ethological understanding of the pig's natural tendency to move toward an illuminated area, yet balk if the light is cast into the pig's eyes or causing shadows in the passageway, provides basic information on how to prepare the loading area before attempting to move pigs. Pigs also have visual depth perception which results in approaching a puddle or a change in floor surface with caution.

An animal's response to the stress may vary depending on genetic predisposition, novelty of the stimuli and previous experience. Animals confronted with a challenging situation due to increased physiological or psychological demand, respond to stress by the autonomic systems, neuroendocrine systems and behavior coping strategies.

When prolonged, stress due to social interaction, physical restraint and transportation stimulates the release of glucocorticoids from the adrenal cortex. This glucocorticoid release, under the control of ACTH from the anterior pituitary gland, may modulate biological systems such as reproductive, growth and immune response

Measuring of cortisol, the main glucocorticoid hormone in humans and pigs, via saliva sampling is easily collected an a non-invasive, non-stressful manner. Saliva sampling also provides "free" unbound cortisol, a better indicator of stress than "total" cortisol measured in blood samples.

Within pig production there are many opportunities for the stockperson to interact with the pig. An indication of a successful handler is based on the ability of an individual, by application of their skills, to optimize the productivity potential of the livestock. Research indicates that the productivity of the animal is related to different, positive or negative, interactions used by stockpeople. These interactions, when perceived as aversive by the pig, invoke a fear response by the pig decreasing efficiency of handling. There is also evidence that the mechanism responsible for the depression in productivity performance is likely to be a chronic stress response of negative or aversive handling techniques.

HYPOTHESIS

The overall purpose of the study were three fold.

1) To qualitatively evaluate human characteristics and behavior that improve the handling of pigs.

2) To document human-pig interaction during handling in simulated "on-farm" environment.

3) To establish criteria for selecting effective stockpeople.

Based on information from the purpose and a pilot study on human to pig interaction the following hypothesis was tested:

Stockpeople who use a higher proportion positive problem solving tactics while moving pigs through an obstacle circuit will minimize the stress responses of the pig.

MATERIALS and METHOD

Study Population

Of 140 animal science students enrolled in an animal handling course at Michigan State University, 113 (81% response rate) completed a questionnaire and self-esteem scale survey (see Appendix 1). The purpose and the design of the study were described and the students were invited to complete a questionnaire and survey during 15 minutes of class time.

Open questions were used to obtain the gender, age, ethnicity, community demographics, and prior experience with domestic pets and experience handling livestock. Due to the diverse backgrounds of students enrolled in animal science, it was expected that there would be both experienced and inexperienced pig handlers. Forty students were selected to participate in the study. Eight people failed to attend the allocated lab times and therefore were not included in the study.

The survey, developed by human psychology researchers at Michigan State University and used in a campus wide study of 4,000 freshman students, uses the Rosenberg (1965) Self Esteem Scale which obtains information regarding a person's sense of self-esteem, competence, resilience, trust and warmth in a relationship. The scale is composed of 58 statements concerning an individual's evaluation of himself or herself (e.g. "On the whole, I am satisfied with myself."). Subjects rated the extent to which they agreed with each statement using 5-point scales on which 1=strong disagreement and 5=strong agreement. The ratings for statements were later summed, with negative statements reverse coded. Higher scores represented higher levels of self-esteem and lower scores representing lower levels of self-esteem.

In this study, the self-esteem scores ranged from 1.0 to 5.0 with the scores of 1.0 to 3.8 representing the group and scores of 4.6 to 5.0 represented the group.

The scores of the subjects of this study were compared and found to be a representative sample of the campus wide population (Aronoff, personal communication). Students selected to continue in the study were chosen from the highest and lowest 33% percentile scores and both groups were matched based on gender, day of study, and time.

Prior to moving pigs, all students were shown the direction to move the pigs and the position of each obstacle was identified and the reason pigs would perceive this area as an obstacle was explained. Each student handler was instructed to move three pigs through the circuit (Figure 2). The students were given a pig board or gate (Figure 3) and were allowed to use whatever method or gestures they perceived necessary to perform the task, within the normal range of pig welfare. There were no time restrictions, however if the task was not completed after eight minutes, the students were asked if they preferred to continue or to resume the experiment.

Circuit Design

The study was held at the Michigan State University Pavilion for Animal and Livestock Education (PALE) facility (Figure 3). The pavilion arena (2100 square meters) was illuminated under artificial ceiling lighting. The flooring material throughout the arena (20 cm depth) was a mixture of sand and topsoil. The study was conducted over two days (Tuesday April 22nd and Thursday April 24th) consisting of three time intervals (10:20 am, 12:40 p.m. and 3:00 p.m.) on each day.

A circuit (Figure 4), composed of metal gates (1.8 meter length by 1.0 meter height), measured approximately 9.1 meters on the inside diameter and 11.0 meters on the outside diameter. The width of the passage area for handler and pigs ranged from a bottleneck 0.43 meters to 2.25 meters depending on the placement of the obstacle. The length of the passage area contains solid white plastic panels (0.9 meters) to obscure the pig's view outside the passage. The circuit contained 3 obstacles similar to an on-farm or pig transportation situation. One obstacle included a wooden ramp with 0.9 meters on both rise, 1.63 meters in length, 0.43 meters in height and 2.5 cm cleats placed every 8-9 cm. The second obstacle was a square black garbage bag, 2.4 square meters, representing a slightly slippery floor surface and the third obstacle was a narrow passage region or bottleneck 0.43 meters in width. On day one, the first obstacle was a wooden ramp followed by the black garbage bag and then the bottleneck. To minimize the learning affect by the pigs which were studied twice, the circuit was reversed on day two (2 days later) with the bottleneck, garbage bag and ramp as first, second and third obstacles respectively (see Figure 2).

Figure 1. A schematic diagram of student handler wearing green coverall, black Wellington boots and holding a gate before three pigs.

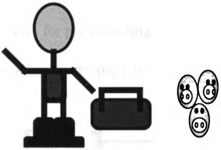


Figure 2. Schematic diagram of a circuit containing three obstacles. A wooden ramp with a 27 ^{0} angle, a black garbage bag as a slippery surface, and a narrow passage (bottleneck) region. The circuit is designed to observe pig behavior, human-pig interaction and human behavior while pigs are moved by the student handlers.

Symbols:

Direction of pig flow on first day of study (Tuesday) with ramp, garbage bag and bottleneck respectively.

Direction of pig movement on second day of study (Thursday) with bottleneck, garbage bag and ramp respectively.

Placement of human observers for pig recording of pig behavior.

Placement of video cameras for human-pig interactive recording of behavior.

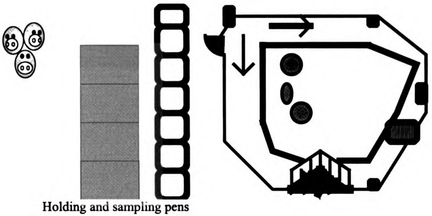


Figure 3. Photograph of study area within the PALE pavilion at MSU.

Figure 4. Photograph of pigs in sampling pens within PALE pavilion at MSU.

Animals

Sixty pigs of mixed genotype (Large White/Landrace/Hampshire) were used in this experiment. They were either castrated males (n=26) or females (n=70). The animals weighed between 70 kg to 90 kg. Prior to the experiment pigs were housed 15 to 16 pigs per pen in a conventional temperature control facility with concrete slatted flooring.

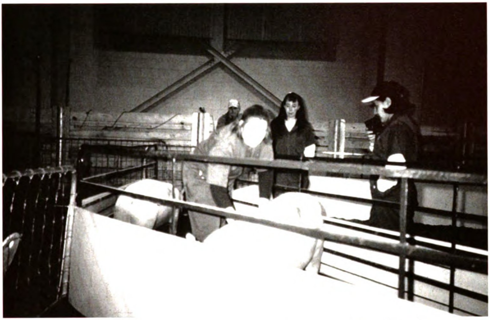
Experimental Protocol

On evenings prior to both days of the study, the pigs were individually identified with large numbers (approximately 30 to 40 cm), using wax crayon markings, on their back and both flanks. In addition, saliva samples were collected two days prior to the study to allow the pigs to become accustomed to the samplers and procedures of saliva collection. Since pigs can discriminate based on colour alone (Klopfer, 1966), importance was placed on the consistency of appearance of each person handling the pigs. Therefore, the person who sampled prior to the study were the same people who sampled the pigs during the study and green coveralls and black rubber Wellington boots (Figure 3) were worn by both the samplers and the student handlers. The wax markings were touched up each morning of the study to ensure clear identification of pigs.

At 7:30 am on each day of the study, pigs were loaded onto a trailer and transported 0.3 km to the PALE facility and allowed to rest and adjust to the new flooring material and penning (13.0 sq. meters) with their penmates for 3 hours prior to the experiment. Pigs were off feed during the study and ad libitum water was made available in the holding pens. Groups of 3 pigs, randomly selected from penmates, were moved into smaller sampling pens at 3.6 sq. meters (Figure 4) 30 minutes prior to moving through the circuit returning to the holding pens once sampling was complete. Of the 54 pigs that moved through the circuit on day one, 35 pigs repeated the circuit on day two, however no pigs repeated the circuit with the same group of three pigs.

Figure 5. Photograph of research assistant using a cotton swab to collect pig saliva, within the sampling pens.

Figure 6. Student handler, wearing coveralls, moving pigs through the circuit using gate provided while observer records the pig's behavior.



Behavior

Human behavior, pig behavior, and human-pig interaction was documented using direct observation, focal sampling and continuous recording. The recording medium were video and audio tapes. Circuit entry and exit points were standardized and time in the circuit was recorded for the duration of each pig and the handler. Time was documented using a stopwatch and verified against time recorded on videotape.

Human Behavior

Human behavior and human-pig interactions were documented using 4 black and white 8 mm video cameras (Panasonic) fitted with a wide angle lens strategically placed at each obstacle and at the entry and exit to the circuit. The cameras were positioned at a height that allowed a frontal view of the human in relation to the pig at both at the beginning of the obstacle and while crossing the obstacle. The cameras were connected to a time-lapse video recorder. Another hand-held cam-recorder was used to follow the handlers, to increase recording of interaction and to record vocalization of the handler.

Behavioral observations

Audio and video tape recordings of pigs and humans were analyzed by focal sampling and continuous recordings. Self-esteem scores of handlers were not known when tapes were evaluated. Each human behavior element was recorded into a behavior analysis computer. Recording of information was as follows:

a) video recordings were briefly reviewed to determine the amount of time the stockperson required to complete the circuit.

b) video recordings were viewed repeatedly to gain familiarity, to determine the nature of interactions observed and identify the pig receiving the behavioral element. A bout criterion interval of 2 seconds was used to separate one interaction or behavioral element from another.

c) observed interactions terms were defined (Table 1).

d) a focus pig was determined within the three pigs. The target pig was defined as the pig which received at least 30 percent more behavioral interaction by the handler, often times the most difficult to handle, than the other two pigs.

e) Check sheets were used to transcribe observations.

