MASTERARBEIT

Titel der Masterarbeit

Sex differences in real-life spatial cognition

An investigation of the mechanisms underlying parking performance of women and men

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Master of Science (MSc)

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“We are what we think. All that we are arises with our thoughts. With our thoughts, we make our world.”

The Buddha

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Abstract

The stereotype of women's limited parking skills is deeply anchored in modern culture. When entering the key items "women" and "parking" in one of the biggest search engines of the World Wide Web, more than 45.000.000 results are obtained. As car parking is a complex, spatial task, and a large body of scientific literature proves the existence of sex differences in spatial cognition in favour for men, it is possible that the prejudice addressing women's poor parking skills has a scientifically proven background. Unfortunately, Behavioural Neuroscientists rarely leave their laboratories and so the cognitive and social mechanisms that possibly affect spatial abilities of parking in women and men have never been investigated systematically. The present study shows that men park more accurate and especially faster than women. Performance is related to mental rotation skills in driving beginners but later shifts to be related to self-assessment in more experienced drivers. Likely, this change in related variables is due to training of mental rotation skills and differential feedback. As a consequence, self-assessment incrementally compensates and replaces the controlling influence of mental rotation skills, as driving experience increases. Results demonstrate that sex differences in spatial cognition found in laboratory experiments persist in real-life situations. However, real-life spatial cognition is also influenced by socio-psychological factors, which modulate the biological causes of cognitive sex differences.

1. Introduction

1.1 Sex differences in cognitive abilities

"Men can't listen as good as women can", "women are not good at reading maps", men can't concentrate on several things at the same time", "women's verbal skills are better than those of men", "men have a better sense of direction compared to women", "women can't park". Such and related stereotypes are deeply anchored in our modern culture (Hausmann, 2007). When entering the key words "difference women and men" in "Google", one of the biggest search engines of the World Wide Web, more than 25.000.000 results are obtained. Besides their frequent appearance in the popular media, reports addressing cognitive sex differences are found on the covers of prominent news magazines such as *TIME* (January 20, 1992). The mass media marked concerned with the "true nature" of sex differences is immense and growing. Millions of dollars have been spent on pseudo-scientific books about the difference between women and men (Halpern, 1996). What is the reason for the wide distribution of stereotypes addressing cognitive sex differences? In how far are they proven scientifically?

It is not long since scientific investigations concerned with sex differences in cognitive abilities were disapproved of, as the detection of differences between women and men was thought to threaten the equality of the sexes. Some researchers were opposed to any comparisons of women and men, especially when differences were found, fearing that the data may be interpreted and misused in ways that support a misogynist agenda or unwittingly provide support for the idea that there are "proper roles" for women and men (Halpern, 1996, 2000). However, a change of perspective has occurred, which is due to two major points. On the one hand, the investigation of sex differences opens the possibility to develop methods of treatment for sex-related (mental) illnesses. On the other hand, most researchers now regard high-quality research as the only way to reject false stereotypes and to understand legitimate differences between women and men (Halpern, 2000). Meanwhile, a large body of scientific literature proves the existence of large and very consistent sex differences for some cognitive tasks, whereas, for other tasks, performance differences are small or absent (Maccoby & Jacklin, 1974; Kimura, 1996, 1999; Halpern, 2000; Halpern & Tan, 2001). Scientific findings are of interest in a diverse array of fields, as answers effect public policies concerning equity and equality, test construction and interpretation, opportunity and achievement, salaries, and access to technology in a complex, often unpredictable, way. It is thus important to study cognitive sex differences with the aim to illuminate their nature and the extent, to which they are present in and have influence on our everyday life (Halpern, 1996).

Meanwhile, a great amount of psychological tests that reveal performance differences between the sexes are in use. Women are, for instance, superior in two tasks that require the rapid retrieval of verbal information from long-term memory (Loring-Meier & Halpern, 1999): the "Letter Fluency Task", requiring subjects to generate words that start with a certain letter, and the "Synonym Generation Task", requiring the retrieval of synonyms. Hines (1990) found effect sizes ranging between d=0.5 (medium effect) and d=1.2 (large effect) for these two psychological test procedures. Another task in which women generally perform better than men is "Finding A's", which measures rapid access to information about words or subject's speed of perception. In this test, subjects must rapidly scan rows of words and cross out the A's. Women furthermore are superior in "Identical Pictures", in which they must compare a target figure with a test figure and decide whether they are identical or not (Halpern & Tan, 2001).

In visual-spatial tasks that require transformations in the visual-spatial working memory, men tend to outperform women (Krikorian et al., 1996). Such tasks include, for instance, the Piaget's Water Level Task, and the Mental Rotation Task. In the Water Level Task, subjects must predict the horizontal orientation of the liquid surface in a tilted bottle (Piaget & Inhelder, 1948), whereas, in the Mental Rotation Task, it is necessary to imagine how an abstract 3-D cube-figure looks like from another perspective (Vandenberg & Kuse, 1978). Men, on average, also outperform women in tasks that involve the tracking of a moving object through space, including e.g. time-of-impact judgements for a figure moving across a monitor (Halpern & Tan, 2001). Such spatiotemporal tasks were used e.g. by Law et al. (1993) and Linn & Petersen (1985, 1986). Besides visual-spatial and spatiotemporal tasks, men excel in spatial-motor tasks such as throwing an object towards a target (Watson & Kimura, 1991).

1.2 Reasons for cognitive sex differences

Scientists with different backgrounds and approaches have discussed several explanations for the existence of cognitive sex differences. First of all, several anatomical and morphological differences between women's and men's brains are discussed in terms of sex differences in cognitive functioning (Güntürkün & Hausmann, 2003, 2007; Güntürkün, 2007). The planum temporale (Figure 1), for instance, an area posterior to the auditory cortex that involves the core of the Wernicke's area, and is thus activated during phonological processing, tends to be larger on the left compared to the right side (Geschwind & Levitsky, 1986; Güntürkün & Hausmann, 2003). As this asymmetry is significantly reduced in women (Shapleske et al., 1999), the planum temporale is though to be involved language lateralization and the reduced asymmetry of speech found in women (McGlone, 1977).

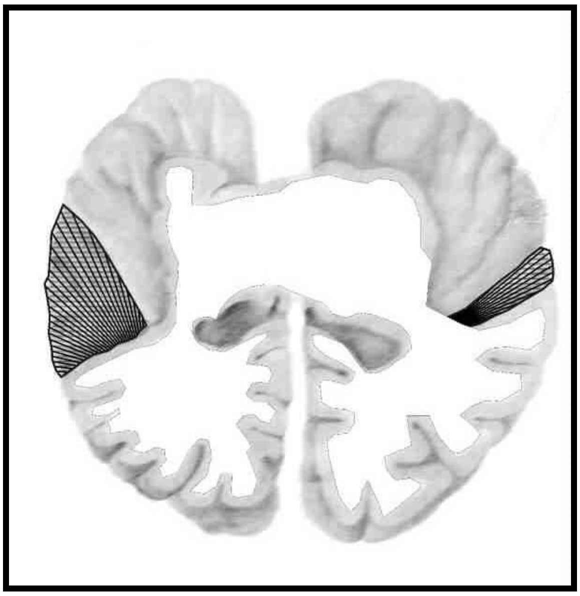

FIGURE 1: The planum temporale. Size of the planum temporale (hatched) in the left and the right hemisphere. Adapted from Güntürkün & Hausmann (2003).

Meanwhile, several sex-dependent left-right differences of cognitive functions such as speech (Shaywitz et al., 1995; Hausmann et al., 1998), spatial orientation (Hausmann & Güntürkün, 1999), and face recognition (Rizzolatti & Buchtel, 1977), have been identified. Overall, women seem to be more symmetrically lateralized than men. Interestingly, however, data of women also show larger variance compared to men's. This is assumed to be due to fluctuations of the gonadal hormones progesterone and estradiol during the menstrual cycle (Figure 2). During the follicular and luteal phase, levels of estradiol / estradiol and progesterone, are elevated, which was associated with a lower performance in spatial tests

(Hausmann et al., 2000). Furthermore, high levels of estradiol and progesterone have been associated with an enhancement of verbal fluency, articulation (Hampson, 1990), and memory (Sherwin, 1988; Phillips & Sherwin, 1992). During menses, gonadal hormone levels are lower, which was found to be associated with higher scores in spatial tasks (Hampson, 1990; Hausmann et al., 2000).

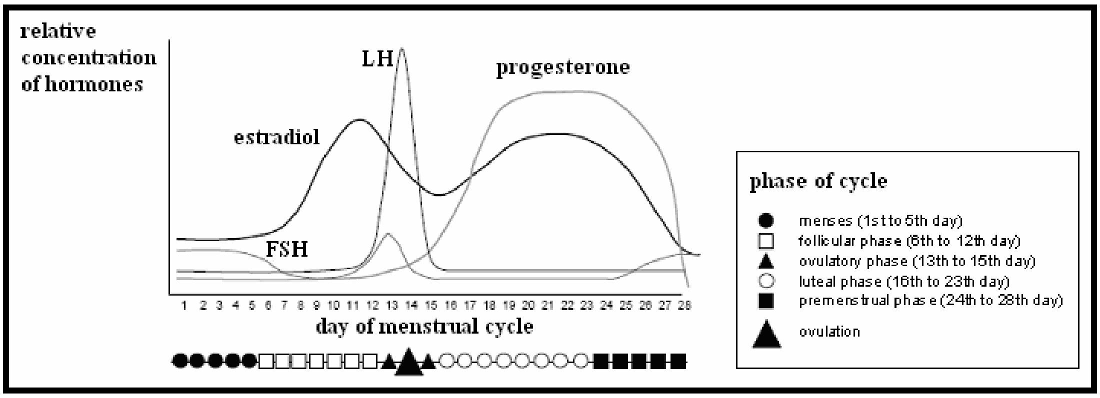

FIGURE 2: The menstrual cycle. Relative concentrations of progesterone, estradiol, LH (lutinizing hormone), and FSH (follicle-stimulating hormone), Adapted from Hausmann (2000).

According to the *Dual Coding Hypothesis* of Güntürkün & Hausmann (2003), the degree of lateralization of cognitive functions is due to two major mechanisms. First, neuroanatomical differences, which develop during early ontogeny and do not change importantly during adulthood, are assumed to mediate functional cerebral asymmetries (time-invariant factors). The second mechanism is thought to be due to time-variant factors that can alter the balance between the two hemispheres. The authors assume that commissural interactions, which can be asymmetrical themselves, mediate this effect. As the efficiency of synaptic transmission at commissural synapses is altered by gonadal steroids, interactions between the two hemispheres depend on sex and change in women over the menstrual cycle, which leads to alternations of functional cerebral asymmetries.

Besides the activating effects of hormones during adulthood, which are described above, prenatal gonadal hormones are capable of organizing the brain during early development (Williams et al., 1990; Williams & Meck, 1991; Gooren & Kruijver, 2002; Thijssen, 2002). Androgens, for instance, are known to masculinize not only behaviour, but also cognitive skills (Helleday et al., 1994; Berenbaum et al., 1995, Berenbaum, 1998). A well-known example for such a masculinization of cognitive functioning is Congenital Adrenal Hyperplasia (CAH), which is caused by an overproduction of adrenal androgens. Girls suffering from CAH were found to have improved spatial skills (Resnick et al., 1986;

Helleday et al., 1994; Berenbaum et al., 1995; Hampson et al., 1998; Kimura, 1999, 2002; Hines et al., 2003).

Not only biological, but also environmental factors can influence cognitive performance. Sociopsychological studies have focused on the effect of sex stereotypes. Stereotype threat, the confrontation of humans with abasing stereotypes of which they are the target, can affect performance negatively (Steele & Aronson, 1995; Steele et al., 2002). Most studies on stereotype threat focused on verbal or quantitative abilities. Typically, stereotype threat decreases performance (Steele & Aronson, 1995; Croizet & Claire, 1998; Spencer et al., 1999; Steele et al., 2002), although activation of a stereotype may influence performance positively, too (Shih et al., 1999; O'Brian & Crandall, 2003). An interesting study was conducted by Yeung & von Hippel (2008), who focused on driving performance of women in a driving simulator. They found that stereotype threat increases the likelihood that female drivers run over jaywalkers. Subjects who were reminded of the stereotype that women are poor drivers (Berger, 1986) were more than twice as likely to collide with pedestrians than women who were not reminded of this stereotype.