Table 1. Human behaviors categorized and defined.

Human Behavior **VARIABLE**	***Description***
Bumping: **BUMP**	Use of the body or gate to exert abrupt and short lasting pressure to the pig, followed by release of pressure or the handler to step back slightly.
Pushing: **PUSH**	Use of the body or gate to exert a constant pressure on the pig to move pig in forward direction.
Blocking: **BLOCK**	Use of the body or a gate placed perpendicular to the pig, providing an immobilized barrier, to prevent pigs from retreating or escaping.
Gating: **GATE**	Use of the gate, by handlers, placed between the handler and the pigs to direct movement of the pig.
Parallel Gating: **PARGTE**	Gate is positioned parallel to the body of the pig.
Slap: **SLAP**	Contact or striking with the hand on the pig's body. The action is made by a full flexion from the elbow.
Slap head: **SLPHD**	Striking the pig's head using the hand, gate or feet.
Vocalization: **HVOCAL**	Verbal communication directed to the pigs; includes whistling, talking, hooting, pishing.
Pat: **PAT**	Contact with hand on the pig's body. The action is made by a full flexion of the wrist.
Problem Solving: **PROBSOLV**	Cumulating behaviors by handlers such that the individual and different variables are summed in the first 50 seconds of the HANTIME and the repeated behaviors are not included in the calculation.

i) **BOLD TYPE** is the variable of human behavior used for statistical analysis

Reliability of behavioral data

Repeatability procedure: To ensure consistency in behavioral elements recorded the following steps were taken.

a) hand-written recordings of number of bouts of interactions with each pig during each task, and the nature of the interaction were carried out tape in a 12 hour mode (12 fields/second).

b) hand-written recordings of number of bouts of physical interaction with each pig during each task viewing tape was observed in in normal mode (60 fields/ seconds).

c) repeat recording of behavioral elements on check sheet viewing tapes in normal mode until repeatability was greater than 85% in each elemental behavior.

d) intra-observer reliability was calculated using the Pearson product moment correlation coefficient for a linear relationship on two data sets from five videos of randomly selected handlers. This calculation was repeated for the three frequent behavioral elements of pushing, gating, and slapping with coefficients of 0.923, 0.842 and 0.854 respectively, with the average of 87.3%.

Pig Behavior

Three "observers", positioned inside the circuit, recorded pig behavior continuously using an audio tape recorder. The categories were previously defined according to the author's definition and observers were trained using a video clip from a pilot study. The following behavior categories were recorded (Table 2).

Information from the audio tapes were transferred to a computer program (Observer, Noldus Information Technology). A hard copy of pig behavior was generated from the program and used to determine the consistency of observers by comparing timing and occurrence of pig behavior to videotapes. Vocalization could not be compared to non-audio tapes. The average reliability of the observers recording behavioral events of each pig, 92.6 %, was established by the mean of simply dividing the number of corrections made by the video observer into the total number of behavioral elements listed on the print out.

Table 2. Pig behaviors categorized and defined.

Pig Behavior Variable	*Description*
Balking: **BALK**	Resisting forward movement while standing firmly and leaning against the handler or gate.
Freeze: **FRZE**	Standing motionless, independent of the presence of the handler, while looking forward. Ears are pricked.
Stop: **STOP**	Pig has stopped motion (walking), may investigate surroundings
Rooting: **ROOT**	Rubbing the rooting disc into and on the flooring surface while in a standing position.
Lying down	Lying or sitting passively lasting for more than five seconds and without pig performing another behavior.
Nosing: **NOSE**	Rubbing of the rooting disc against materials such as obstacles, penning and human feet. Includes pigs standing still or walking.
Turning around **TURN**	Pig turns around to change field of vision or to prior to moving in the opposite direction. or to
Escaping **ESC**	Pigs moves away from the obstacle, past the handler toward the beginning of the circuit
ESC:TURN	The pig must turn in order to reposition itself to move in the opposite direction and to move past the handler. Escape to turn ratio is a calculation of the number of escapes by an individual pig divided by the number of times the pig turned around.
Eliminative behavior	Urination and defecation
Vocalizations	
1) Low grunt **LOGRUN**	low tonal calls, associated with rooting or nosing an object
2) High grunt **HIGRUN**	high pitched tonal sounds, pig is generally excited.
3) Squealing **SQUEAL**	intense high pitch vocalization, pig is generally resisting handling. In case of doubt, behavior is recorded under HIGRUN.

i) Other categories include walking (WALK) and running (RUN) were not included in the analysis because these variables were states whereas the other variables were counted as events.

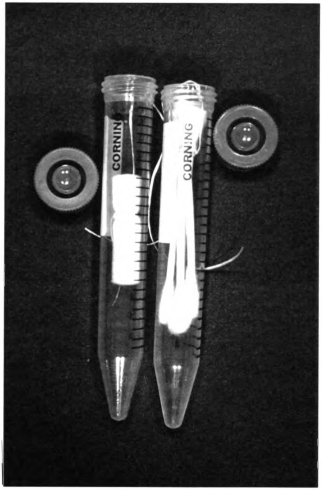
ii) BOLD TYPE depicts the category of pig behavior used in statistical analysis

Cortisol Analysis

To obtain human saliva samples, students were asked to void their own saliva into a Petri dish (Day 1) and a conical tube (Day 2) and to place the lid on that container. The sample was then given back to the research assistant who placed the container on ice. The human samples were taken concurrent to the pig saliva samples.

Pig saliva was collected from pigs using cotton buds (Q-tips, Johnson and Johnson) on day one and using cotton dental rolls on day two. To retrieve the dental rolls from the pigs' mouth, approximately 30 cm length of no wax dental floss (Johnson & Johnson) was tied at the center of the (Figure 7). The pigs were allowed to chew the buds and rolls for about a minute. The first saliva sample, the basal level, was taken in the pen prior to moving pigs into the circuit. The second sample (time zero) was taken immediately on completion of the circuit, and the third, fourth, and fifth samples were taken at 10 minutes, 20 minutes and 30 minutes past time zero respectively. Cotton buds and rolls containing saliva were placed into 15 ml conical tubes, sealed and placed on ice until moved into a -20^0 C freezer. The samples were later thawed and centrifuged at 2500 rpm for 5 minutes to collect saliva from the buds and rolls and to separate saliva from particulate matter. Saliva samples were kept at -20^0 C until assay.

Figure 7. A polypropylene tube containing a cotton roll (left) and suspended with dental floss. The second tube (right) contains 5 cotton buds tied together and suspended using dental floss.



All saliva samples were thawed and centrifuged at 3000 *g* for 5 minutes. Saliva was decanted into aliquots, frozen and kept at -20°C until assay was processed. Salivary cortisol was then measured by radioimmunoassay procedure using an assay for saliva samples (Diagnostic Products Corporation Coat-A-Count Cortisol Determinations in Saliva, September, 1992).

Human cortisol (HCORT) was determined by the mean concentration (nmol/l) of all samples. Pig cortisol was calculated based on the area under the curve on percent increase from basal level (CORTAUC) at four intervals, time zero, 10, 20, and 30 minutes post completion of the circuit.

Validation Studies

Fluid retention of cotton rolls and cotton buds

Complete extraction of saliva collected from the cotton collection material was important to ensure sufficient volume of saliva for RIA assay. To measure the fluid retention of the cotton (dental) rolls and the cotton buds, twenty pp conical tubes containing 2 ml of water were weighed. Ten cotton rolls and 10 bundles of 4 cotton buds were immersed into the tubes allowing absorption of the water. The rolls and buds were then suspended within the tubes, centrifuged at 3000 *g* for 5 minutes, removed from container and fluid retention was calculated against the final weight. The cotton dental rolls retained 1.4% of the fluid, while the swabs retained 7.3 % fluid, likely due to the paper material of the Q-tip stick.

Non-specific binding of cortisol in the cotton rolls and cotton buds

To determine the non-specific binding of cortisol to the material, 12 ml of standard cortisol solution (see dilution above) was divided into 3 sets (rolls, buds and control) of 2 tubes. Two cotton rolls and two bundles of cotton buds were immersed in 2 ml of standard cortisol solution . The two controls contained only solution. The rolls and buds were suspended within 15 ml conical tubes (see Table 3) and all samples, including controls, were centrifuged for 5 min at 3000 *g*. 200 μl of standard solution were pipetted, in duplicate, into coat-A-count cortisol RIA kit (DPC) and the manufacturer protocol was followed (Coat-A-Count cortisol determinations in saliva, Diagnostics Products Corporation, September 4, 1992). The results of the assay (see Table 3) depicts cortisol retention for the cotton buds and cotton rolls. Reduction of standard concentration resulted in a higher coefficient of variation and linearity is lost.

Table 3. Measures of cortisol retention using cotton rolls, cotton buds and control samples from tube 1 (T1) and tube 2 (T2).

Expected standard solution (nmol/l)	Rolls T1	Rolls T2	Buds T1	Buds T2	Control T1	Control T2
13.8	16.0	18.5	16.8	15.5	13.2	14.9
6.9	8.6	8.3	11.0	17.0	8.0	9.4
2.76	3.3	8.8	5.0	5.8	2.2	2.8

c) Dilution curve of cortisol samples (Figure 8).

100 ml of saliva was collected over 2 hours beginning at 6:00 am from five non-experimental pigs and one human, when free cortisol is at peak levels (Baldwin and Stephens, 1973; Cooper et al., 1989; Zanella, 1992). Saliva samples were serially diluted using stripped saliva (species specific).

Charcoal double stripped saliva

60 ml of saliva was collected from 5 pigs and from 3 humans. Samples were placed in flasks containing 2 g of sieved charcoal (Fischer C-1776 Carbon Decolorizing Alkaline Norit-A) and mixed using a rotation mixer. Saliva was left mixing overnight at 4 ^{O}C. On the following day the charcoal was separated from the plasma by spinning down at 3000 *g* for 20 min. The human and pig saliva recovered was mixed with 4 g of sieved charcoal and left mixing for a further period of 1 hour. The solution was then spun at 3000 g for 20 min and the saliva collected was re-spun at 20,000 *g* for 30 minutes. The saliva recovered was passed through filters and standard solutions were prepared following the protocol described.

Interassay coefficient

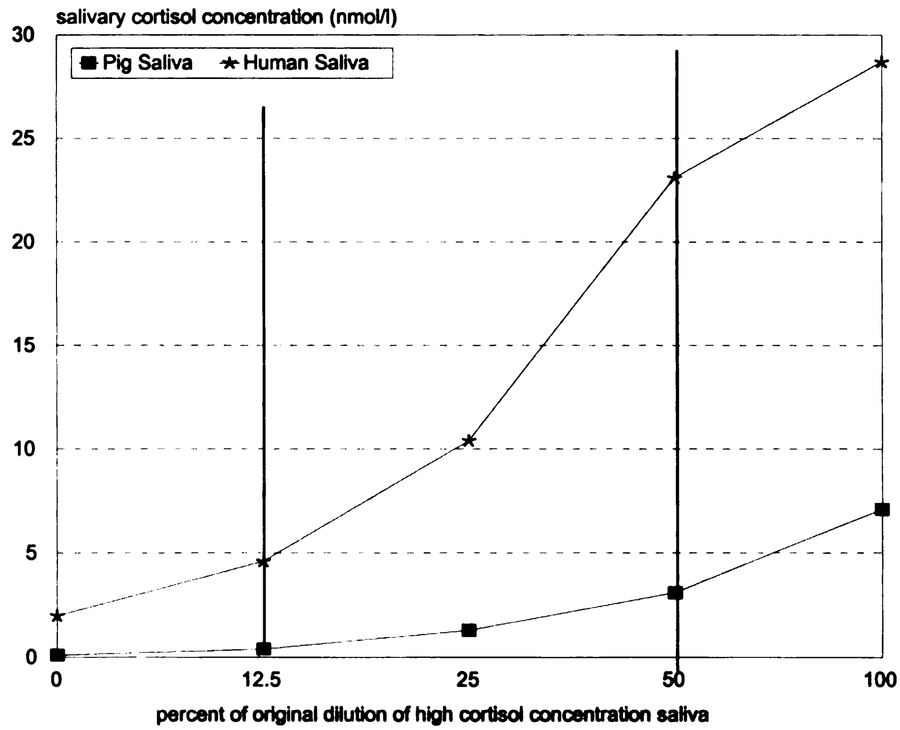
The inter-assay coefficient of variation for controls (std/mean x 100) on thirteen assays at 15.4 nmol/l concentration and 3.4 nmol/l concentration was 11.29 and 17.05 percent respectively.

The intra-assay coefficient of variation on 28 duplicate samples was 8.38 percent. Intra-assay calculations were based on the following formula:

$$(\Sigma\ (d/\mu \times 100)^2/2N)^{1/2}$$

where d = the difference between duplicate estimates
μ = the mean of the duplicate estimates
N = the number of duplicate samples

Figure 8. Serial dilution of pig and human salivary cortisol (nmol/l) based on the percent of stock high cortisol saliva sample.



Spiked saliva samples (stock cortisol solution)

Hydrocortisone (Sigma, N0. H-4001) was kept as a stock A = 1µg/ml solution in EtOH. Stock A was diluted 1 in 5 (stock B) which had 200 ng/ ml.

Stock A and B were pipetted into pp conical tubes. The tubes were dried down under N_2. The samples were vortexed and incubated at room temperature for 30 minutes. Samples were aliquoted in eppendorf test tubes.

Standard cortisol solutions, quality control (QC), were as follows:

QC1= 13.8 nmol/l (30µl A + 6ml of stripped saliva)

QC2= 6.90 nmol/l (15µl A + 6ml of stripped saliva)

QC3= 2.76 nmol/l (30µl B + 6ml of stripped saliva

QC4= 1.38 nmol/l (15µl B + 6ml of stripped saliva)

Basal cortisol

To establish a salivary cortisol depletion curve and to validate basal levels of salivary cortisol levels and control responses to handling in juvenile pigs, saliva samples were collected using cotton buds. Five barrow penmates ranging from 150 to 200 pounds were selected and identified using a marking stick crayon and sampled on three consecutive days at approximately 4:00 PM.

Inter-pig variation of salivary cortisol.

On day one pigs were mock sampled for salivary cortisol by taking three saliva samples within a 1 minute period. On day two, basal levels were determined by taking three saliva samples within a maximum 2 minute time period. The inter assay coefficient of variation (std/mean X100) of saliva samples taken from 5 pigs within one minute are 26.6%, 47.0%, 8.4%, 41.7%, 0% (Table 4)

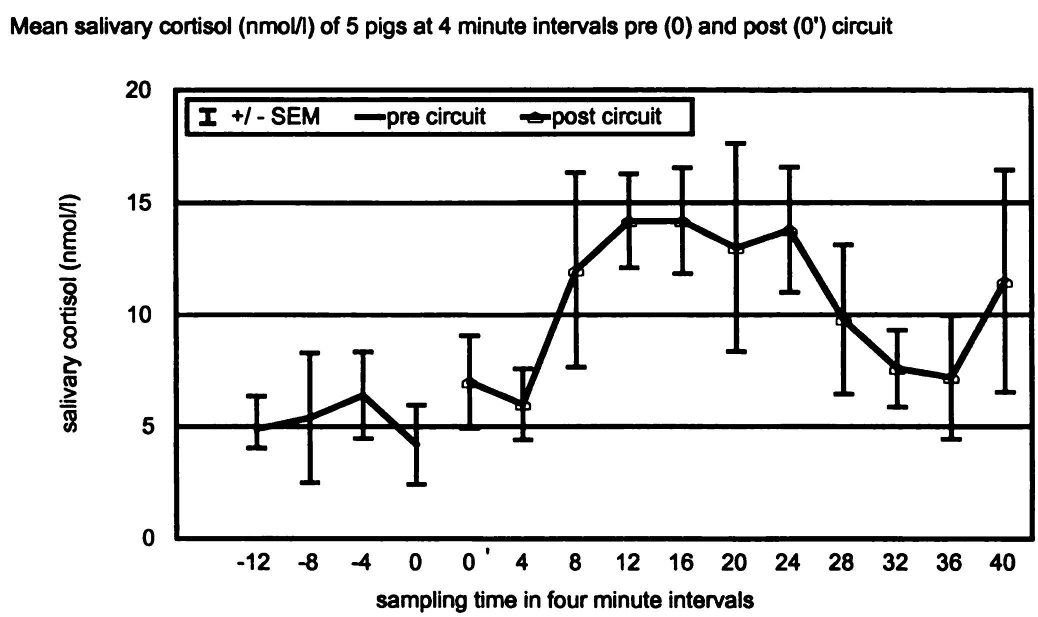
Table4. Basal salivary cortisol (nmol/l) determined from 5 different pigs and three samples collected within a two minutes time period.

Cortisol (nmol/l)	Pig 1	Pig2	Pig 3	Pig 4	Pig 5
Mean	4.33	5.33	13.67	7.33	4.0
Std	1.15	2.51	1.16	3.06	0.0

Determining Sampling Intervals

To establish a salivary cortisol depletion curve (Figure 9) and to validate basal salivary cortisol levels and control responses to handling in juvenile pigs, saliva samples were collected from five barrows. Samples were taken at four minute intervals beginning 12 minutes prior to moving through a circuit. At time zero, the pigs were moved out of their pens, into the aisle, along the aisle, over a ramp, across a black plastic bag and returned to their pens. The time to complete the circuit was recorded and another saliva sample was taken. The sampling continued every four minutes until 40 minutes post circuit completion. Samples were placed on ice immediately post collection and stored at -20°C until analysis using direct radioimmunoassay (DPC). The peak cortisol concentrations results are depicted in Figure 9.

Figure 9. Mean salivary cortisol of pigs at 4 minute intervals from 12 minutes prior to circuit to 40 minutes post completion of the circuit.



Statistical Analyses

PROC GLM, PROC MIXED and PROC CORR were used from SAS software library SAS INSTITUTE Inc. SAS/STAT Guide for Personal Computers, (Version 11.6 Cary, North Carolina: SAS Institute Inc., 1994). Descriptive analyses were computed for range, mean and standard deviation for dependent continuous variables whereas estimated coefficient, standard error of the coefficient and P-values were constructed for categorical data, and dependent and independent continuous variable data. Non-normality was determined by using normal probability plots. Human behavior and pig behavior were separately correlated using a Pearson's Product Correlation analysis with both *All Pigs* data and the data set restricted to the *Focus Pig Only*. This analysis was used to determine associations and discern similar behavioral elements. Regression analysis for dependent variable human cortisol CORTAUC was conducted using a 2 level PROC MIXED model for independent variables, pig and human behavior, with a random effect for the handler. A 2 sample Students t test was used to compare cortisol measure of pigs repeating the circuit. Significance was established at $P \leq 0.05$.

Definition: All Pigs and Focus Pig

During the study it was noted that while moving a group of pigs, handlers often dealt with one pig more than the other two. This particular pig, usually resistant to moving through the circuit, became the focus of the handler. It was considered that congruent analysis of the interaction between the handler and this pig would provide a direct breakdown of the association with human behavior and pig physiology and behavior. To investigate the nature of interactions of handler to one pig, in addition to all pigs, the data was analyzed using a congruent, restricted data set (*Focus Pig*, n=23) and the complete data (*All Pigs*, n=32).

The criteria of the Focus Pig include:

1) There is a maximum of 1 *Focus Pig* per handler.
2) Behavioral elements by the handler toward the *Focus Pig* exceed behavioral elements toward the other pigs by at least 30 percent.
3) HANTIME must exceed one minute.
4) There is a minimum of 15 behavioral elements by the handler toward the *Focus Pig*.

Dependent Variable Analysis

HANTIME Analysis

The handler's time in the circuit is considered the time taken to move pigs in the circuit. Pigs tend to move in a group and it is expected that pig-pig interactions may influence the time in the circuit. Since the last pig to exit the circuit preceded the handler, the handler time encompassed time in the circuit for three pigs and a handler. Handler time analysis (HANTIME) was conducted using a general linear regression bivariate model for the average of three pigs.

Seven handlers did not complete the circuit with all three pigs. Five of the handlers discontinued moving pigs due to frustration or exhaustion. Of the other two groups, one pig jumped out of the circuit and in the second group a pig showing typical signs of respiratory distress was removed.

HCORT and CORTAUC Analysis

Measuring Human Cortisol (HCORT)

During the two days of the study, student handlers (n=32) provided 160 saliva samples, of which 102 samples were measurable using Direct RIA of cortisol. Since 47 of the missing 58 measures were on day one, the most likely cause is the type of container used for saliva collection. The containers used by handlers to provide a sample a 2 ml petri dish on day one and a 12 ml conical tube on day two. It is considered that the shallow and smaller volume of the dish may have limited sample volume provided by the handlers compared to the conical tubes.

Further data analysis revealed that a maximum of 19 handlers had submitted measurable samples within the same interval (i.e. post to 10 minutes or 10 to 20 minutes). Therefore, it was decided to take the mean of measurable samples (minimum of two measures per handler) to determine a human cortisol concentration per handler (n=28). This mean value is reasonable for human cortisol measures since, unlike the pigs that do not know when the stressful episode with be, a human subject anticipates moving pigs and therefore basal levels may be higher than post handling. In addition, humans tend to have a more stable circadian rhythm (Guyton, 1991), without the episodic spikes reported in juvenile pigs (Ruis et al, 1997).