Several evolutionary hypotheses have been proposed for the existence of cognitive sex differences. However, most of them are logically flawed or have no substantial support, as few species have been tested (reviewed by Jones et al., 2003). In the context of spatial cognition, strongest support was found for the range size hypothesis, which suggests that range size was the selection pressure that acted to increase spatial ability (Gray & Buffery, 1971). According to this hypothesis, sex differences in spatial skills in favour for males are found when these have larger home ranges than females. However, besides the fact that evolutionary hypotheses are not testable, they ignore large bodies of data that do not conform to these explanatory frameworks. Also, they heavily rely on questionable analogies from other animal species (Halpern, 2000). The range size hypothesis, for instance, is mainly based on data of three species of voles (Gaulin & Fitzgerald, 1986, 1989).

It is important to keep in mind that cognitive sex differences are not caused by *either* biological *or* environmental factors. Rather, underlying variables are dependent; they interact and jointly contribute to individual cognition and behaviour. Thus, it is important to focus not only on one factor. Rather, it should be the aim of researchers to gain insight into the complex interaction of different variables. The psychobiosocial hypothesis of Halpern (1996, 2000) is based on the idea that some variables are both biological and environmental and inextricably entwined. Thus, cognitive sex differences are caused by complex interactions between biological, psychological and social variables (Figure 3).

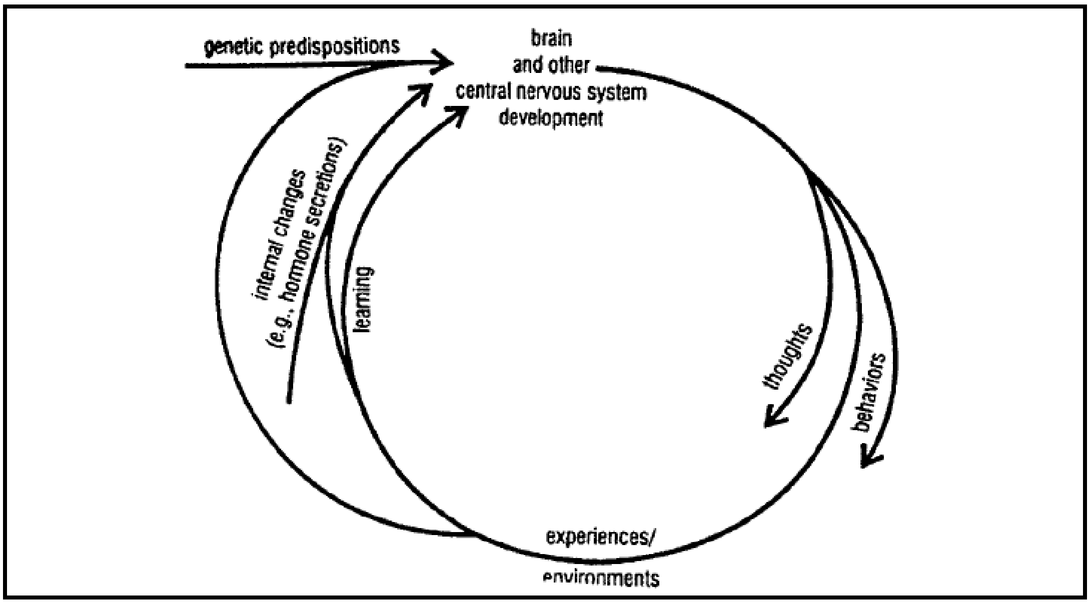

Figure 3: Schematic diagram of the psychobiosocial model of cognition. Nature and nurture are continuous and inseparable. Adapted from Halpern (2000).

1.3 Real-life relevance of cognitive sex differences

It is the common goal of researchers to understand human cognition and behaviour as it occurs in a complex, natural environment (Kingstone et al., 2008). As outlined by Kingstone et al. (2003, 2008), however, research relies heavily on the – remarkably successful – methods of experimental psychology, which originated in the late 1950s to early 1960s. These methods mainly include minimization of environmental complexity and maximization of experimental control. Thus, experiments are conducted in artificial, standardized and controlled experimental contexts. Human cognition, however, is not invariant and regular across situations. Rather, cognitive processes vary extremely with changes in context. Consequently, the transferability of laboratory findings to real life is not necessarily given. A brief literature overview reveals that minimal changes within a laboratory setting compromise the replicability of an observed effect (e.g. Wolfe & Pokorny, 1990; Atchley & Kramer, 2001).

Broadbent (1971, 1991), one of the most important researchers in experimental psychology, was convinced that real-life experiments must be the basis of psychological theory. A study of human behaviour in real life was conducted by Güntürkün (2003), who observed kissing couples in public areas such as international airports, large railway stations, beaches and parks. He found that twice as many adults turn their heads to the right than to the left when kissing, suggesting that a rightward head-motor bias, previously known to be present shortly before and after birth only, persists into adulthood.

Kingstone et al. (2008) point out that it is important to *first* make observations in the natural environment of humans, *before* going into the lab. The authors state that, by this means, researchers are prevented from being locked into a laboratory paradigm with the a priori assumption that the applied paradigm or task is tapping into processes that are expressed in everyday situations. An exemplary study was conducted by Land & Lee (1994), who investigated the behaviour of humans while they steered a car around a corner, the results being interesting for human performance modelling, vehicle engineering and road design. In a subsequent study, Land & Hoorwood (1995) conducted controlled lab experiments in a driving simulator to find out about what types of cornering information are critical for normal and abnormal driving behaviour. Importantly, the second study was based on a detailed description of real-world driving behaviour (Kingstone et al., 2008).

Thus, the finding that women perform less good in specific spatial tests does not necessarily imply that they perform less good in spatial real-life situations, too. It is therefore surprising that only few attempts have been made to investigate spatial cognition in a complex, natural environment, requiring the integration of multiple skills. Although large-scale navigation has been investigated in natural environments (Cornell et al., 1989, 1992; Abu-Ghazzeh, 1996), and several evolutionary hypotheses have been proposed (reviewed by Jones et al., 2003), attempts to prove the ecological validity of standardized psychological tests for spatial cognition are extremely rare.

1.4 Mental Rotation Test

Largest and most consistent differences in favour for men are found for the Mental Rotation Test, a paper-and-pencil test for spatial cognition (Vandenberg & Kuse, 1978; see Figure 4). This psychological test typically requires the identification of similar, although rotated, abstract 3-D cube figures designed by Shepard & Metzler (1971). On average, men make fewer mistakes than women (e.g. Oosthuizen, 1991; Resnick, 1993; Masters, 1998) and perform faster (e.g. Petrusic et al., 1978; Kail et al., 1979). This advantage for men is found for different age groups (Vandenberg & Kuse, 1978) as well as for different cultures (Jahoda 1980; Oosthuizen, 1991). Presently, the Mental Rotation Test is one of the most frequently cited tests in the context of sex differences in cognitive abilities. Furthermore, it is regarded as *the* test proving male’s superiority in spatial cognition.

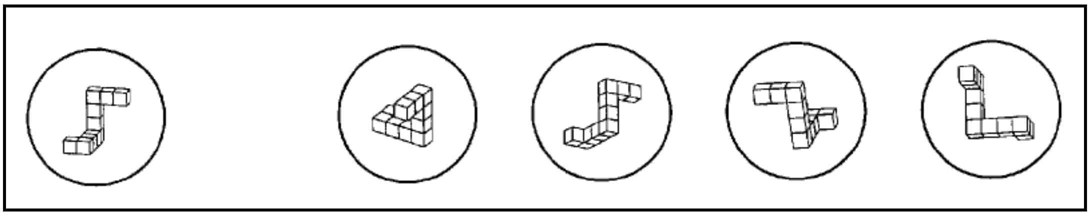

FIGURE 4: Sample item from the Vandenberg & Kuse (1978) Mental Rotation Test. Subjects must identify the two rotated versions of the target figure on the left. Here, the first and the third item (from the left) of the four alternatives are correct.

Astonishingly, however, mental rotation has never been examined in a natural setting. Furthermore, the scientific principle described by Kingstone et al. (2008) to *first* observe human behaviour and cognition in the natural environment *before* going into the lab (described in Section 1.3) is unfulfilled with respect to the Mental Rotation Test. Shepard & Metzler (1971) designed the abstract 3-D cube figures in order to examine the human ability to determine that two two-dimensional pictures portray objects of the same three-dimensional shape even though the objects are depicted in very different orientations. The existence of a sex difference in the ability to rotate these 3-D cube figures mentally, however, was found rather "accidentally" by Vandenberg & Kuse (1978), who constructed the paper-and-pencil Mental Rotation Test.

An attempt to prove the ecological validity of the Mental Rotation Test was made by Pearson & Ialongo (1984). Subjects conducted the Mental Rotation Test along with two measures of environmental knowledge. These measures were a landmark location task and a route knowledge task, which were based on a slide-simulated walk through and unfamiliar urban environment. The authors found that mental rotation was part of the skills necessary to replicate a cognitive map. Nevertheless, they considered it as necessary, to distinguish spatial ability from environmental cognition. However, the relevance of the findings of Pearson & Ialongo (1984) is questionable, because their study did not include a real-life situation but natural environment was simulated.

1.5 Women, men, and cars

The stereotype of women's limited driving skills is deeply anchored in our modern culture. According to Berger (1986), it originated during the early twentieth century. The author states that, during this time, women driving cars were regarded as a serious threat for defenders of the status quo, which was a society dominated by men. Driving women threatened to restructure their social status and family life, as they became more independent from men. For defenders of the status quo, the stereotype was a means to limit female use of cars. In our daily life, we can observe the manifestations of this stereotype. When couples travel together in a vehicle, for instance, the man usually drives. Furthermore, the idea that women are poor drivers is frequently present in sexist jokes (Yeung & von Hippel, 2008). This is the case although the stereotype addressing women's driving skills has no scientifically proven background. Rather, men are actually the ones who are known to be involved in accidents more frequently than women (e.g Gebers & Peck, 2003; Williams, 2003).

Possibly even more widespread than the stereotype addressing women's general driving skills, is the stereotype addressing women's poor parking skills. It is therefore not surprising that this issue has also been addressed by Allan and Barbara Pease in their pseudo-scientific bestselling book "Why men don't listen and women can't read maps". Here, a mysterious unpublished study is mentioned, which is supposed to prove women's (extremely!) poor parking skills. Unfortunately, and despite huge public interest in the topic, no details about the study are known, which makes it impossible to prove the validity of the findings.

Navigating a car into a parking space is a task that is fundamentally spatial in its nature. While keeping in mind the dynamic position of the vehicle relative to the surrounding area (including e.g. parking cars and kerb), the driver must steer towards the parking space. It is possible that mental rotation is the major cognitive mechanism contributing to the creation of an image of the surrounding area. Due to the fact that men rotate more accurately and rapidly, the prejudice addressing women's poor parking ability might origin in scientific findings, which prove that men are superior in certain spatial tests. On the other hand, social factors may contribute to parking performance. The stereotype of women's poor driving skills, for instance, was found to influence driving performance of women negatively (Yeung & von Hippel, 2008). Also, the wide distribution of the stereotype may have an impact on self-assessment, which, in turn, could affect parking ability.

1.6 Aim of the study

In the present study parking performance of women and men was investigated. Subjects carried out three different types of parking manoeuvres (forward and backward bay, and reverse parallel parking), whereupon their performance was related to their performance in the Mental Rotation Test and to self-assessment of parking and driving skills. The outcome of this study is important for three reasons. First, results may shed light on the validity of a stereotype, which is deeply anchored in modern culture but which has never been investigated systematically. Second, real-life relevance of theories established in standardized psychological test procedures may be unravelled. In this context, the present study is designed to investigate the ecological validity of the Mental Rotation Test, which is among the most often cited tests in the context of sex differences in spatial ability in favour for men. Last but not least, mechanisms underlying parking performance are investigated. On the one hand, mental rotation may be related to parking performance in order to create an image of the surrounding area. Furthermore, social variables may play an important role. It is hypothesized that neither mental rotation ability (a biological variable) nor self-assessment (a social variable) determines performance exclusively. Rather, they are assumed to jointly determine individual performance.

2. Methods

2.1 Subjects

A total of 65 subjects (30 women, 35 men) participated in the study. Participants were driving beginners, who possessed the driving licence not longer than two weeks, or students with limited driving experience. Criterion for participation for students was that they had never possessed an own car and had not driven regularly (more than twice a week for a time period of more than three months) since acquisition of the driving licence. Women's mean age was 20.90 (Standard Deviation (SD)=3.27); the mean age of men was 22.26 (SD=3.31). Age did not differ significantly between the sexes ($t(63)= -1.66$, $p=0.63$). Intelligence Quotient (IQ), determined with a language-based IQ-test, the "Mehrfach-Wortwahl-Test" (Lehrl, 1978; Appendix B), was 101.03 (SD=9.64) for women and 100.86 (SD=7.38) for men. IQ of women and men did not differ ($t(63)=0.08$, $p=0.93$). Handedness was determined with the Edinburgh Handedness Inventory (Oldfield, 1971; Appendix C). The laterality quotient (LQ) determined by this test provides values ranging between -100 and +100; negative values indicating a preference for the left, positive values a preference for the right hand. The mean LQ of women was 75.80 (SD=41.38), the mean LQ of men was 60.85 (SD=51.77). No significant sex difference was found for LQ ($t(63)=1.27$, $p=0.21$). Participants were neurologically healthy, had normal or corrected visual acuity, were naïve of the experimental hypothesis and received 50 € for participation. Furthermore, they gave written informed consent and were treated with the declaration of Helsinki. The study had been approved by the ethics committee of the Ruhr-University Bochum.

2.2 General experimental procedure

After subjects had been welcomed, they carried out three types of parking manoeuvres: forward bay parking, backward bay parking and reverse parallel parking. Each manoeuvre was carried out twice, namely from the left and from the right side. Thereupon, subjects were asked to assess their driving and parking skills in a questionnaire, and conducted the Mental Rotation Test.

2.3 Parking manoeuvres

Parking manoeuvres were conducted with an Audi A6 Limousine automatic (C6/4F, provided by the Audi Forum Ingolstadt, see Figure 5) in an area of a car park that had been closed off for the public.

FIGURE 5: Experimental car. Subjects conducted parking manoeuvres in an Audi A6 Limousine.

Two parking spaces, one for bay and one for parallel parking, were provided (Figure 6). Each parking space measured 4.9 m × 1.8 m, which corresponded to the size of the Audi. Parking spaces were restricted by junk cars. The distance between the two junk cars restricting the bay parking space was 3.6 m (two times the width of the Audi). The rear side of the parking space was bordered by a wall, located at a distance of 30 cm. The distance between the cars restricting the parallel parking space was 7.35 m (one and a half times the length of the Audi). Here, the bordering wall was located at a distance of 70 cm. Distances between junk cars had been determined in preliminary tests. Size of parking spaces made completion of a manoeuvre possible within few minutes without too much effort for pretest subjects.

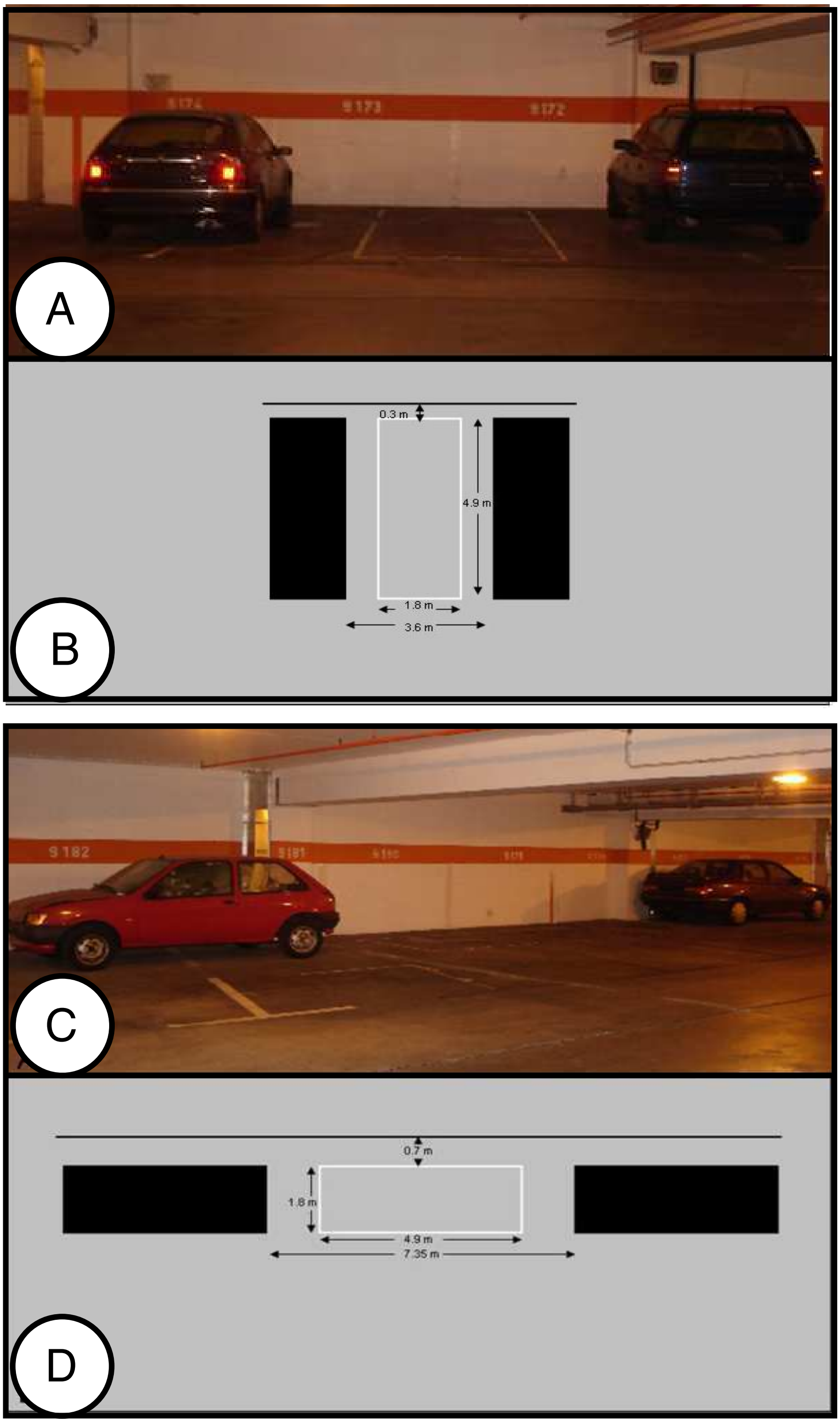

FIGURE 6: Parking spaces for bay (A) and parallel (C) parking. Parking spaces were marked with white tape and restricted by junk cars. **Schematic drawings of the parking spaces for bay (B) and parallel (D) parking**. Black squares: junk cars. White frames: parking spaces. Black lines at the upper sides: wall.

Starting positions for the different types of parking manoeuvres were specified by connecting the centre of each position (corresponding to the centre of the Audi when standing at the starting position) with the centre of the parking space in a right angle. Thus, measurements formed the x- and the y-axis of a two-dimensional coordinate system, the intersection of the two axes representing the zero point. For forward left and right bay parking, starting positions were located at a distance of 13.2 m (x-axis) and 6.7 m (y-axis) of the parking space. Starting positions for backward left and right bay parking were located at a distance of 8.2 m (x-axis) and 4 m (y-axis). Bay parking manoeuvres were filmed from a distance of 13 m from the centre of the parking space (Figure 7).

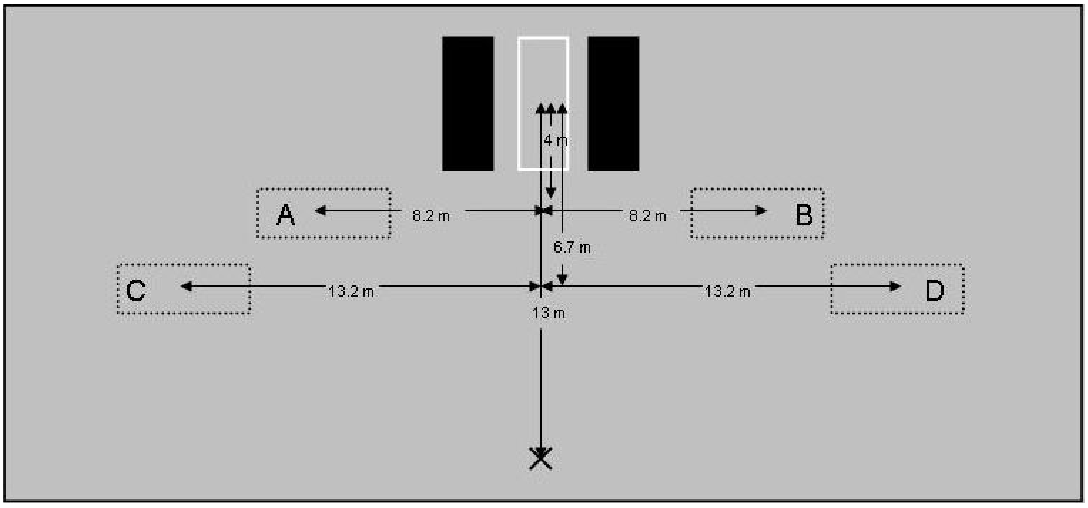

FIGURE 7: Starting positions for bay parking. Subjects parked four times from predetermined starting positions (squares in dashed lines): A=backward bay parking left, B=backward bay parking right, C=forward bay parking left, D=forward bay parking right. Black squares: junk cars. White frame: parking space. Black cross: camera position.

Starting positions for reverse parallel parking were located at a distance of 6.4 m (x-axis) and 2.8 m (y-axis) of the parking space. The distance between camera and centre of the parking space was 12 m. Appropriate starting positions had been determined in preliminary tests in a way that, from each position, it was theoretically possible to park the car without having to back up (Figure 8).

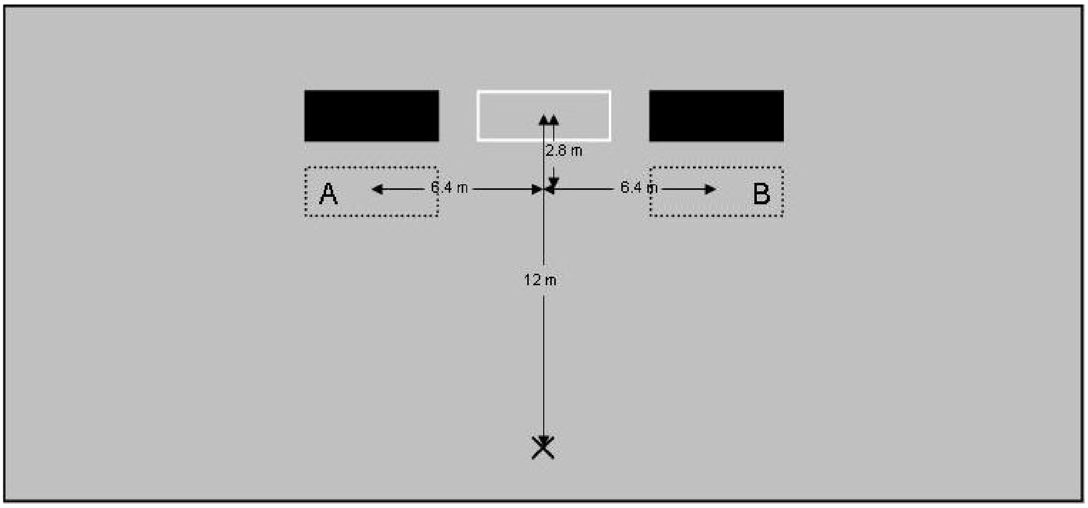

FIGURE 8: Starting positions for reverse parallel parking. Subjects parked two times from predetermined starting positions (squares in dashed lines): A=parallel parking left, B=parallel parking right. Black squares: junk cars. White frame: parking space. Black cross: camera position.