Regression analysis was conducted using a general linear model for categorical and continuous independent variables.

Measuring Pig Cortisol Levels (CORTAUC)

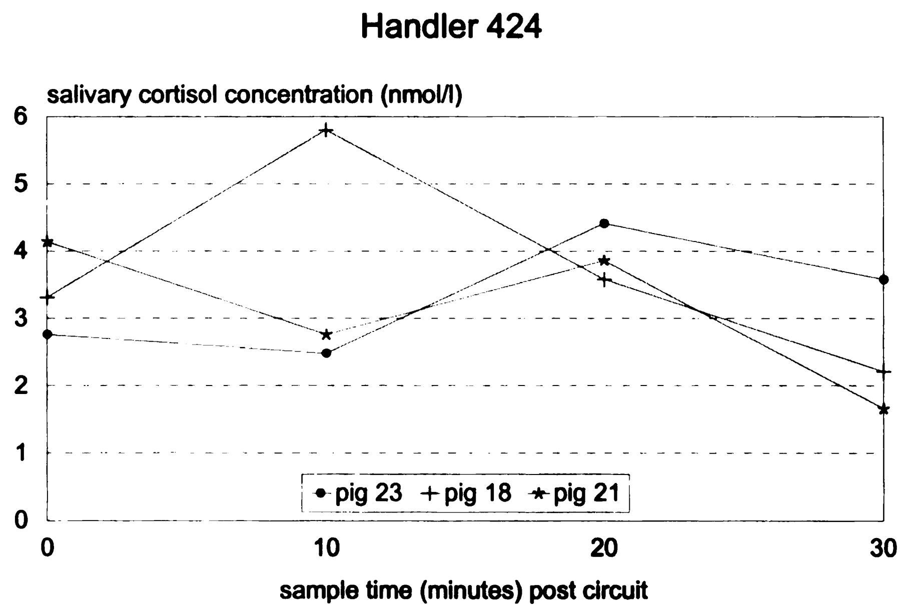
To establish the change in concentration levels of cortisol for an individual pig over time, area under the curve (% change•min), a statistically valid method (Matthews et al., 1990) was identified and calculated for each pig. Since the time in the circuit varied between handlers, HANTIME was excluded from the calculation. The time factor was standardized to 30 minutes (x-axis) to included 4 serial measures of cortisol (see Figure 11b): immediately post HANTIME (time zero) and 10, 20, and 30 minutes later. For the y-axis, salivary cortisol concentration levels (nmol/l) were adjusted for individual pig basal levels by calculating the serial measures as a percent difference in cortisol concentration from the basal salivary cortisol concentration (see Figure 11b).

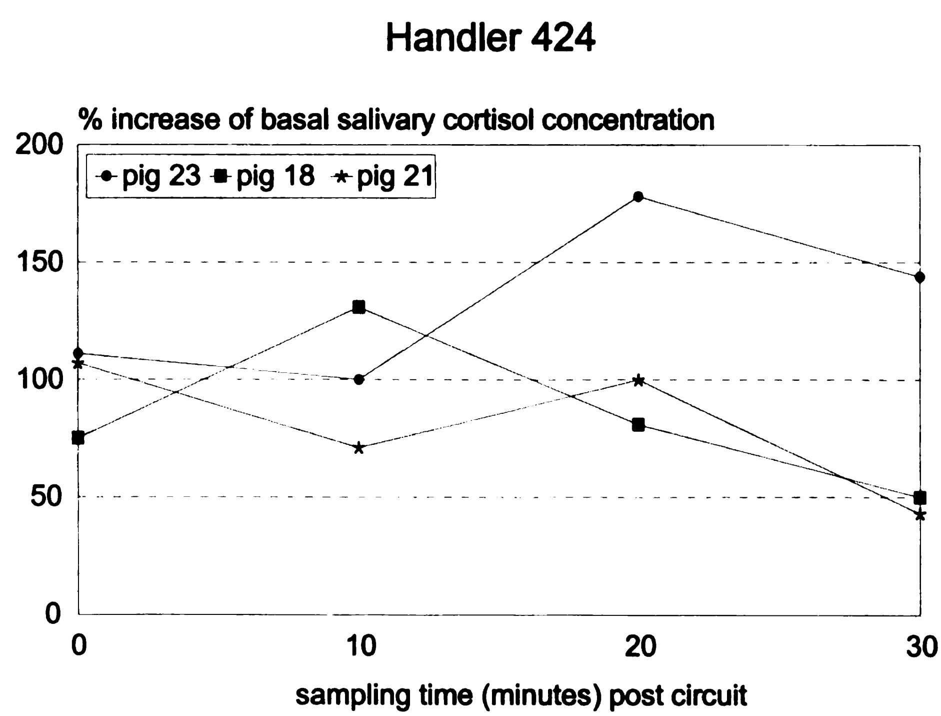
Regression analysis was conducted using a PROC MIXED 2 level model including a random effect variable for handler for continuous independent variables. ANOVA calculations were used for categorical variables.

Independent Variable Analysis

The time in the circuit varied between handlers and subsequently frequency of behavioral elements increased as time increased. Therefore human and pig behavior is determined in rates, calculated based on frequency of behavior per time unit.

Figure 10a, 10b. Two separate line graphs over the four 10 minute sampling intervals for a group of three pigs moved by handler. The top figure demonstrates cortisol concentration (nmol/l) without adjustment for basal levels. The bottom graph demonstrates cortisol concentration with adjustment for basal levels at percent increase over basal cortisol concentrations





RESULTS

Study Population

Descriptive Results of Handler Characteristics

The self esteem scale scores for the 115 survey participants, 74 females and 29 males, ranged from 1.0 to 5.0 (mean=4.09; SD=0.754). Selected subjects, 20 females and 13 males, were based on high and low self-esteem scores and gender and stratified based on lab times. Esteem scores ranged from 1.0 to 5.0 (n=32; mean=4.009; SD=1.109). Scores of the low self esteem group ranged from 1.0 to 3.8 (n=18; mean=2.987; SD=0.822) and scores of the high self esteem group ranged from 4.6 to 5.0 (n=14; mean=4.859; SD=0.128).

Descriptive Results of Handler Behavior

The descriptive analysis of human behavior is shown in Table 5. The definitions of these behavior variables are listed on page 45.

Table 5. Descriptive statistics of variables of human behavior for complete data set.

Continuous Variable	N*	Mean	S D	Minimum	Maximum
GATE	32	1.32	0.022	0	0.089
BLOCK	32	0.017	0.02	0	0.137
PAT	32	0.010	0.02	0	0.125
BUMP	32	0.017	0.028	0	0.187
VOCALIZE	32	0.02	0.069	0	0.333
PUSH	32	0.03	0.041	0	0.272
SLAP	32	0.038	0.07	0	0.373
SLPHD	32	0.004	0.01	0	0.061
PARGTE	32	0.0003	0.0017	0	0.011
PROBSOLV**	32	5.5	1.43	2	10.0

*Denotes the mean values of handler behavior toward the group of three pigs.
**Denotes cumulative sum of different variables in the first 50 seconds of HANTIME

ANOVA of Handler Characteristics

Effects of Self Esteem on Handler Behavior

When handler self esteem scores were compared to frequency of handler behaviors in both *All Pigs* and *Focus Pig Only* data bases (Table 6), rate of slapping SLAP (P=0.06) in the restricted focus pig data set was higher in handlers who scored lower on self esteem. Conversely, those with lower self esteem scores were less likely to block (BLOCK) the focus pig (P=0.09).

Effects Of Gender On Handler Behavior

There was little influence of gender on human behavior, with one exception; male handlers in this study showed an increased tendency (PUSH, P=0.08) of pushing the focus pig when compared to the female handlers (Table 7).

Table 6: Mean values and significance based on ANOVA computation of self esteem and rate of human behavior of the *All Pigs* data and the data set restricted to *Focus Pig*.

Data Set	***All Pigs*** [a]			***Focus Pig*** [b]		
Continuous Variable	Low (n=14)	High (n=18)	P value	low (n=9)	high (n=14)	P value
GATE	1.51	1.21	0.39	2.505	1.75	0.39
BLOCK	0.74	1.19	0.13	0.88	1.97	0.09
PAT	0.28	0.83	0.21	0.26	1.20	0.31
BUMP	0.69	1.23	0.17	1.16	2.61	0.17
HVOCAL	0.81	1.81	0.51	0.00	0.37	0.19
PUSH	2.15	1.50	0.24	5.16	3.48	0.29
SLAP	2.90	1.76	0.33	7.37	2.37	0.06
SLPHD	0.35	0.20	0.36	0.23	0.41	0.52
PARGTE	0.00	0.034	0.27	0.00	0.04	0.39
PROBSOLV	4.87	6.00	0.06	4.88	5.78	0.20

a) n=32 handlers; b) n = 23 handlers

**Denotes cumulative sum of different variables in the first 50 seconds of HANTIME

Table 7: Mean values and significance based on ANOVA computation of gender and rate of human behavior of the *All Pigs* data and the data set restricted to *Focus Pig Only.*

Data Set	***All Pigs*** [a]			***Focus Pig Only*** [b]		
Continuous Variable	Male (n=12)	Female (n=20)	P value	Male (n=9)	Female (n=14)	P value
GATE	1.29	1.37	0.83	2.43	1.79	0.24
BLOCK	0.71	1.16	0.14	1.23	1.74	0.54
PAT	0.85	0.43	0.36	0.62	0.96	0.33
BUMP	0.76	1.13	0.36	1.85	2.16	0.88
HVOCAL	0.74	1.75	0.50	0.14	0.27	0.78
PUSH	2.33	1.46	0.12	5.51	3.21	0.08
SLAP	2.26	2.26	0.99	4.17	4.43	0.90
SLPHD	0.16	0.33	0.30	4.32	0.23	0.19
PARGTE	0.00	0.03	0.34	0.02	0.00	0.34
PROBSOLV	5.25	5.65	0.52	5.33	4.88	0.81

a) n=32 handlers; b) n = 23 handlers
**Denotes cumulative sum of different variables in the first 50 seconds of HANTIME

Human Salivary Cortisol

ANOVA for the dependent variable human cortisol (HCORT, n=28) was conducted using a general linear model with independent variables regarding pig and human behavior.

Categorical Variables with the Dependent Variable Human Cortisol:

ANOVA of HCORT using the independent categorical variables are presented in

Table 8. The major finding was the strong positive association of high cortisol found in males handling the focus pig (P=0.001).

Table 8: ANOVA computation of mean human cortisol (nmol/l) levels and categorical variables using *All Pig* data and *Focus Pig* only data set.