First, subjects were made familiar with the Audi. They were asked to sit on the driver's seat and to adjust the seat, the rear and side view mirrors. In Germany, driving schools generally use cars with manual transmission, which also are used by the majority of the German population. Thus, subjects were instructed how to drive an automatic. After potential questions had been answered, a test drive was conducted. Subjects drove a distance of approximately 35 m, backed up, and drove back the same distance. Then, they backed up again and manoeuvred the car into approximately the same position as in the beginning. Thereupon, subjects had a closer look at the parking spaces. They were told to park in the middle between the junk cars and to imagine an everyday situation such as parking in front of a supermarket. Furthermore, they were instructed to have a closer look at the Audi, especially at the length of rear end and hood. It was pointed out that not the gas pedal but only the idling mixture supply should be used, that no advices would be given by the experimenter, and that the engine must be turned off after a manoeuvre had been completed. Importantly, subjects were not allowed to modify starting positions (e.g. by driving further away from the parking space). Rather, they were told to drive towards the parking space directly from the predetermined position. Nevertheless, subjects could back up as often as necessary later. Prior to the beginning of each parking manoeuvre, the experimenter drove the car into the starting position and subjects were informed which manoeuvre to conduct next. Speed and accuracy were recorded. Speed was defined as time in seconds between first movement of the car and turning off the engine. Accuracy was defined as area in percent of the parking space that was covered by the Audi, and was calculated based on the distance of the car from the boundaries of the parking space using a Matlab 7.0.4 (The MathWorks Inc., Natic, USA).

2.4 Self-assessment

Directly after parking manoeuvres had been completed, subjects were handed out a questionnaire (see Appendix D for a German version of the Questionnaire) in which they were asked to assess their general driving and parking skills ("general self-assessment"; including the questions: "are you rather bold or shy when driving?", "how good, in general, do you drive?", and "how good, in general, do you park?"), and their performance during the experiment ("actual self-assessment"; including the questions: "how good, do you think, did you park during the experiment?", and "do you assess your performance during the experiment being better or less good compared to your general parking skills?").

2.5 Mental Rotation Test

Participants were tested in the redrawn version of the Vandenberg & Kuse (1978) Mental Rotation Test by Peters et al. (1995), in which they had to identify rotated versions of 3-D cube figures designed by Shepard and Metzler (1971; see Appendix E for a German version of the test). The test consisted of 24 items (two subsets of 12 items each). In each case, the stimulus on the left was the target. Subjects had to determine, which two of the four sample stimuli on the right side of the target were rotated versions of the target stimulus. Subjects had three minutes for each subset of 12 items, which were conducted directly after each other. A score of "1" per item was given, if both rotated versions of the target had been identified correctly. A score of "0" was given, if only one of none of the rotated stimuli had been identified. Thus, the maximum overall score was 24.

3. Results

3.1 Parking manoeuvres

A 3x2 repeated measures analysis of variance (ANOVA) with parking manoeuvre as within-subjects factor and sex as between-subjects factor was calculated to investigate, whether parking speed (time in seconds between first movement of the car and turning off the engine; see 2.3) and parking accuracy (area in percent of the parking space that was covered by the experimental car; see 2.3) differed between the three types of manoeuvres, and whether parking performance differed between women and men. A significant main effect parking manoeuvre was found ($F_{(2,124)}=36.90$; $p<0.001$). Least time was necessary for forward bay parking (mean=55.18; SE=3.39), followed by backward bay parking (mean=76.58; SE=3.44). Most time was necessary when subjects reverse parallel parked (mean=91.40; SE=5.66). Furthermore, men (mean=59.67; SE=3.52) parked significantly faster than woman (mean=91.36; SE=4.88; $F_{(1, 62)}=28.67$; $p<0.001$) with an effect size of Cohen's d=1.33 (very large effect) in all types of manoeuvres (Figure 9). This sex difference remained, when the three types of manoeuvres were analyzed separately (Bonferroni-corrected post hoc tests; $p<0.001$ for all three types of manoeuvres).

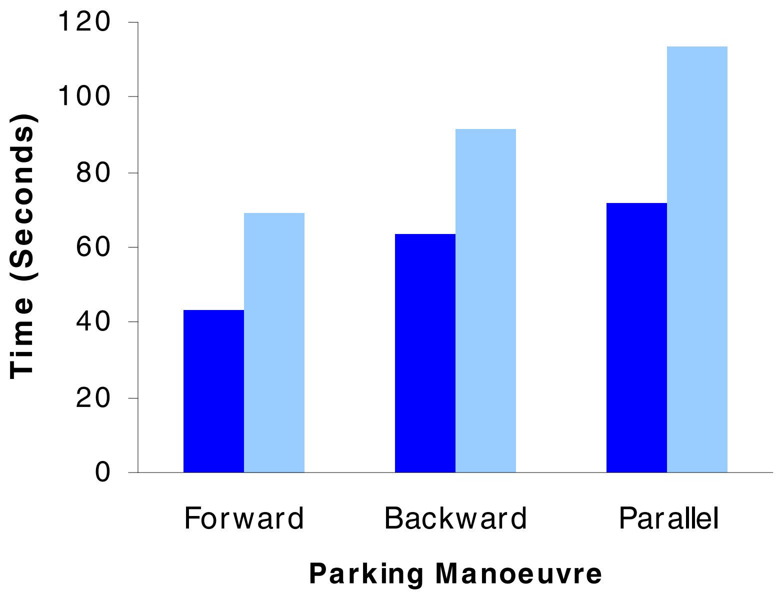

Figure 9: Time in seconds necessary to complete a parking manoeuvre. Shown are forward, backward, and parallel parking manoeuvres. Women=light blue, Men=dark blue.

In contrast to parking speed, no significant differences in parking accuracy were found between the three types of manoeuvres ($F_{(2,124)}$=2.65; p=0.08). Thus, percentage of area of the parking space covered by the experimental car did not differ between the three types of parking manoeuvres (bay parking forward: mean=88.69; SE=0.59; bay parking backward: mean=88.31; SE=0.56; reverse parallel parking: mean=86.99, SE=0.79). The same as for parking speed, parking accuracy differed between the sexes (Figure 10). Compared to men (mean=88.97; SE=0.56), women (mean=86.87; SE=0.72) covered less area of the parking space ($F_{(1,62)}$=5.47; p<0.05) with an effect size of Cohen's d=0.58 (medium effect). When the three types of manoeuvres were analyzed separately, however, the observed sex difference reached the significance level only for reverse parallel parking (Bonferroni-corrected post hoc test; p<0.5), but not for forward (p=0.22) or backward bay parking (p=0.14).

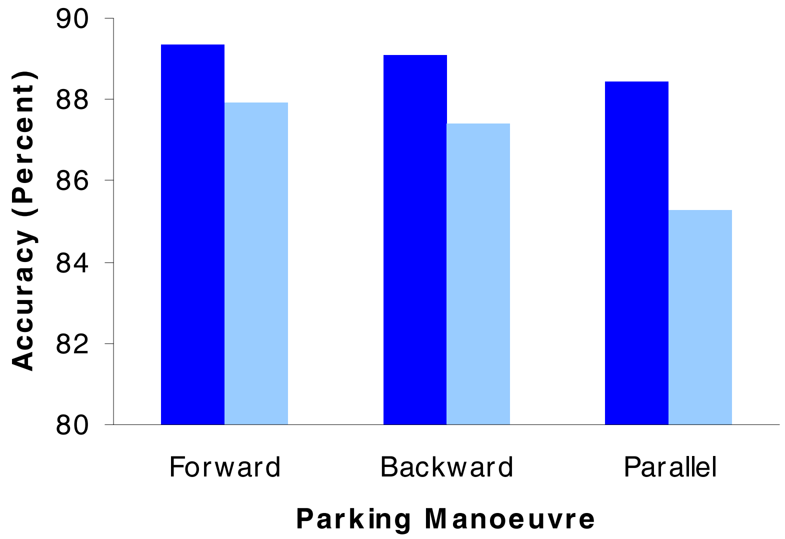

Figure 10: Accuracy in percent necessary to complete a parking manoeuvre. Shown are forward, backward, and parallel parking manoeuvres. Women=light blue, Men=dark blue.

It is well-known that greater accuracy can be reached by a decrease in speed (Zhai et al., 2004). To take both parking speed and accuracy into account, and thus obtain a more objective measure of subject's parking ability, parking speed and accuracy were combined to Inverse Efficiency Scores (IES). IES were calculated by dividing parking speed by parking accuracy. By this means, any potential speed-accuracy trade-off effects in the data are eliminated. The lower the IES, the better parking performance of subjects (Townsend & Ashby, 1978, 1983; Spence et al., 2001).

As for parking speed and accuracy, an ANOVA was calculated for IES (Figure 11). A significant main effect parking manoeuvre was found ($F_{(2,124)}$=36.40; p<0.001). Subject's performance was best when bay parking forward (mean=63.05; SE=4.18), followed by bay parking backward (mean=87.27; SE=4.02) and reverse parallel parking, for which highest scores were found (mean=108.37; SE=7.43). Across all three types of manoeuvres, men's IES (mean=67.53; SE=3.98) was lower than the IES of women (mean=107.77; SE=6.53; $F_{(1,62)}$=29.18; p<0.001) with an effect size of Cohen's d=1.34 (very large effect). This sex difference remained, when the IES of the three types of parking manoeuvres was analyzed separately (Bonferroni-corrected post-hoc tests; p<0.001 for all three manoeuvres).

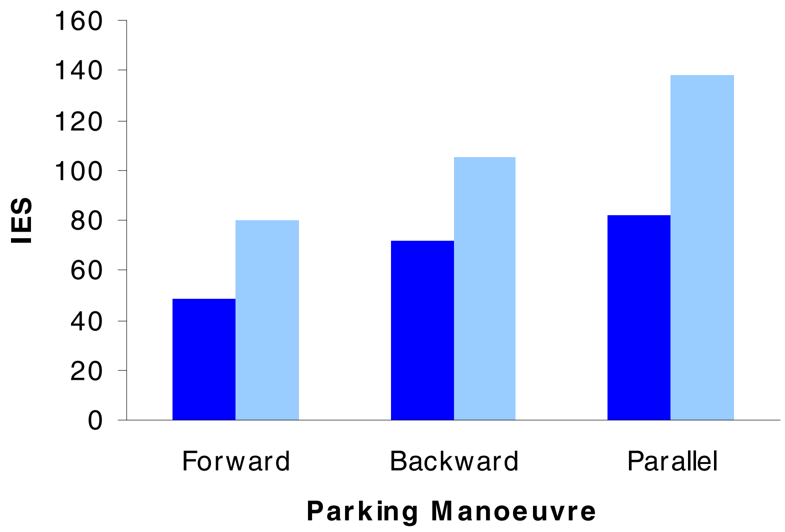

FIGURE 11: Inverse Efficiency Scores for parking manoeuvres. Shown are forward, backward, and parallel parking manoeuvres. Women=light blue, Men=dark blue.

3.2 Self-assessment

After parking manoeuvres had been completed, subjects were asked to assess their actual and general driving and parking skills. Subsequently, a composite score for actual (including the questions: "how good, do you think, did you park during the experiment?" and "do you assess your performance during the experiment being better or less good compared to your general parking skills?") and general self-assessment (including the questions: "are you rather bold or shy when driving?", "how good, in general, do you drive?" and "how good, in general, do you park?") was calculated (see Appendix D). To determine, whether actual and general self-assessment differed between the sexes, t-tests were calculated. It was found that women (mean=0.34; SD=0.65) assessed their general parking skills worse than men (mean=0.91; SD=0.60; t(63)=-3.71; p<0.001), but not their actual parking performance in the experiment (women: mean=-0.08; SD=0.77; men: mean=0.06; SD=0.85; t(63)=0.70; p=0.49).

The two variables actual and general self-assessment were not correlated (two-tailed Neyman-Pearson Correlation Coefficient $r=0.08$; $p=0.53$). This indicates that subjects differentiated between their performance in the experiment and their general parking ability.

3.3 Mental Rotation Test

The percentage of correct answers in the Mental Rotation Test (Appendix E), in which subjects had to identify rotated versions of a target stimulus, was analyzed by means of the t-test. In accordance with literature, men (mean=51.23; SD=18.76) performed significantly better than women (mean=41.67; SD=16.14; $t(61) = -2.15$, $p<0.05$).