Data Set	***All Pigs*** [a]				***Focus Pig Only*** [b]			
Categorical Variable	N	HCORT mean	SEM ±	P value	N	HCORT mean	SEM ±	P value
ESTEEM								
Low	13	10.2	0.41	0.30	9	9.75	1.67	0.43
High	15	8.36	0.27		12	8.05	1.32	
RPTS								
no	46	9.94	0.56	0.16	9	9.81	1.96	0.40
once	38	8.37	0.61		12	8.01	1.25	
HGENDER								
Male	11	11.32	0.41	0.06	9	12.07	1.55	0.001
Female	17	7.89	0.27		12	6.32	0.89	
PGENDER								
Male	26	8.61	0.81	0.61	5	7.52	1.32	0.51
Female	70	9.47	0.58		16	9.17	1.30	

(a) n=67; (b) n=21

Pig Salivary Cortisol

Descriptive Analysis

The minimum, maximum, mean and standard deviation CORTAUC was min; 783.33 % change•minute, max; 21675.0 % change•minute, mean; 5062.0 % change•minute and SD; 3913.0 % change•minute.

<u>Bivariate Analysis: Effect of Class Variables on Salivary Cortisol</u>

Results of ANOVA for the *CORTAUC*, (n=85) was conducted using a general linear mode with categorical variables (Table 9). The major finding was the significantly higher

CORTAUC (P=0.05) in the 37 pigs that had not repeated the circuit. This was confirmed using a Student's t-test comparing cortisol levels from the 31 pigs repeating the circuit to the cortisol levels determined from day one and day two (P=0.02).

Table 9. ANOVA analysis with CORTAUC (% change nmol/l•min) and categorical variables for *All Pigs* data set and restricted data set for *Focus Pigs Only*.

Data Set	*All Pigs* [a]				*Focus Pig Only* [b]			
Categorical Variable	N	CORTAUC mean	SEM ±	P value	N	CORTAUC mean	SEM ±	P value
ESTEEM								
Low	15	5141.90	632.81	0.72	9	6623.89	1314.10	0.36
High	17	4767.01	559.30		14	5105.60	749.00	
RPTS								
no	51	5598.00	546.62	0.13	11	7111.67	1071.02	0.02
once	37	4300.91	633.21		12	4405.42	732.65	
HGENDER								
male	12	5198.86	786.87	0.59	9	5116.48	548.27	0.47
female	20	4770.32	477.56		14	6074.64	1061.77	
PGENDER								
male	25	4652.60	619.13	0.52	6	6777.5	1953.14	0.38
female	63	5211.69	529.83		17	5319.31	650.73	

a) n = 85; b) n = 23

Time in the Circuit

Descriptive Statistics

The variable HANTIME is representative of the handler time in the circuit. Since the handler does not precede the pigs they were moving and because the correlation between individual PIGTIME and HANTIME was high (P=0.000), HANTIME was assigned as the time of completion for both *All Pigs* and *Focus Pigs* data set.

The minimum HANTIME was 0.80 minutes and the maximum was 13.75. The mean HANTIME was 4.48 minutes with a standard deviation of 3.71 minute.

Association of Categorical Variables with Time in the Circuit:

Results of regression analysis of the dependent variable HANTIME with categorical variables for ESTEEM, HGENDER, and RPTS are presented in Table 10.

Esteem and Gender

Handlers with high self-esteem were not significantly different with the time required to move *All Pigs* (P=0.60) and *Focus Pigs Only* (P=0.70) from those handlers scoring lower in self esteem. In addition, male handlers were not significantly (*All Pig;* P=0.80; *Focus Pig Only;* P=0.47) faster moving pigs through the circuit than were the female handlers.

Repeat Pigs

All Pigs data results reveal that pigs which repeated the circuit on day two (RPTS) were not different (P=0.60) from pigs moving through the circuit for the first time. Analysis using the *Focus Pig Only* data set demonstrates that pigs repeating the circuit have a tendency of less time in the circuit (P=0.10).

Table 10. ANOVA computation with mean and standard error of HANTIME (minutes) and categorical variables ESTEEM, REPEATS, Human gender (HGENDER), and Pig gender (PGENDER) variables.

Data Set	*All Pigs* [a]				*Focus Pig Only* [b]			
Categorical Variable	N	HANTIME mean	SEM ±	P value	N	HANTIME mean	SEM ±	P value
ESTEEM								
Low	15	4.88	1.16	0.60	9	4.75	1.31	0.49
High	17	4.17	0.78		14	4.72	0.89	
REPEATS								
No	58	4.90	0.79	0.12	11	5.51	1.19	0.05
Once	38	3.84	0.45		12	4.02	0.86	
HGENDER								
Male	12	4.25	0.73	0.80	9	4.05	0.78	0.47
Female	20	4.61	0.97		14	5.16	1.09	
PGENDER								
Male	26	4.15	0.71	0.52	6	3.35	0.98	0.58
Female	70	4.60	0.45		17	5.21	0.90	

a) n = 32; b) n = 23

Handler Behavior

Correlation Amoung Human Behaviors:

As presented in Table 11, correlations were determined among the physiological stress of handlers (HCORT), time required to move pigs (HANTIME), and behavior and handler strategies. Note: Correlation and P values are represented in Table 11 for the All Pigs data set, while correlation and P values will be included in the text for the focus pig data set). HCORT was inversely associated with HANTIME ($r = -0.37$, $P=0.05$). The variable Problem Solve (PROBSOLV), was moderately positively correlated with HCORT ($r=0.43$) and negatively correlated with HANTIME ($r= -0.37$). Human behaviors BLOCK ($r=0.37$, $P=0.04$) and HVOCAL ($r=0.34$, $P=0.05$) were also correlated with PROBSOLV. Analysis using both data sets showed negative association between directive behavior such as GATE with PROBSOLV (r= -0.47, *P*=0.007; r= -0.43, *P*=0.04; *All Pigs* and *Focus Pig* respectively). PARGTE, an ineffective position of holding the gate while moving pigs, was slightly positively associated with HANTIME (r=0.303; r=0.440, *P*=0.10; *P*=0.10, *All Pigs* and *Focus Pig* data sets respectively). There was a negative correlation of HCORT with HANTIME (r= -0.37, *P*=0.05) and corroborated in the *Focus Pig* sample (r= -0.42, *P*=0.06).

The strongest correlation among handler behaviors is HVOCAL and BLOCK (r=0.73, *P*=0.000). Review of the videotapes reveal that blocking is used by the handler to prevent the pig from retreating back toward the start of the circuit or at least opposite of the obstacle, and if successful prevents the pig(s) from escaping. Furthermore, using the *Focus Pig* set, there is a significant association between HVOCAL and SLPHD (r=0.44, *P*=0.03) and PUSH and GATE (r=0.42, *P*=0.05).

Table 11. Correlation analysis of HANTIME, PROBSOLV and RTHVOCAL with rates of human behavior using the *All Pigs* data set.

Continuous Variable	HANTIME		PROBSOLV		RTHVOCAL	
All Pigs data	r	P value	r	P value	R	P value
GATE	-0.187	0.31	**-0.467**	**0.007**	-0.162	0.37
BLOCK	-0.220	0.23	**0.372**	**0.04**	**0.729**	**0.0001**
BUMP	-0.294	0.10	0.226	0.21	0.065	0.72
HVOCAL	-0.306	0.09	**0.338**	**0.05**	1.00	0.00
PUSH	0.100	0.59	-0.014	0.45	0.070	0.70
SLAP	-0.292	0.10	0.144	0.43	0.196	0.28
SLPHD	0.223	0.22	0.271	0.13	0.081	0.66
PARGTE	0.303	0.09	0.278	0.12	-0.075	0.68
PAT	-0.112	0.54	0.207	0.25	0.114	0.53
PROBSOLV	**-0.388**	**0.03**	1.00	0.00	**0.338**	**0.05**
HCORT	**-0.373****	**0.05**	**0.426****	**0.02**	0.263	0.17

ALL PIGS, n=32; **n=23; r denotes correlation value

Effects of Handler Behavior on Human Salivary Cortisol

As presented in Table 12, behavior that was associated with a significant increase in HCORT was human behaviors SLAP (*P*=0.05) and PROBSOLV (*P*=0.0001) and pig behavior BKWD (*P*=0.048).

Table 12. Regression analysis of mean and standard error of human cortisol HCORT (nmol/l) and rate of handler behavior for *All Pigs* data and the restricted *Focus Pig Only* data set.

Data Set	***All Pigs*** [a]			***Focus Pig Only*** [b]			
Variable Human Behavior [a]	Estimate	±SE	P value	Variable Human Behavior [b]	Estimate	± SE	P value
BLOCK	-20.5	63.94	0.75	BLOCK	-67.7	36.7	0.81
PAT	-15.8	42.8	0.71	PAT	-49.7	33.9	0.16
SLAP	0.51	0.25	0.05	SLAP	0.20	0.19	0.29
PROBSOLV	1.14	0.47	0.0001	PROBSOLV	0.97	0.62	0.13

[a] denotes *All Pigs*, n=15; [b] denotes *Focus Pig Only*; bold type denotes $P \leq 0.05$

The Effect of Human Behavior on Pig Salivary Cortisol

As presented in Table 13, a tendency was shown for association between the human behavior, patting (PAT) and increased pig salivary cortisol (*P*=0.10). This is supported in the *Focus Pig Only* analysis which reveals a significant increase in cortisol concentrations with a higher rate of patting (*P*=0.03). In contrast, when handlers increased bumping, (BUMP), while handling the target pig, there was a significant reduction in CORTAUC levels (*P*=0.05).

The Effect Human Behavior on Time in the Circuit (Table 14)

Although most human behavior had no significant effect on HANTIME, handlers using a variety of behavioral elements in the first 50 seconds of circuit time (PROBSOLV) significantly reduced the time in the circuit (P=0.03). Other behaviors bumping, slapping and vocalization, at best, demonstrated a tendency ($P\leq0.10$) for less time in the circuit while an increase in rate of parallel gating was mildly associated to an increase of time in the circuit (P=0.09). Confirming that finding, the association of parallel gating (PARGTE) using *Focus Pigs Only* data also showed a tendency toward increased time in the circuit (P=0.10).

Table 13. Regression analysis with dependent variable CORTAUC (percent increase of cortisol by time (minute)) and human behavior for *All Pigs* and the restricted *Focus Pig Only* data sets.

	All pigs [a]			***Focus Pigs Only*** [b]		
Variable Human Behavior	Estimate	± SE	P value	Estimate	± SE	P value
GATE	- 195.74	315.93	0.54	- 234.23	425.48	0.59
BLOCK	- 255.97	309.94	0.41	- 438.21	441.97	0.33
PAT	534.19	325.57	0.10	847.50	367.86	0.032
BUMP	- 272.18	238.87	0.26	- 492.14	238.87	0.05
HVOCAL	- 90.17	100.32	0.37	- 1262.57	947.28	0.20
PUSH	135.37	165.50	0.42	- 102.95	210.19	0.63
SLAP	14.53	101.27	0.89	82.85	125.79	0.52
SLPHD	89.80	658.71	0.89	39.59	822.46	0.97
PARGTE	23.87	4115.2	0.99	992.00	4946.5	0.84

PROBSOLV	220.38	245.75	0.37	270.74	422.58	0.53

a) n= 85 pigs; b) n=23 pigs

Table 14. Regression analysis of HANTIME estimated coefficient (± SE) and different rates of *All Pigs* and *Focus Pigs Only* handler behavior.