3.4 Relationships between the variables in the overall sample

One-sided Neyman-Pearson Correlation Coefficients were calculated to investigate the relationship between general self-assessment / mental rotation skills, and parking performance. Data analysis revealed that mean IES correlated significantly with general self-assessment ($r=-0.41$; $p<0.001$). Thus, the better subjects assessed their ability to drive and park, the lower the IES and better their parking performance, respectively. However, no significant correlation was found between IES and mental rotation skills ($r=-.16$; $p=0.10$).

3.5 Relationships between the variables in the split sample

Numerous psychological studies prove that spatial abilities, including mental rotation skills, underlie strong training effects (e. g. Kail & Park, 1990; Lohman & Nichols, 1990; Voyer, 1995; Glück et al., 2002; Cherney & Neff, 2004). The sample in the present study, however, consisted of driving beginners, who possessed the driving licence not longer than two weeks, and students with more, although still limited, driving experience (see 2.1 for details).

To investigate whether the relationship between parking performance and self-assessment / mental rotation skills changed according to experience, the sample was split into subjects that had their driver's licence since less than 14 days (n=17) and more experienced drivers (n=48). As for the overall sample, one-sided Neyman-Pearson Correlation Coefficients were calculated to investigate the relationship between general self-assessment and mental rotation skills, respectively, and parking performance. In the driving beginner sample, mental rotation (r=-0.56; p=0.12) but not general self-assessment (r=-.44; p=0.04) correlated with mean IES when significance levels were adjusted for multiple comparisons, leading to a cut-off point of p=0.025. In contrast, no correlation with mental rotation ability (r=0.07; p=0.33), but a much stronger one with self-assessment was observed (r=-0.60; p<0.001) in more experienced subjects.

4. Discussion

4.1 Summary of results

Data analysis revealed that parking performance of women and men differed between types of manoeuvres. Although no significant difference was found for parking accuracy, parking time was shortest for forward bay parking, followed by backward bay and reverse parallel parking, for which most time was necessary. This trend was reflected by IES, too. Across all three manoeuvre types, men were significantly more accurate than women. When manoeuvres were analyzed separately, however, accuracy differences did remain for reverse parallel parking only. Furthermore, a sex difference in parking speed was found. Men parked significantly faster than women and their IES was smaller, reflecting a better performance of men. Analysis of the self-assessment questionnaire revealed that women assessed their general but not their actual parking skills not as good than men did. In line with literature, men outperformed women in the Mental Rotation Test. In the overall sample, IES correlated negatively with general self assessment, whereas no significant correlation was found between IES and mental rotation skills. In the split sample, however, IES correlated with mental rotation skills in driving beginners and self-assessment in more experienced drivers.

4.2 Performance differences between the types of manoeuvres

Subject's parking performance – at least with respect to parking time and IES – was best for forward bay parking, worse for backward bay parking, and worst for reverse parallel parking. This result can be explained in terms of increasing spatial challenges. Attempts to integrate the heterogeneous cluster of tasks in a single definition for spatial cognition are rather rare (Witelson & Swallow, 1987). Nevertheless, some authors have tried to describe the cognitive processes involved. Linn & Petersen (1985), for instance, proposed to describe spatial ability as skill in representing, transforming, generating, and recalling symbolic, non-linguistic information. According to Halpern (2000), it refers to the ability to imagine what an irregular figure looks like if it were rotated in space or the ability to discern the relationship between shapes and objects. According to these descriptions, navigation of a car into a parking space is a task that is essentially spatial in its nature, as it requires the constant mental representation of the dynamic position of the car relative to the surrounding area. During forward bay parking, the parking space is located in the visual field of the driver, as she or he is oriented towards the direction the car moves. Thus, the driver is not necessarily required to transform or generate symbolic information, or to mentally represent the reference area. As the area relevant for parking is directly observable, the driver need not imagine e.g. size of parking space, or position of cars restricting the parking space, which are mental processes that are considered as being spatial. Nevertheless, estimation of the length and width of the car is necessary to some extent during forward bay parking. During backward bay parking, things already become more complicated. Now, the driver is oriented in the opposite direction than the vehicle moves. When looking straight ahead, the parking space and its surroundings are not directly observable, and spatial skills such as representing and recalling non-linguistic information are required. During use of rear and side view mirrors, the driver must imagine the actual position of the objects observed. When wanting to bay park backwards on the right, for instance, the driver must turn the steering wheel to the right, too. When looking over the shoulder to orient towards the driving direction, however, the parking space turns out to be on the left in reference to the driver's body position. The driver must now be able to mentally rotate back into her or his initial position (i.e. an orientation against driving direction). Otherwise, problems to turn the steering wheel in the correct direction can occur. Things are most complicated during reverse parallel parking, as it involves a change of direction (which is not the case for bay parking backwards): When reverse parallel parking on the right, for instance, the steering wheel must first be turned to the right, whereupon the driver must countersteer to the left. As for bay parking backwards, the right turns out to be on the left when the driver looks over the shoulder. It is now most challenging to mentally represent the position of parking space and other reference points relative to the own body position constantly. Conclusively, subject's parking performance can be regarded as depending on the complexity of spatial skills required.

4.3 Performance differences between the sexes

Across all three types of parking manoeuvres, men parked significantly more accurate than women. However, when manoeuvres were analyzed separately, the sex difference in accuracy remained for reverse parallel parking only. Analysis of parking time revealed that men parked within significantly less time. This was the case across all three types of manoeuvres and for separate analysis of each manoeuvre. When accuracy and time differences between the sexes are expressed in percent, they correspond to differences of 2.1% and 35%, respectively. Thus, the sex difference in parking speed is much more marked, whereas the difference in accuracy can be considered as being barely relevant in real life.

A possible interpretation of the sex difference in parking time is that women drive more cautious and thus slower than men to avoid accidents, a frequent cause of death especially among teenagers (U.S. Center for Disease Control, 2004). Literature proves that men are more prone to accident involvement and risky driving (Gebers & Peck, 2003; Williams, 2003; Waldron et al., 2005). According to the U.S. Department of Transportation (2004), men are involved in serious car accidents three times as often as women. Possibly, this difference partly is due to the fact that men, on average, spend more time in cars than women (Harris et al., 2006). Importantly, however, risk assessment during driving is different between the sexes. This is indicated, for instance, by the fact that women use seat belts more often than men (Waldron et al., 2005), whereas men tend to run yellow lights more often (Konecni et al., 1976). One might argue that driving behaviour in the traffic has nothing to do with parking behaviour. However, men engage in risky behaviour in a broad array of domains, which is indicated by a meta-analysis of Brynes et al. (1999), who reviewed more than 150 papers. It was found, for instance, that women are less likely to engage in risky behaviour in gambling, recreational, and health domains (Harris et al., 2006), while men die much more often from drowning or accidental poisoning (Waldron et al., 2005). This suggests that women, in contrast to men, also are more cautious and less risky during parking, e.g. to avoid damage of the experimental car. This characteristic is likely to be reflected in the time necessary to complete a manoeuvre.

However, a sex difference in risk taking behaviour leading to significantly slower driving does not explain why women's parking position, especially for reverse parallel parking, was less accurate compared to men's. Actually, one must assume that slow driving should lead to a *better* and not worse result, as subjects have more time. This, however, was not the case. Thus, risk-taking differences cannot explain the observed sex difference sufficiently.

Obviously, other mechanisms influence parking behaviour. In the overall sample, general self-assessment was related to parking performance. Furthermore, women assessed their general driving and parking skills not as good as men did. Such sex differences in self-assessment are frequently documented in literature. Numerous psychological studies prove that women's self-confidence, assessed, for instance, by performance expectancies and self-assessment of skills and performances completed, is lower than men's in a wide array of fields (Maccoby & Jacklin, 1974; Lenney, 1977). This is the case although the intellectual and academic abilities of women and men appear to be equal (Maccoby & Jacklin, 1974). It is likely that differences in self-assessment are caused by differences in achievement: Individuals, who hold low estimates of their skills, are in fact likely to perform less well than those with higher estimates (Battle, 1965; Diggory, 1966; Feather, 1966;). Women also avoid achievement situations and tend to give up more easily (Weiner et al., 1971). Whereas previous authors suggested that women are less self-confident across almost all achievement situations, Lenney et al. (1977, 1980) found that sex differences in self-confidence are modulated by situation variables and especially likely to occur when evaluation criteria are ambiguous. The authors suggest to define evaluation criteria unambiguously to avoid sex differences in self-confidence and to provide a clear specification of guidelines for tasks. In the present study, subjects were informed very clearly about their task, i.e. how to complete each parking manoeuvre. However, they were not informed about the experimental hypothesis and how their parking performance was assessed by the experimenter. However, it still is possible that they assumed that the study was about sex differences and the experimental setup could have led to implicit stereotype activation. Nevertheless, one might conclude that sex-differences in self-assessment and task characteristics were the factors underlying parking performance.

Interestingly, however, parking performance was *not* related to self-assessment in driving beginners, but only in more experienced drivers. In beginners, mental rotation ability was found to correlate to performance. Obviously, neither risk- nor self-assessment differences can explain the observed sex difference in parking performance sufficiently. A third explanation suggests that not self-assessment, but mental rotation is the main mechanism underlying performance, although it is replaced by self-assessment in more experienced drivers. The correlation found between parking performance of beginners and score achieved in the Mental Rotation Test demonstrates that mental rotation is a crucial aspect involved in parking (see also 4.2). As men were superior in the Mental Rotation Test, which is in line with literature (e.g. Petrusic et al., 1978; Kail et al., 1979; Oosthuizen, 1991; Resnick, 1993;

Masters, 1998), the sex difference in parking performance of beginners can be considered as being due to their skill to mentally rotate objects in three-dimensional space.

Why, however, is mental rotation correlated to performance only in driving beginners, whereas self-assessment underlies performance in more experienced drivers? This shift in related variables can be explained in terms of training effects as well as differential feedback, respectively. This explanatory model is supported by multiple studies proving that practice has a positive effect on performance in spatial tasks, including mental rotation tasks (e.g. Kail & Park, 1990; Sorby & Baartmans, 2000; Cherney & Neff, 2004; Kinsey et al., 2007). Although the more experienced drivers who participated in the experiment did not drive regularly and had never possessed an own car, they had their driver's licence since several months or years. It is thus very likely that the mental rotation processes involved during parking in beginners had been subject to training effects, leading to the absence of a relation between mental rotation skills and performance in more experienced drivers. But how come women assessed their driving and parking skills not as good as men in the sample of more experienced drivers? And why did self-assessment now correlate with performance? Additionally, effects of differential feedback are explanatory. Studies of the degree to which performance at a task is due to prior success or failure at the task indicate that failure does overall depress performance and rating of one's skills and performance (Lazarus & Ericksen, 1952; Osler, 1954; Sarason, 1956; Katchmar et al., 1958). Feather (1966), for instance, divided subjects working at a task consisting of anagrams into an initial-failure and an initial-success group. Results showed that subject's mean performance was significantly lower after initial failure than after initial success. The effect of prior on future performance can be applied on parking: In driving beginners, mental rotation is correlated to parking performance. As men have better mental rotation skills, they park faster and more accurate. Women's mental rotation skills are not as good as men's. As a consequence, they park especially slower, but also less accurate. As men, on average, observe their parking skills as being good, and women, on average, observe their parking skills as being not as good, they receive positive and negative feedback, respectively. This "prior success" and "prior failure" effects future performance. On the one hand, it leads to men assessing their skills as being good, which leads to a good performance. On the other hand, it leads to women assessing their skills as being not as good, which leads to a performance which is not as good. Although skill in mental rotation, the major brain mechanism necessary for parking, is trained over time, and thus does no longer underlie performance in more experienced drivers, the sex difference remains as a consequence of self-assessment and differential feedback. This theoretical model of parking performance in visualized in Figure 12.