Data Set	***All pigs*** [a]			***Focus Pig Only*** [b]		
Variable Handler Behavior	Estimate	±SE	P value	Estimate	± SE	P value
GATE	2603.0	2500.3	0.30	17.8	1672.2	0.99
BLOCK	-3590.7	2907.4	0.23	- 49.1	1744.7	0.98
PAT	-1219.0	1981.1	0.54	189.6	1629.2	0.90
BUMP	- 3678.5	2183.4	0.10	- 847.9	1009.5	0.41
HVOCAL	- 995.4	563.9	0.09	- 2771.4	3808.4	0.47
PARGTE	46035.1	26398.8	0.09	30412.5	18084.3	0.11
PUSH	864.0	1584.0	0.59	72.3	820.0	0.93
SLAP	- 1211.4	723.3	0.10	- 456.9	493.1	0.36
SLPHD	6644.1	5303.4	0.22	- 2533.2	3194.6	0.44
PROBSOLV	**- 51.756**	**22.46**	**0.03**	- 30.8	27.4	0.27

Pig Behavior

Table 15. Descriptive analysis of pig behavior variables for the *All Pig* data set.

Variable	N**	Mean	S D	Minimum	Maximum
TURN	96	0.03	0.025	0	0.13
BKWD	96	0.014	0.012	0	0.035
FREEZE	96	0.003	0.006	0	0.04
BALK	96	0.008	0.016	0	0.113
ESCAPE	96	0.005	0.009	0	0.041
ROOT	96	0.01	0.014	0	0.067
NOSE	96	0.02	0.02	0	0.09
LOGRUN	96	0.02	0.027	0	0.12
HIGRUN	96	0.007	0.01	0	0.07

SQUEAL	96	0.02	0.038	0	0.18
ESC:TURN	67	0.202	0.042	0	0.83

**Denotes pig specific values of pig behavior

Correlation among Pig Behaviors

Using data (Table 16) the Pearson's correlation analysis determined a significant positive correlation (r=0.374, *P*=0.000) between the avoidance behaviors ESC and TURN. Significant and mild correlation of ESC with pig vocalizations were LOGRUN (r=0.20), HIGRUN (r=0.30) and SQUEAL (r=0.26) while TURN was significant and moderately correlated to SQUEAL (r=0.34). Explorative behavior NOSE was highly significant, yet a low negative correlation to both RTESC (r= -0.25, *P*=0.01) and TURN (r= -0.20, *P*=0.05). Significantly positive correlated with TURN were ROOT (r=0.20) and LOGRUN (r=0.25).

The pig measure ESC:TURN ratio was, on average, 3.4 turns to 1 escape or an ESC:TURN ratio of 0.29. The ESC:TURN measure was moderately correlated to vocalizations HIGRUN (r=0.40) and SQUEAL (r=0.24).

Vocalizations LOGRUN, HIGRUN and SQUEAL were investigated for possible correlation with other pig behaviors. In addition to strong associations with TURN AND ESC, there was substantial correlation among pig vocalizations of LOGRUN with HIGRUN (0.37) and SQUEAL with HIGRUN (0.24). Inspectorial behavior such as ROOT and FRZE (r=0.20; r=0.24, respectively) were associated with LOGRUN.

Using restricted *Focus Pig Only* data set, correlation analysis of pig behavior with measures of pig cortisol (CORTAUC) revealed significant association with vocalization HIGRUN (r=0.49, *P*=0.02) and a tendency toward LOGRUN (r=0.35, *P*=0.10). Similar to ALL PIGS analysis, TURN is strongly associated with RTESC (0.52, *P*=0.01) and

LOGRUN (r=0.50, *P*=0.01) and vocalizations HIGHRUN is strongly associated to LOGRUN (0.54, *P*=0.008).

Table 16. Correlation between pig behavior variables escape, turn, low grunts, high grunts, and squeal to other rates of pig behavior for *ALL PIGS* data set (correlation; *P* value).

Variables Human Behavior	ESC	TURN	LOGRUN	HIGRUN	SQUEAL
ESC	1.0; 0.00	**0.374; 0.0002**	**0.204; 0.05**	**0.304; 0.003**	**0.260; 0.009**
TURN	**0.374; 0.0002**	1.00; 0.00	**0.251; 0.01**	0.120; 0.25	**0.333, 0.001**
ESC:TURN	**0.824; 0.0001**	0.036; 0.77	0.174; 0.16	**0.399; 0.0008**	**0.240; 0.05**
BALK	0.171; 0.10	-0.053; 0.61	0.204; 0.21	-0.03; 0.72	0.040; 0.67
ROOT	0.132; 0.20	**0.200; 0.05**	0.172; 0.09	0.100; 0.33	-0.135; 0.19
BKWD	-0.120; 0.24	0.077; 0.46	0.068; 0.51	0.014; 0.89	0.108; 0.29
FRZE	0.014; 0.89	0.076; 0.46	**0.242; 0.02**	-0.129; 0.21	0.031; 0.76
NOSE	**-0.249; 0.01**	**-0.200; 0.05**	0.076; 0.46	0.081; 0.43	0.093; 0.37
LOGRUN	**0.204; 0.05**	**0.251; 0.01**	1.0; 0.00	**0.370; 0.0002**	0.164; 0.11
HIGRUN	**0.305; 0.003**	0.120; 0.25	**0.370; 0.0002**	1.00; 0.00	**0.244; 0.02**
SQUEAL	**0.264; 0.009**	**0.338; 0.0009**	0.164; 0.11	**0.244; 0.02**	1.00; 0.00

n= 96; bold type denotes $P \leq 0.05$

Regression Analysis of Pig Behavior

<u>Human Saliva</u> (Table 17)

Pig Behavior, ESC:TURN, was inversely near significance (*P*=0.06) to human cortisol concentrations. Interestingly, pig behaviors associated with reduced HCORT included other avoidance behavior TURN (*P*=0.036) and ESC (*P*=0.016) as well as investigatory behavior ROOT (*P*=0.004). Analysis from *Focus Pig Only* data revealed no significant association to HCORT.

Table 17. Regression analysis of mean cortisol HCORT (nmol/l) and rate of pig behavior for *All Pigs* data and the restricted *Focus Pig* data set.

Data Set	***All Pigs*** [a]			***Focus Pig Only*** [b]		
Independent Variable Pig Behavior[a]	Estimate	±SE	P value	Estimate	± SE	P value
ESC	**-296.1**	**114.8**	**0.02**	-117.5	0.19	0.19
TURN	**- 104.1**	**47.2**	**0.04**	-34.4	33.1	0.31
ESCTURN	- 3.9	2.0	0.06	- 3.8	2.9	0.18
BALK	-43.3	88.1	0.63	263.36	153.4	0.10
ROOT	**-240.4**	**77.0**	**0.004**	-130.16	67.2	0.07
LOGRUN	-100.4	55.0	0.08	-28.4	40.7	0.49
HIGRUN	-130.69	111.4	0.25	6.98	41.9	0.83
SQUEAL	6.82	47.5	0.89	41.0	22.9	0.08

a) denotes *All Pigs*, n=67; b) denotes *Focus Pig Only*; **bold type** denotes $P \leq 0.05$

Pig Salivary Cortisol

Pig vocalization HIGRUN, was associated with a tendency (*P*=0.075) using the *All Pigs* data and a significant increase (*P*=0.019) in CORTAUC levels with the *Focus Pigs Only* data set.

Time in the Circuit (Table 18)

The variable HANTIME was significantly associated with independent variables for pig behavior. Avoidance behavior of pigs, such as turning and escaping, (TURN and

ESCAPE) significantly increased the time in the circuit (P=0.005, for both behavior). Focus pig data supports such behavior as significantly highly associated with increased time in the circuit (TURN, P=0.002, and ESC, P=0.008). A ratio of escape to turn was significantly associated (ESC:TURN, P=0.000) with an increase in HANTIME

Pig vocalization, low grunting and high grunting, (LOGRUN and HIGRUN) were significantly associated with longer time in the circuit (P=0.000). Motion behavior in pigs such as walking (WALK, P=0.002) was significantly associated with less time in the circuit.

While rooting (ROOT) was significantly associated (P=0.01) with an increase of HANTIME, another investigatory behavior, nosing (NOSE), was significantly associated (P=0.02) with a decrease in HANTIME.

Table 18. Regression analysis of HANTIME estimated coefficient (± SE) and using *All Pigs* data and restricted *Focus Pig Only* data set.

Data set	All Pigs			Focus Pig Only		
Independent Variable Pig Behavior[a]	Estimate	±SE	P value	Estimate	± SE	P value
TURN	**1.65**	**0.54**	**0.005**	**1.23**	**0.54**	**0.0024**
BKWD	- 0.52	1.59	0.75	- 0.24	1.16	0.83
FRZE	3.99	2.54	0.13	- 0.64	1.71	0.71
BALK	- 1.31	1.10	0.24	- 0.99	1.98	0.62
ESC	**4.36**	**1.43**	**0.005**	**2.91**	**0.99**	**0.008**
ROOT	**2.60**	**0.97**	**0.01**	1.33	0.86	0.13
NOSE	**- 1.57**	**0.62**	**0.02**	- 0.42	0.86	0.63
LOGRUN	**2.10**	**0.57**	**0.0009**	0.65	0.48	0.19
HIGRUN	**4.18**	**1.19**	**0.001**	0.87	0.52	0.11
SQUEAL	0.49	0.47	0.30	- 0.04	0.31	0.91
ESC:TURN	**0.87**	**0.52**	**0.0007**	286.3	166.1	0.11

DISCUSSION

The discussion is presented in subsections that allow methodical review of findings based on the three purposes of this study. The first aim of this study was to provide information, based on characteristics of the study population, on the nature of interactions which humans are likely to perform when handling pigs. Secondly, this study attempted to determine the success of different handler strategies by observing the interrelationship of behavioral and physiological response of pigs. The last objective was to provide scoring or a scale, derived from the present study, to deduce methods of selection and training of stockpeople.