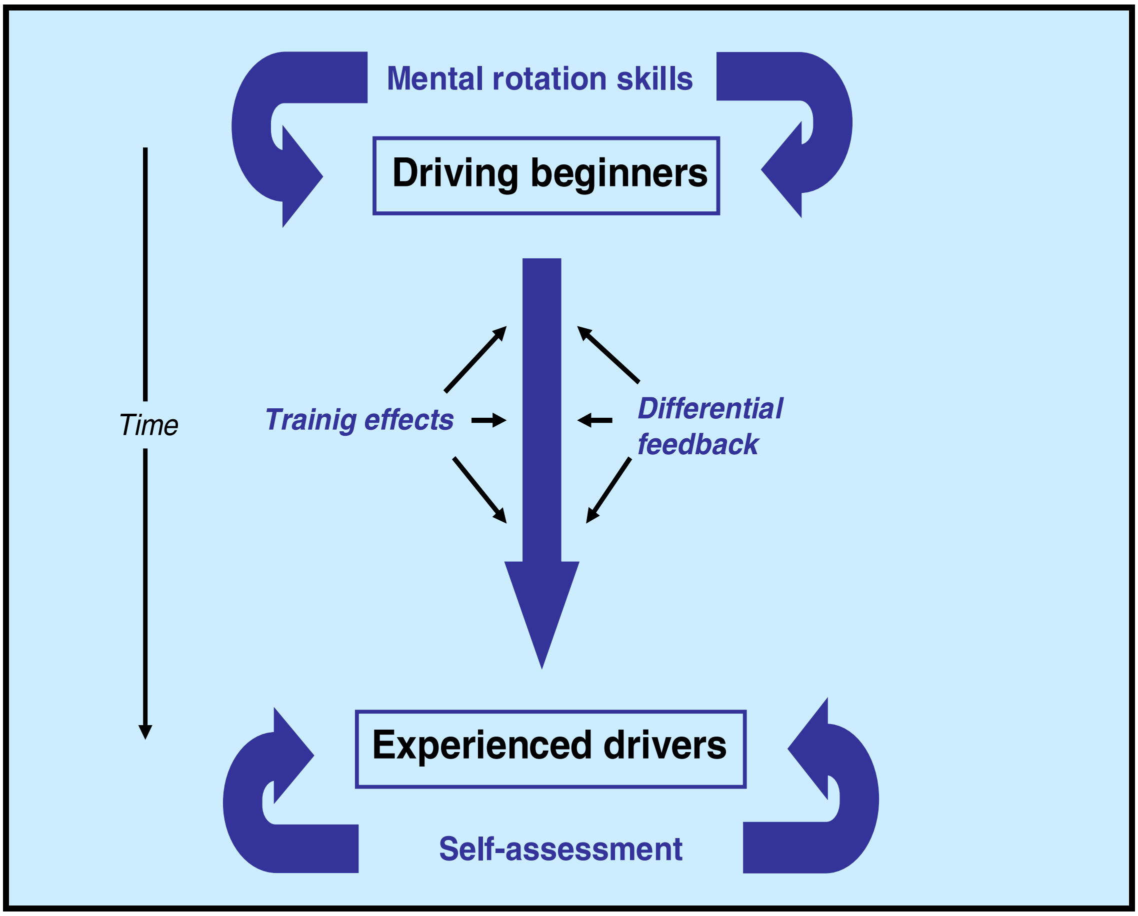

FIGURE 12: Theory of parking performance. In driving beginners, mental rotation skills underlie parking performance. Due to training effects and differential feedback, mental rotation is replaced by self-assessment in more experienced drivers

5. Conclusion

The present study had been conducted for three main reasons. One aim had been to unravel the validity of a stereotype, which is deeply anchored in modern culture, but which had never been investigated with scientific methods. A further goal had been to gain insight into the ecological validity of the Mental Rotation Test – one of the most frequently cited psychological tests in the context of sex differences. Last but not least, it had been the aim to investigate mechanisms responsible for individual parking performance (see 1.6).

It was found that women park much slower than men, and, although to a much smaller extent which can be considered as being barely relevant in real life, also less accurate. It is possible that sex differences in risk-assessment had some influence on this result, as literature proves that women cause fewer accidents and drive more cautious compared to men. However, this does not explain why women tended to park less accurate, too, as slower driving actually must lead to a better result. Data analysis revealed that women assessed their general parking and driving skills not as good as men did. In line with literature, men furthermore outperformed women in the Mental Rotation Test. As parking performance was related to mental rotation skills in driving beginners, and to self-assessment in more experienced drivers, these two variables can be considered has having main influence on performance.

An explanatory model suggests that mental rotation is the major brain mechanism involved during parking. With months and years of experience, however, training effects and differential feedback grasp in order to replace the controlling effect of mental rotation skills bit by bit. Lastly, this results in the observed effect of self-assessment on parking performance in experienced drivers. Thus, not only spatial, but also social variables influence parking performance. Conclusively, the Mental Rotation Test can be considered as having some ecological validity. Importantly, however, biological foundations for sex differences are modulated by socio-psychological factors.

6. Outlook

The present study gave rise to a theoretical model of parking performance. In this model, the biological foundation of parking performance – namely mental rotation ability – is modulated and replaced by a social factor – namely self-assessment – as experience increases. As this theory was established in a real-life situation, it is now possible to prove the validity of this theory in subsequent laboratory tests.

Investigations of the brain activity of subjects with differential experience in a driving simulator, detailed self-assessment and self confidence questionnaires, as well as different measures of spatial cognition, may shed light on the validity of this theory and are likely to extend it. The present sample consisted of driving beginners and more experienced drivers, who did not drive regularly and had limited driving experience. To obtain clear cut results, it may be advantageous, to replace the latter group by drivers who drive frequently and regularly since several years.

A factor that had not been examined in the present experiment is the possible impact of implicit stereotype activation on parking performance. As the stereotype of women’s poor parking skills is widely spread, it is possible that it had influenced parking performance of women negatively during the present experiment. One may thus compare samples that were reminded of the stereotype that women are poor drivers with a control group, and possibly a sample, that was told that women’s driving and parking skills were found to be superior to men’s.

In women, performance on spatial tasks is influenced by fluctuations of progesterone and estradiol during the menstrual cycle. It is therefore interesting to examine in subsequent experiments, whether gonadal hormone levels have an impact on the spatial challenges during driving and parking. Furthermore, cortisol levels may be determined and examined for their possible impact on subject’s performance.

There are thus numerous possibilities to improve and expand the theoretical model of parking performance that was elaborated in the present study. These possibilities range from cognitive over social to hormonal variables. Driving simulator studies or a combination of real-life and laboratory experiments may shed light on the complex interaction of these factors.

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Appendix

(A) List of abbreviations

ANOVA	Analysis of Variance
CAH	Congenital Adrenal Hyperplasia
FSH	Follicle-stimulating hormone
IQ	Intelligence Quotient
LH	Lutinizing Hormone
LQ	Laterality Quotient
SD	Standard Deviation
SE	Standard Error

(B) Intelligence Test

Name:

Datum:

Beruf:

Alter:

Mehrfach-Wortwahl-Test (Version B) MWT(B)

Sie sehen hier mehrere Reihen von Wörtern. In jeder Reihe steht höchstens ein Wort, das Ihnen vielleicht bekannt ist. Wenn Sie es gefunden haben, streichen Sie es bitte deutlich an.

1. Nale – Sahe – Nase – Nesa – Sehna
2. Funktion – Kuntion – Finzahm – Tuntion – Tunkion
3. Struk – Streik – Sturk – Strek – Kreik
4. Kulinse – Kulerane – Kulisse – Klubihle – Kubistane
5. Kenekel – Gesonk – Kelume – Gelenk – Gelerge
6. siziol – salzahl – sozihl – sziam – sozial
7. Sympasie – Symmofeltrie – Symmantrie – Symphonie – Symplanie
8. Umma – Pamme – Nelle – Ampe – Amme
9. Krusse – Surke – Krustelle – Kruste – Struke
10. Kirse – Sirke – Krise – Krospe – Serise
11. Tinxur – Kukutur – Fraktan – Tinktur – Rimsuhr
12. Unfision – Fudision – Infusion – Syntusion – Nuridion
13. Feuderasmus – Fonderismus – Föderalismus – Födismus – Föderasmus
14. Redor – Radium – Terion – Dramin – Orakium
15. kentern – knerte – kanzen – kretern – trekern
16. Kantate – Rakante – Kenture – Krutehne – Kallara

17. schalieren – waschieren – wakieren – schackieren – kaschieren
18. Tuhl – Lar – Lest – Dall – Lid
19. Dissonanz – Diskrisanz – Distranz – Dinotanz – Siodenz
20. Ferindo – Inferno – Orfina – Firanetto – Imfindio
21. Rilkiase – Kilister – Riliker – Klistier – Linkure
22. kurinesisch – kulinarisch – kumensisch – kulissarisch – kannastrisch
23. Rosto – Torso – Soro – Torgos – Tosor
24. Kleiber – Beikel – Keibel – Reikler – Biekerl
25. Ralke – Korre – Ruckse – Recke – Ulte
26. Lamone – Talane – Matrone – Tarone – Malonte
27. Tuma – Umat – Maut – Taum – Muta
28. Sorekin – Sarowin – Rosakin – Narosin – Kerosin
29. beralen – gerältet – anälteren – untären – verbrämen
30. Kapaun – Paukan – Naupack – Aupeck – Ankepran
31. Sickaber – Bassiker – Kassiber – Sassiker – Askiber
32. Pucker – Keuper – Eucker – Reuspeck – Urkane
33. Spirine – Saprin – Parsin – Purin – Asprint
34. Kulon – Solgun – Koskan – Soran – Klonus
35. Adept – Padet – Edapt – Epatt – Taped
36. Gindelat – Tingerat – Indigenat – Nitgesaar – Ringelaar
37. Berkizia – Brekzie – Birakize – Brikazie - Bakiria

(C) Edinburgh Handedness Inventory

Bitte geben Sie für die folgenden Aktivitäten oder Objekte an, welche Hand Sie hierfür gebrauchen, indem Sie ein „+“ in das jeweilige Kästchen schreiben. Wenn Ihre Präferenz so stark ist, dass Sie niemals versucht haben, die andere Hand zu gebrauchen, dann geben Sie ein „+ +“ an. Nur wenn Sie wirklich unentschlossen sind, geben Sie ein „+“ in beide Kästchen ein. Einige von den nachfolgenden Aktivitäten erfordern beide Hände. In diesem Fall steht der Teil der Aufgabe in Klammern, für den die Handpräferenz gesucht ist.

Bitte versuchen Sie alle Punkte zu beantworten. Lassen Sie einen Punkt bitte nur dann unbeantwortet, wenn Sie überhaupt keine Erfahrung mit dem Objekt oder der Aufgabe haben.

		Links	Rechts
1	Schreiben		
2	Zeichnen		
3	Werfen		
4	Schere		
5	Zahnbürste		
6	Messer (ohne Gabel)		
7	Löffel		
8	Besen (oberste Hand)		
9	Streichholz anzünden		
10	Dose öffnen (Deckel)		

Nur vom Untersucher Auszufüllen:

L.Q.

(D) Self-assessment Questionnaire

Versuchspersonencode ___________________

Liebe/r Versuchsteilnehmer(in), im Folgenden werden dir verschiedene Fragen zur Einschätzung deiner generellen Fahr- bzw. Einparkfähigkeit gestellt. Außerdem bitten wir dich, deine während des Versuchs durchgeführten Einparkmanöver einzuschätzen. Bitte beantworte alle Fragen so gut wie möglich. Falls du die Antwort nicht genau wissen solltest oder dir unsicher bist, wähle jene Antwort, die am ehesten zutrifft.

1. Generelle Einstellung gegenüber dem Autofahren

Bist du beim Autofahren ängstlich oder mutig?

sehr ängstlich   eher ängstlich   mittelmäßig   eher mutig   sehr mutig

Wie gut schätzt du deine Fähigkeiten zum Autofahren generell ein?

sehr gut   eher gut   mittelmäßig   eher schlecht   sehr schlecht

Wie gut schätzt du deine Fähigkeiten zum Einparken generell ein?

sehr gut   eher gut   mittelmäßig   eher schlecht   sehr schlecht

2. Einparkmanöver während des heutigen Versuchs

Wie gut, glaubst du, waren deine für die heutige Studie durchgeführten Einparkmanöver?

sehr gut   eher gut   mittelmäßig   eher schlecht   sehr schlecht

Wie gut, glaubst du, war deine heutige Einparkfähigkeit verglichen mit deiner sonstigen Einparkfähigkeit?

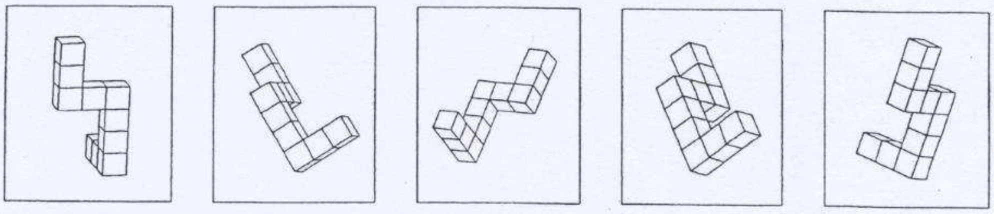
sehr gut   eher gut   mittelmäßig   eher schlecht   sehr schlecht

(E) Mental Rotation Test

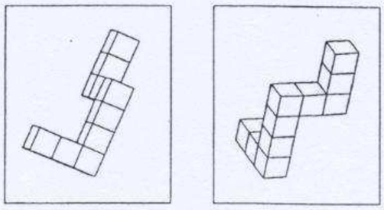
Mental Rotations Test (MRT-B)

Michael Peters, PhD

Bitte sehen Sie sich diese fünf Figuren an



Beachten Sie, daß es sich bei allen Bildern um das gleiche Objekt handelt, das aus verschieden Betrachtungswinkeln gezeigt wird. Versuchen Sie das Objekt in Ihrer Vorstellung zu bewegen (oder sich selbst relativ zum Objekt), um die benachbarten Objekte so in Deckung zu bringen.

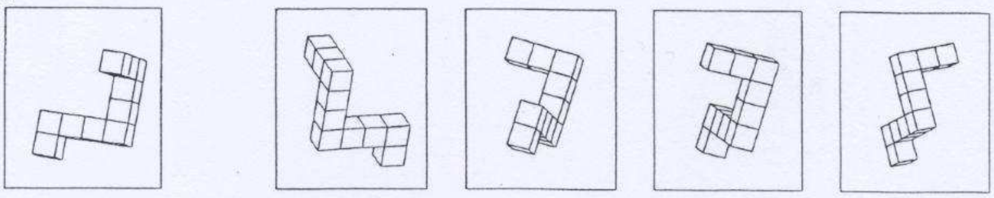


Hier sind zwei Zeichnungen einer neuen Figur, die sich von dem Objekt der ersten fünf Zeichnungen unterscheidet. Überzeugen sie sich selbst davon, daß diese zwei Zeichnungen ein Objekt zeigen, daß sich von den oberen fünf Objekten unterscheidet und nicht durch Rotieren in eine identische Ansicht mit ihnen gebracht werden kann.

Betrachten Sie nun dieses Objekt:

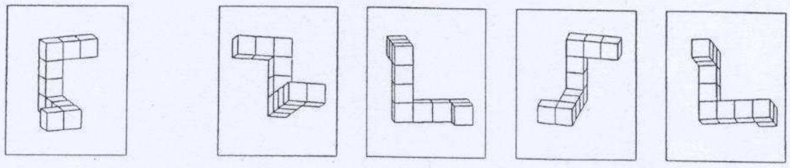
Zwei von diesen vier Zeichnungen zeigen dasselbe Objekt. Können Sie diese zwei finden? Kreuzen Sie diese groß an.

1.



Wenn Sie die erste und dritte Zeichnung markiert haben, haben Sie die richtige Wahl getroffen. Hier kommen drei weitere Aufgaben. Wieder ist das Zielobjekt zweimal in jedem Satz mit vier Alternativen vorhanden. Daraus sollen Sie die Richtigen heraussuchen.

2.



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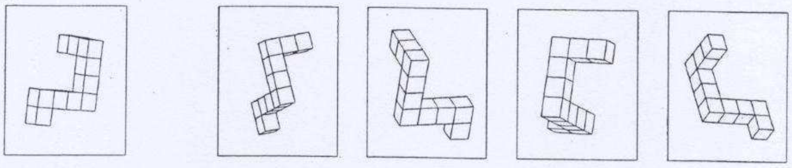

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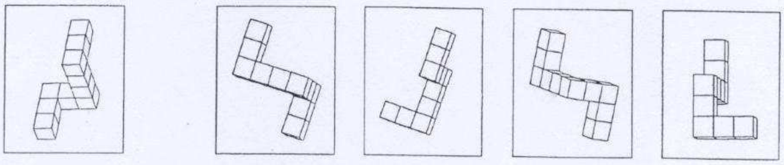

Korrekte Wahl: 2: zweites und drittes
3. erstes und viertes
4: erstes und drittes

Wenn sie den Test durchführen denken Sie bitte daran, daß es bei jedem Problem zwei und nur zwei Figuren gibt, die mit dem Zielobjekt übereinstimmen.

Sie bekommen nur dann einen Punkt gutgeschrieben, wenn Sie beide korrekte Figuren markieren. Wenn Sie nur eine der Figuren markieren, dann wird die Aufgabe nicht gewertet.

A

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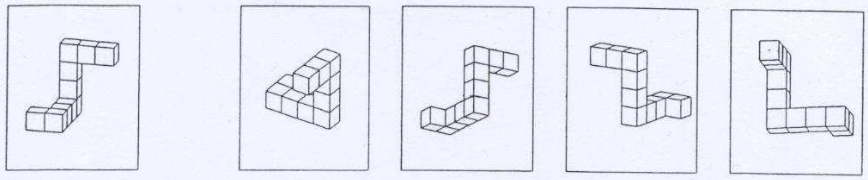

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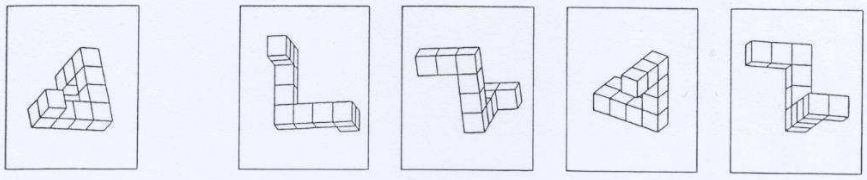

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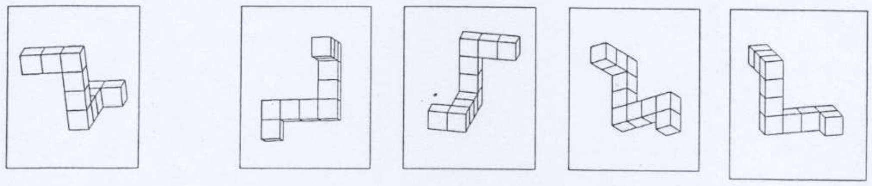

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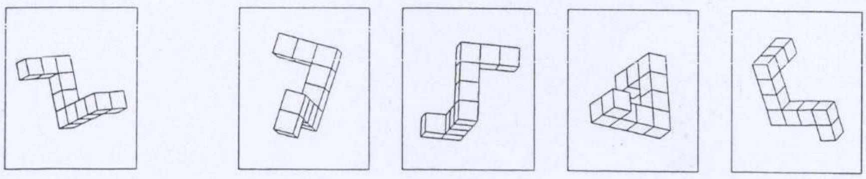

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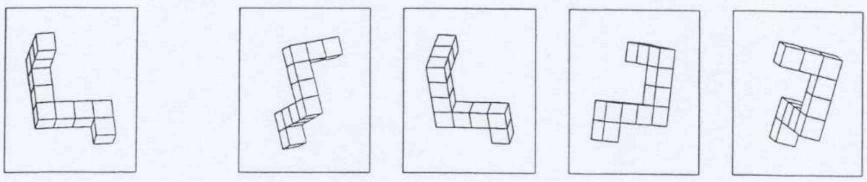

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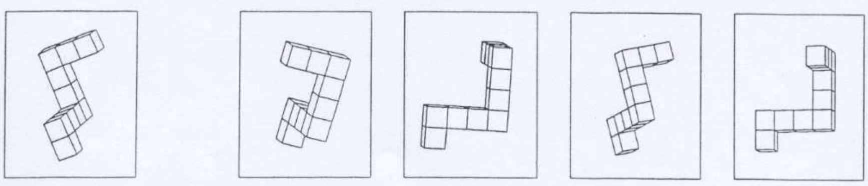

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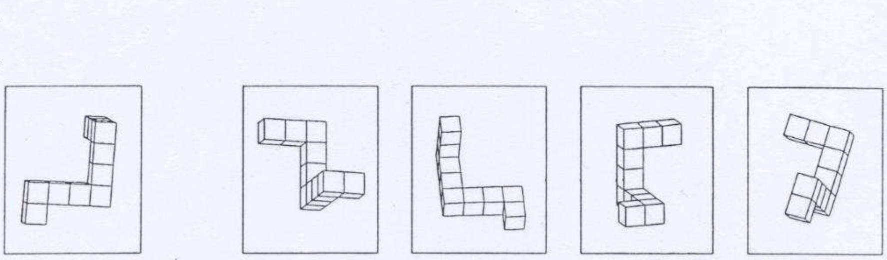

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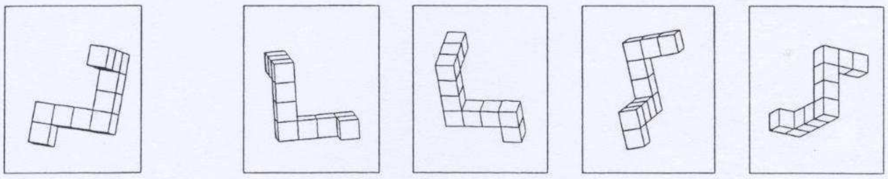

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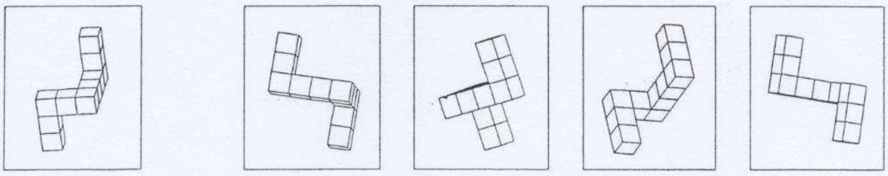

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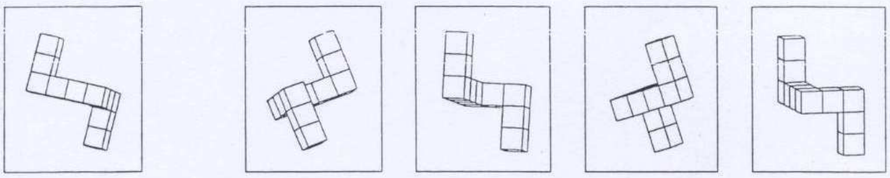

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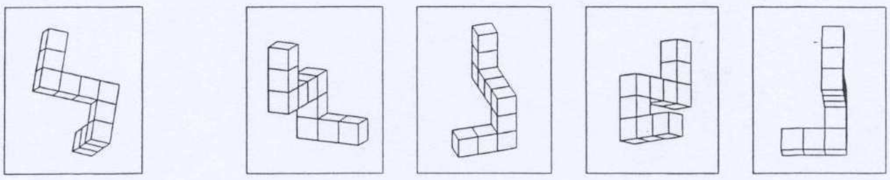

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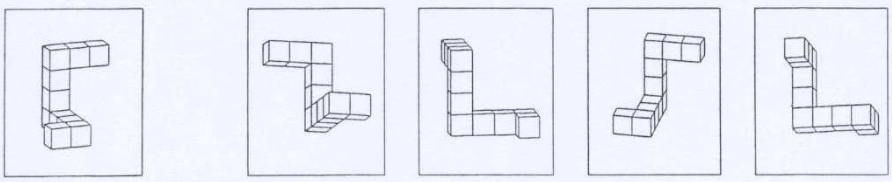