The Study Population: Human Characteristics and the Interactions Used by Handlers

Self-esteem

In general, the self-esteem score used in this study was not a strong variable in predicting behaviors used by handlers when interacting with pigs with two exceptions. First, those handlers who scored lower in self-esteem while handling the focus pigs were mildly associated with an aggressive behavior of slapping. Hemsworth et al., (1989) points out that behavior such as slapping and kicking, regardless of infliction, was considered aversive by pigs. Slapping, by humans, is generally considered an aggressive behavior (Crowell, 1986) and may be a result of frustration experienced by those of a lower self-esteem while moving the often non-compliant focus pig. At the other end of esteem score, the restricted focus pig data set also revealed an association between higher self-esteem and blocking behavior. Those of higher self-esteem may be less likely to revert to aggressive behavior or perhaps blocking, whether learned or part of the problem solving behavior repertoire, will thwart frustrating events such as escape behavior by pigs. Thus, frustration and aggressive behavior such as slapping are reduced.

The fact that a global personality scale was not highly predictive of individual human behavior is not surprising. There was a shift toward the higher self-esteem scores that may be explained by the fact that respondents may misreport their behavior and attitudes in a positive bias on self reports, especially in cases of socially desirable behaviors such as self-esteem (Ajzen, 1988). A review of the personality literature reveals that correlations between characteristics and behaviors relevant to those characteristics are often nonsignificant (Ajzen, 1988). According to Ajzen, personality is derived from a genetic component diverged with the individual's experiences, creating a complex human. This complexity makes it difficult to predict single or overt human behaviors based on a questionnaire assessing personality traits. Rather, predictions of behavioral tendencies are made based on the average person's experience or past behavior in a similar situation. These behavioral observations are referred to as base rate data

(Baughman and Welsh, 1962; Ajzen, 1988). Utilization of this data allows us to better predict and measure human behavior

Another factor to consider is that people are generally expected to act in accordance to their intentions (Ajzen, 1988). While the present study measured self-esteem against dependent variables time and cortisol, the handlers were instructed simply to move pigs without consideration of time in the circuit. Therefore the handlers intentions or pretensions may have been different from those measured (time and cortisol) in the study.

Gender

For the most part, gender did not predict behavioral approaches used by males contra behavioral approaches used by females. Based on a national survey of pig stockpeople, women constitute only 3% of that workforce (Miller, 1996), therefore there is a paucity of information on female pig handlers. Although anecdotal, it is a belief among many pig producers that women's personalities are better suited for working in the environment of the farrowing house. These same beliefs may suggest that males and females are suited for working in separate phases of pig production and that selecting a stockperson may be gender based. Our research would submit that when compiling the biological response of juvenile pigs, such as behavior, time in the circuit, and cortisol, there is no difference between males and females.

Human Cortisol

Human cortisol was associated with less time in the circuit and an increase with human behaviors slapping and problem solving. Almost any type of physical or mental stress can lead to an increase in cortisol (Guyton, 1996). Unpredictability and suspense are effective stimuli for an activation of the adrenal system (Hubert and de Jong-Meyer, 1989). An increase in problem solving behavior in the first 50 seconds of time in the circuit would likely be both physically and psychologically stimulating. Similarly, slapping, considered an aggressive behavior, suggests a confrontation between the handler and the focus pig, resulting in higher cortisol response. It is well documented that the adrenal response of human subjects includes an anticipatory stimulus. In a number of studies, Kirschbaum and Hellhammer (1989) investigated the changes in salivary cortisol levels under psychological stimulation. Using a suspense film ("Psycho") as a stressor in humans to measure both actual and anticipatory adrenal response, this group determined that only anticipation stress was a good predictor of cortisol concentrations. Similar results were obtained in a study with young police officers facing a violent group of football fans. In this case however, cortisol concentration in these police officers was elevated both in anticipation of and during confrontation.

Surprisingly, human cortisol response to pig avoidance and investigatory behavior was inversely associated with behaviors escape, esc:turn, and rooting. The focus pig data confirms this negative association with rooting, although with less significance. The present study also found an association between low grunts and lower human cortisol. According to (Hafez and Signoret, 1969) low grunts are an indication of rooting in pigs.

In a review paper, Kirschbaum and Hellhammer (1989) explained that in mild stressful situations not only the "stressor" but also the personality factors are important determinants of salivary cortisol response. These authors support the theory of personality factors by citing a study whereby children watched either a scary film or a control film. The study found that highly anxious children showed increased cortisol concentrations during both a scary (stress) film and a control film, while children with low anxiety did not respond to either the stress or the control film with an elevated cortisol levels. The determination of higher salivary cortisol values obtained by RIA for men when compared to women is in agreement with one study published where males subjects had higher basal cortisol values than women participants (Cooper et al., 1989).

Handler Strategies:

Interrelationship of the Behavioral and Physiological Response of Pigs

There are two main factors to which pigs respond when handled: the response to the handler and environmental stressors such as the facilities, and the relationship or physical position to other pigs. In addition to observing and documenting human to pig interaction, another objective of the study was to emulate an on-farm environment by providing an opportunity for pig to pig interaction and documentation of the responses.

Human Behavior and Pig Biological Response

The aggregation of handler behavior, problem solving, was strongly associated with less time in the circuit. These findings corroborated with the hypothesis derived from an earlier pilot study. Based on the preliminary pilot data, it was expected that the unpredictability of pig behavior would constitute more problem solving or an increase in behavioral elements necessary for success in moving pigs through the circuit in less time. Problem solving involves decision making and the generation of alternative responses, strategies, and behaviors needed to find a solution (Anderson, 1996).

Generally, analysis of individual handler behavior against covariances, time and cortisol, revealed individual handler behaviors were not significant in reducing time in the circuit, however, while moving the focus pigs, patting may be classified as a stressor and bumping may be associated with lower pig cortisol. In contrast to other work, a distinct category for non-aversive (pleasant) and aversive (unpleasant) behavior based on time and cortisol, was not obvious. Such findings are contrary to a previous study conducted by Hemsworth et al, (1989) comparing fear and stress indices of sows to predefined categories of human behavior. Hemsworth et al., (1989) found that the stockperson behavior toward pigs was a good predictor of plasma cortisol and fear response. The unpleasant behavior category containing hits, slaps, and kicks were more aversive to pigs than the category of stockperson behavior containing pats and strokes. A criticism of this study is the experimental bias as the human behaviors were pre-classified based on intuitively accepted allocations of patting and stroking as pleasant behaviors and slapping, kicking, and hitting as unpleasant behaviors. The confederates recorded the amount of time each stockperson spent with each pig, and the number of bouts of physical interaction within each classification of pleasant or unpleasant behavior.

Human behavior blocking and vocalizing were highly correlated and problem solving was moderately correlated with both blocking and vocalizing. Blocking requires body and hands to prevent pigs from moving backwards or escaping, thus it is a likely that vocalization is an alternative and cognitive strategy for handlers to maximize the success of driving pigs through the circuit.

Pigs Behavioral Response

Avoidance behavior turn and escape were strongly associated with higher time in the circuit. Pigs perceive a person standing erect to be more threatening than one squatting (Muira et al., 1996), however, a certain level of fear is desired and therefore it is appropriate to stand when driving pigs. According to Gray (1987), escape and avoidance are indices of fear. The causal stimuli of this fear can be based on intensity or novelty, and may arise from social interaction, evolutionary danger or conditioned fear stimuli. The pig will turn back and attempt escape when there is fear of unfamiliar conditions such as change in floor material (Grandin, 1980), a funnel into a single race or a ramp (van Putten and Lambooij, 1993) or interaction with another pig. It was noticed that if one pig in the group escaped past the handler within the first 50 seconds of time in the circuit, there were a significant increase in multiple escapes by pigs in that group. This may be a learned success response by the pig, whereby as the more the pig succeeds, the more persistent the pig is in its subsequent attempts and with some handlers, the pig invariably wins.

Avoidance may not be the only expression of fear. High grunts emitted from the focal pig were significantly associated with higher cortisol measures. Squeals and high grunts were correlated to both escape and the esc:turn ratio. This suggests that as the esc:turn ratio increases so does stress indicator, vocalization. This observation concurs with research showing that high pitched vocalization was accompanied with escape attempts (von Borrel and Ladewig, 1992). Based on data from the present study, it was not evident if pig vocalization preceded the escape. Social species that collaborate in defense against predators, such as pigs and humans, vocalize quite often when caught or hurt (Broom, 1993). If fearful, an animal may squeal, emit high grunts, or remain silent and immobile (e.g. freezing). It is important to note that vocalization may not have been stimulated by handler interaction alone, but also from pig-pig interaction.

Nosing, an orientation behavior was inversely associated with turning and escape and resulted in decreased time in the circuit. Orientation response is behavior that allows the animal to investigate and observe the stimuli and as fear and avoidance behavior responses wane, the animal will approach the stimulus and explore the area. Once the animal is fully acquainted, the exploratory behavior will be terminated and the animal will move forward (Gonyou, 1993). Gonyou states that animals should be allowed to investigate the surroundings without being forced. Additionally, orientation behavior is argued to be negatively correlated with time since fear is related to low levels of ambulation and exploratory behavior is related to high levels of ambulation (Whimbey and Denenberg, 1967).

Based on analysis, pig behavior rooting was associated with an increased time in the circuit. Although not supported statistically, observation of video tapes suggest that rooting was not exclusively a exploratory behavior but a stereotypic activity used by the pig as a stress coping mechanism often followed by an attempt to escape. Broom et al. (1995) investigated coping ability of sows in different housing systems, and deemed an excess of "normal" activities as drinking, rooting or chewing as stereotypic behavior.

Validation studies confirmed the reliability of the methods of salivary cortisol collection, detection of free cortisol and the sensitivity of radioimmunoassay procedure (see pp 51-56). However, in consideration of the minimal response of cortisol as an indication of human and pig behavior, three plausible rationales are described. First, pigs have an episodic circadian rhythm, as seen with the considerable inter-individual pig differences as shown in Table 5, which may have skewed the overall results. Secondly, mean basal cortisol levels of pigs in the present study were lower than levels referenced in the literature (Zanella and Unshelm, 1994). The pigs in this experiment were found either rooting the flooring material or lying down close to each other. This may have had a calming effect on the pigs both before and after the circuit, as environmental enrichment aids animals in dealing with stressful situations and tends to reduce general fearfulness (van Putten, 1988). The dirt and peat floors of the circuit and holding pen area would sufficiently provide enough environmental enrichment to improve the coping capability and reduce stress. The last and most likely reason is that, as mentioned previously, animal stress response is based on the intensity, novelty and stimuli arising from social interaction. The pigs used for this study had been herded at least 3 times from the hot nursery to the cold nursery to the grower pens and again to the finishing pens. Furthermore, group structure had not changed since the grower stage. Therefore, while the circuit and obstacles were novel, the pig salivary cortisol levels in response to human handling were most likely diluted.

Selection of Stockpeople

While it is interesting to speculate that human characteristics such as self-esteem may be good predictors of handler success based on time required to move pigs or pig stress indices, the data does not indicate such an effect. The self-esteem scores of university students may be higher than scores representing the general population.

However according to Ravel et al, (1996) stockpersons investigated had higher global self-esteem than the average person in Quebec. Human cortisol concentrations were associated with time in the circuit and pig behavior however, requesting saliva samples from a potential stockperson applicant is not advisable for most farms.

A significant finding in the present study is the relationship between problem solving behavior by handlers and reduced time in the circuit. Since problem solving is defined as the number of different behaviors by the individual within the first 50 seconds of the circuit, it is worth noting that a person who responds to a task with an increase in behavioral tactics may not indicate problem solving behavior traits. For example, at the beginning of an assigned task, situation assessment and planning, would likely require additional time whereas assertive or even aggressive behavior may be an immediate response without time delay to action resulting in more behavior tactics during the initial period.

While problem solving data has not necessarily established a cause and effect to reduced time in the circuit, observing a potential stockperson as they navigate through an unpredictable procedure such as driving juvenile pigs may provide insight on the plasticity of that employee. In addition, problem solving techniques were not used more frequently by males or females.

CONCLUSION

Problem solving is an important stockperson skill necessary for effectively handling unpredictable situations encountered when moving pigs. The present study provides qualitative information regarding the impact of on-farm handling strategies on quantitative physiological and behavioral responses of pigs.

When compiling the biological response of juvenile pigs (behavior, time, and cortisol), human characteristics of self-esteem and gender were not strong predictors of efficiency of handling, however pig responses were qualitatively affected by the problem solving ability of the stockperson. Personality profiles may provide a better understanding of the employees when recruiting or targeting recruits. However, as suggested in this study, each stockperson is a compilation of genetic and personal experience placed in a situation of unknown determinants of pig handling. Therefore, to predict human behavior as it relates to personality traits, gender, and livestock handling experience, it is important to establish a base rate data of handler strategies to better predict human pig interaction for future studies. Given that this is the first study of it's kind, the present study provides initial data of human behavior while handling juvenile pigs.

Research over the last decade has concluded that many negative unpleasant actions by the pig are actually induced by the stockperson. As presented, pig behaviors escape, turn and vocalization proved to be good indicators of increased time to move pigs in the circuit. These behaviors are more likely to be avoided when the stockperson moves pigs in small groups, clears the pathway of debris and uses solid penning dividers and gates of appropriate width.

The role of the stockperson continues to change as the industry endeavors to improve productivity. Commercial pigs were traditionally transported and moved two to three times before transported at market. Multiple opportunities for transport of pigs when younger and smaller, provided an opportunity to train pigs in moving out of the pen and into a passageway or onto a truck. This training reduces fear of novelty by the market age when pigs are older, larger and physically challenging for handlers. With modern swine production, however, weaned pigs are placed and remain in pens with the same penmates, adequate in space allotment, until market weight. This unchallenging environment may reduce the animal's ability to cope in a stressful situation such as transportation. Present information and future studies to identify the successful sequence of handler behaviors required to move pigs, while monitoring pig response such as pig vocalization, may provide effective indices when training stockpeople on proper handling techniques.

APPENDIX

APPENDIX

SURVEY OF PERSONAL EXPERIENCES

Some of the sentences found below describe different characteristics of a person. Some of them are concerned with an individual's reaction to events. Others are concerned with the nature of relationships. As you read them, take a moment to think about yourself, your characteristics, and your reactions to your experiences in events and personal relationships. Answer the following items with them in mind. For each attribute, event, or personal reaction, we ask you to consider how it applies to you - ranging from whether it doesn't apply to that it strongly applies. Indicate your choice by marking the appropriate response on the enclosed answer sheet. Fill in the corresponding circle on the answer sheet with a #2 pencil that refers to the number that best represents your beliefs and impressions. Please do not write on this survey.

<u>Note</u>: Words such as "close" and "intimate" refer to psychological or emotional closeness with others. By "others," "people," "partner(s)," and "close relationships" we refer to people who you encounter frequently, including your parents, other relatives including your spouse or siblings, other important adults, special friendships, romantic partners, co-workers, important acquaintances.

Using the scale below, fill in the appropriate number (1 through 5) on the answer sheet for each item.

Not at all like me or Strongly disagree		Somewhat like me or Neither agree or disagree		Very much like me or Strongly agree
1	2	3	4	5

1. I am generous with my friends.
2. I'm somewhat uncomfortable being too close to others.
3. I worry that others don't value me as much as I value them.
4. I don't mind asking others for comfort, advice, or help.
5. On the whole, I am satisfied with myself.
6. I would rate the <u>overall functioning</u> of my family as:

1	2	3	4	5
The members of my family function well together				The members of my family do not function well together

7. I quickly get over and recover from being startled.
8. I find it difficult to trust others completely.
9. I often worry that others don't or won't really love me.
10. I seek comfort from others when I'm troubled or ill.

11. At times, I think I am no good at all.
12. I enjoy dealing with new and unusual situations.
13. I worry about others getting too close to me.
14. I sometimes get frustrated and angry because no one loves me the way I'd like to be loved.
15. I'm not the kind of person who readily turns to others in times of need.
16. I feel that I have a number of good qualities.
17. I usually succeed in making a favorable impression on people.
18. I don't like people getting too close to me.
19. People have often let me down.
20. I like to tell my partner(s) all about my day.
21. I am able to do things as well as most other people.
22. I enjoy trying new foods I have never tasted before.
23. It's risky to open up to another person.
24. I worry about being alone.
25. I rarely ask others for any kind of help.
26. I feel I do not have much to be proud of.
27. I would rate the <u>warmth</u> in my family as:

1	2	3	4	5
Warm and available				Cold, distant and uncaring

28. I sometimes feel that getting too close will cause trouble for me.
29. I worry about being abandoned by others.
30. I like to share new ideas with my partner(s).
31. I certainly feel useless at times.
32. I like to take different paths to familiar places.
33. It's best to be cautious in dealing with most people.
34. I often get frustrated because others don't understand my needs.
35. When something good happens, I can hardly wait to tell certain people.
36. I am regarded as a very energetic person.
37. I feel that I'm a person of worth, at least on an equal basis with others.
38. I am more curious than most people.
39. I find it easy to trust others.
40. Often, just when you think you can depend on someone, the person doesn't come through.
41. I don't hesitate to ask for help when I need it.

42. I wish I could have more respect for myself.

43. I would rate <u>respect and regard</u> in my family as:

1	2	3	4	5
Lack of respect for feelings and messages of others				Consistently respectful of others' feelings and messages

44. Most of the people I meet are likable.

45. Others often want me to be closer than I feel comfortable being.

46. I've generally been able to count on partner(s) for comfort and understanding.

47. I'm not very comfortable having to depend on other people.

48. All in all, I am inclined to feel that I am a failure.

49. I usually think carefully about something before acting.

50. Other people don't take my concerns seriously.

51. I find that others are reluctant to get as close as I would like.

52. I'm comfortable having other people depend on me.

53. I take a positive attitude toward myself.

54. I like to do new and different things.

55. My daily life is full of things that keep me interested.

56. I rarely worry about others leaving me.

57. I would be willing to describe myself as a pretty "strong" personality.

58. I get over my anger at someone reasonably quickly.

PART 2

BACKGROUND INFORMATION

The following are items and questions concern yourself and your family. For each item and question please fill in the number on the scoring sheet that is the most accurate answer regarding yourself and/or your family.

59. My sex:
    1. Male
    2. Female

60. My age at my last birthday:
    1. 17 or 18
    2. 19 or 20
    3. 21 or 22
    4. 23, 24, or 25
    5. 26 or older

61. My ethnicity/racial group:
    1. Caucasian/Non-Hispanic
    2. African American/Non-Hispanic
    3. Hispanic/Latino
    4. Asian American
    5. Other (please describe your ethnicity/racial group on the margin of the scoring sheet)

62. The kind of community in which I lived for most of my life:
    1. large city (over 250,000 persons)
    2. medium size city (between 50,000-250,000 persons)
    3. small city (between 25,000-50,000 persons)
    4. suburban community (village or town of less than 25,000 persons) near a city
    5. rural

63. My prior experience with animals, as pets, "family members,"and/or as part of our family's business (e.g., agricultural, farm) was:
    1. Very satisfying
    2. Satisfying
    3. Neutral
    4. Dissatisfying
    5. Very dissatisfying

64. My prior experience handling livestock (e.g., pigs, sheep, horses) was:
    1. Very extensive
    2. Substantial
    3. Small
    4. None

65. Father's education:
    1. Some high school or less
    2. High school graduate
    3. Some college or technical school
    4. College or technical school graduate
    5. Professional/graduate degree

66. Mother's education:
    1. Some high school or less
    2. High school graduate
    3. Some college or technical school
    4. College or technical school graduate
    5. Professional/graduate degree

67. How often did you go home this semester?
    1. Not at all
    2. Several times
    3. Nearly every weekend
    4. Only for the holidays

68. My current relationship status:
    1. Single and not dating
    2. Dating several different people
    3. Dating the same person for the last year
    4. Engaged
    5. Married

YOU ARE NOW FINISHED. THANK YOU VERY MUCH FOR TAKING THE TIME TO ANSWER OUR QUESTIONS. PLEASE MAKE SURE YOU HAVE YOUR CORRECT PID ON BOTH THE ANSWER SHEET AND CONSENT FORM.

You understand this research addresses how the attitudes and interpersonal style of handling by various individuals will relate to behavioural and physiological response of pigs.

If you choose to participate, you understand that it will take no longer than a one-half hour for the questionnaire, and if asked to volunteer for the handling study, you are not required to remain longer than the two hour lab time slot.

You understand that the video tapes made of you managing a group of pigs within this animal handling exercise, in which you are taking part, may be shown to animal handling classes as part of their educational experience in better and less stressing methods of handling pigs.

You understand that the investigation has been explained and that there are no known obvious risks outside the normal handling practices which are written in your "animal handling course" objectives. The project does provide full coveralls to protect your clothing and high rubber boots to protect your feet and lower legs. The pigs may defecate and urinate, but since the number of pigs is three, this is not expected to be an offensive odour to you. Any manure or urine will be cleaned up between pig groups.

You understand that prior to moving pigs you will submit a sample of saliva and your pulse will be taken. You will then be instructed to move into the pens housing the pigs. From this point you will then move three pigs through a circuit designed to incorporate common features found in pig handling facilities (Figure 1). Each of you selected as handlers will move animals involved in this study. After you have completed the circuit, you will be asked to submit saliva samples and pulse rate will be retaken.

You freely consent to participate in this research and understand that you may withdraw participation at any time.

You understand that all results will be treated with strict confidence and all individuals will remain anonymous in any report of research.

If you have any questions or concerns you can feel free to contact Dr. Adroaldo Zanella at 517/432-4134 or Dr. Madonna Gemus at 517/432-2944.

Signature ______________________________

Date ____________________

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