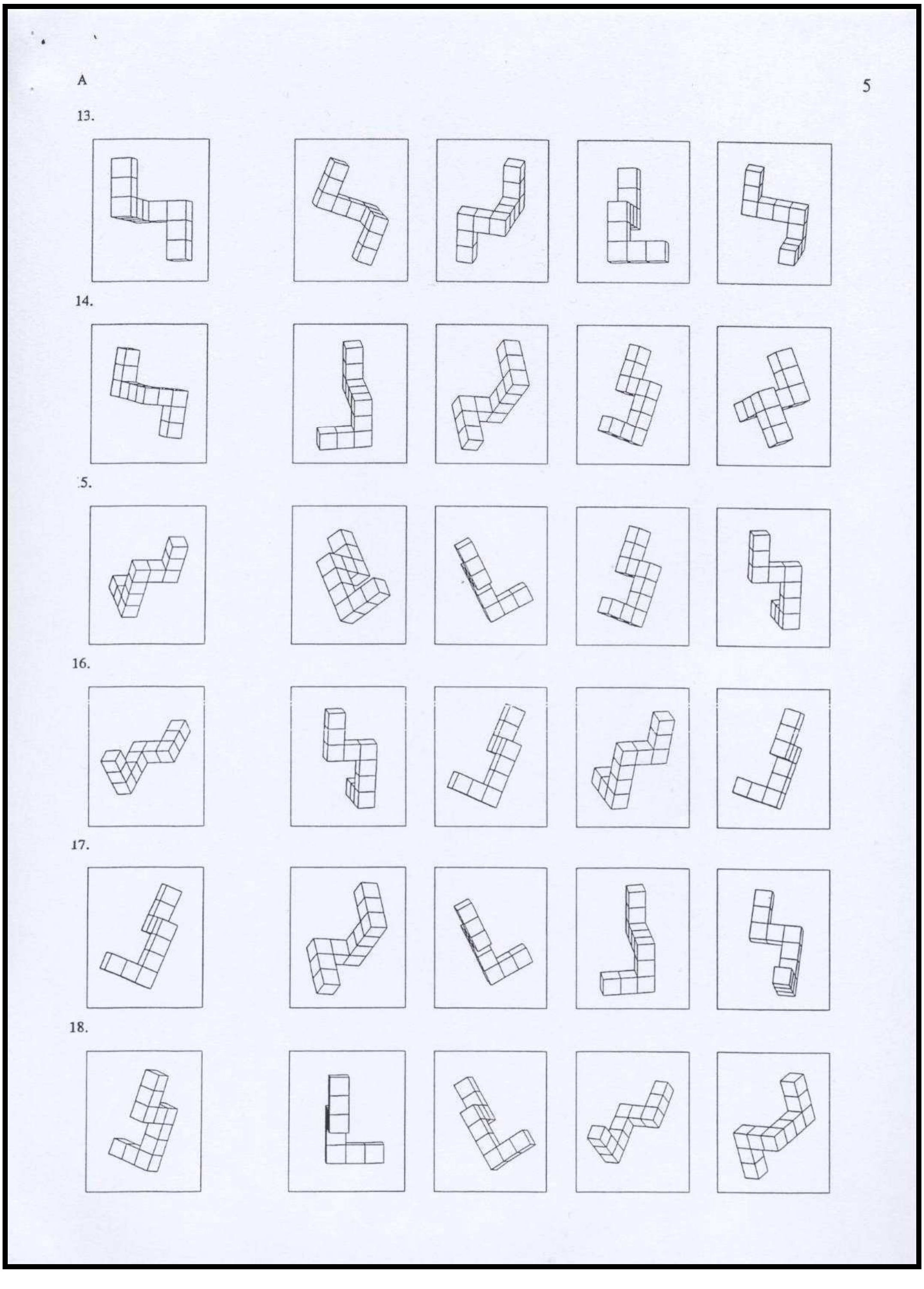
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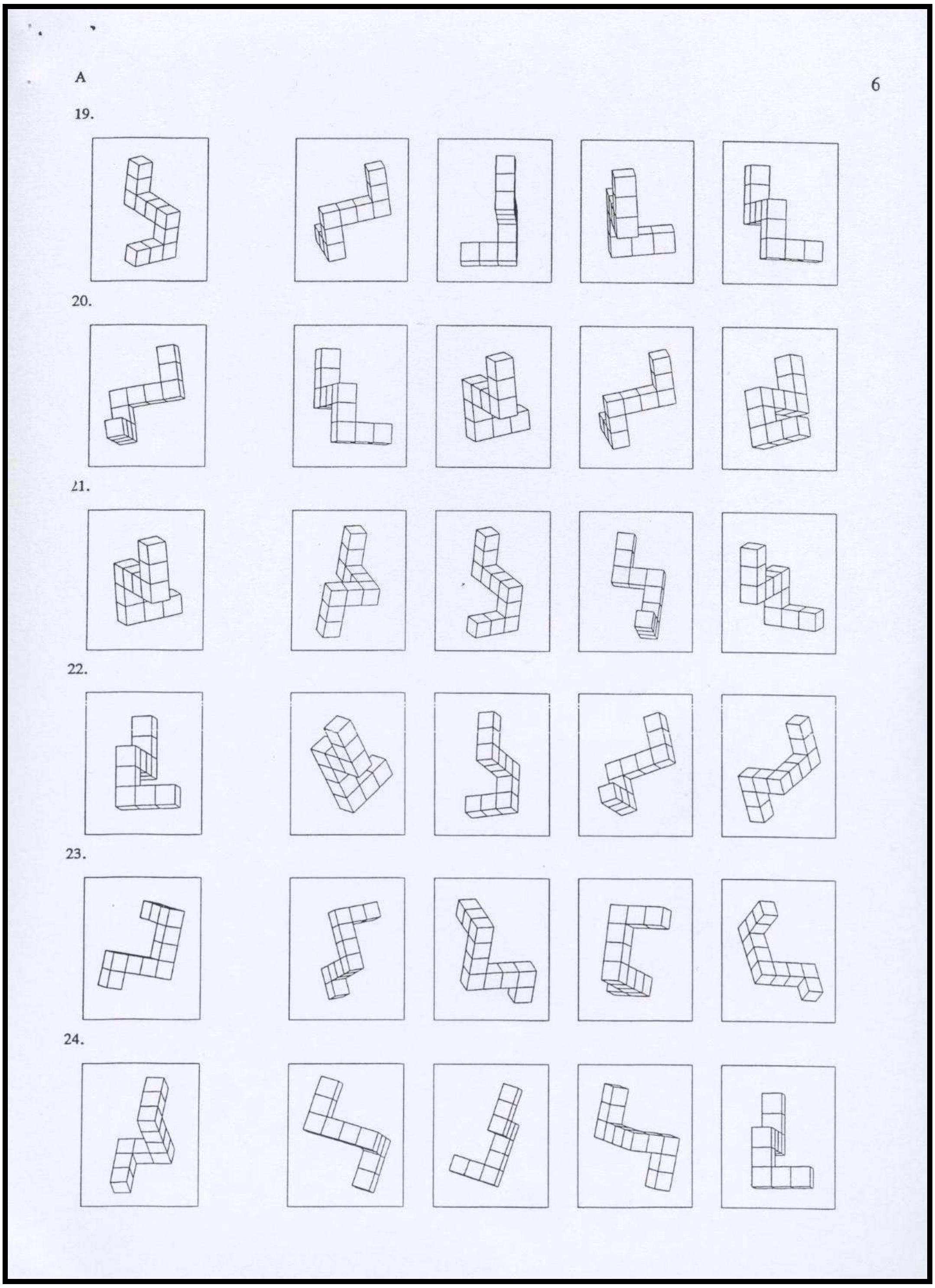
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24.

(F) Deutsche Zusammenfassung

In unserer modernen Kultur ist das Vorurteil, dass Frauen nicht einparken können, weit verbreitet. Dies ist z. B. an einer Unmenge von Treffern zu erkennen, die man erhält, wenn man die Schlüsselwörter „Frauen“ und „Parken“ in eine der weltweit größten Suchmaschinen des World Wide Web eingibt. Da es sich beim Einparken um eine räumliche Aufgabe handelt, und zahlreiche wissenschaftliche Studien zu räumlicher Kognition einen Geschlechtsunterschied zugunsten von Männern belegen, ist es nahe liegend, dass das Vorurteil seinen Ursprung in wissenschaftlichen Ergebnissen hat. Trotz der weiten Verbreitung des Vorurteils wurde das Einparkverhalten von Frauen und Männern jedoch noch nie mit wissenschaftlichen Methoden untersucht. Diese Studie zeigt, dass Männer genauer und vor allem schneller als Frauen einparken. Bei Fahranfängern korreliert die Einparkfähigkeit mit der mentalen Rotationsfähigkeit, bei Probanden mit größerer Erfahrung mit der Selbsteinschätzung. Es ist nahe liegend, dass dieser Wechsel von zugrunde liegenden Variablen auf Trainingseffekte und positives bzw. negatives Feedback zurückzuführen ist. Folglich beeinflussen nicht nur räumliche, sondern auch soziale Variablen die Einparkfähigkeit. Zusammenfassend lässt sich sagen, dass der Mentale Rotationstest eine gewisse ökologische Validität besitzt. Räumliche Kognition im wirklichen Leben ist jedoch sehr komplex und wird von anderen Faktoren beeinflusst.

(G) Curriculum Vitae

Personal Data

Name:	Claudia Christine Wolf
Date of birth	05th of November 1981
Place of birth	Mississauga, Canada
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Marital status:	Unmarried
Parents:	Prof. Dr. Dr. Detlef Wolf Annerose Wolf
Siblings:	Dr. Susanne Wolf Anne-Margret Wolf

Education

1987-1988	First Avenue Public School Ottawa, Canada
1988-1992	Michael Grundschule Münster, Germany
1992-2002	Schillergymnasium Münster, Germany
	School leaving certificate: Abitur
	Grading: 2.2

Studies

2002-2003	**Undergraduate Studies: German Philology, Biology**
	Westphalian Wilhelms-University, Münster
2003-2006	**Undergraduate Studies: Biology**
	Westphalian Wilhelms-University Münster
2006	**Bachelor's thesis**
	Westphalian Wilhelms-University Münster, Institute for Neurobiology and Behavioural Biology
	Subject of the thesis: *Social status and anxiety-like behaviour in male mice of the inbred strain C57BL/6*
	Referee: Prof. Norbert Sachser
	Grading: 1.3
Since 2006	**Graduate Studies: Neurobiology, Behaviour and Cognition**
	University of Vienna
Since 2008	**Master's thesis**
	Ruhr-University Bochum, Institute of Cognitive Neuroscience, Department of Biopsychology, Faculty of Psychology
	Subject of the thesis: *Sex differences in cognitive abilities*
	Referees: Prof. Ludwig Huber (University of Vienna), Prof. Onur Güntürkün (Ruhr-University Bochum)

Internships and further activities

2005	**Internship in the editorial office of the Journals REPTILIA and DRACO**
	Berlin, Germany
	Activities: Revision of manuscripts, preparation of articles
2007	**Student assistant for the project „technical intelligence in kea, *Nestor notabilis*“**
	University of Vienna, Faculty for Animal Cognition
	Activities: Data acquisition, analysis and discussion
2007-2008	**Student assistant for the Master’s program „Cognitive Science“**
	University of Vienna, Faculty of Philosophy
	Activities: Organization of seminars, mentoring of students
Since 2008	**Student assistant for the project „cognitive sex differences“**
	Ruhr-University Bochum, Institute of Cognitive Neuroscience, Department of Biopsychology, Faculty of Psychology
	Activities: Data acquisition, analysis, and discussion
	Student assistant for the project „audition and aging“
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	Activities: Conduction of EEG-Studies

Student assistant at the IKGF

International Consortium for Research in Humanities, Ruhr-University Bochum

Activities: Translation of German texts into English, administrative activities

Publications

Papers:

Gaydon, G. K., Wolf C. C., Ortner, T. M. & Huber, L. (2008): How to solve a mechanical problem: The relevance of visible and unobservable functionality for kea. *Submitted to Proceedings of the Royal Society B.*

Wolf, C. C., Ocklenburg, S., Ören, B., Becker, C., Bös, C., Hofstätter, A. Popken, M., Thorstensen, T. & Güntürkün, O. (2009): Sex differences in parking are affected by social and biological factors. *Manuscript in preparation.*

Conference Abstracts:

Wolf, C. C., Gajdon, G. K., Bürger, C. & Huber, L. (2008): Do kea, Nestor notabilis, solve mechanical problems according to prior non-rewarded exploration experience? *Poster presented at ECBB 2008, 4th European Conference on Behavioural Biology, July 14-20, Dijon, Frankreich.*

Wolf, C. C., Ocklenburg, S., Ören, B., Becker, C., Bös, C., Hofstätter, A. Popken, M., Thorstensen, T. & Güntürkün, O. (2009): Sex differences in real-life spatial cognition. *Poster presented at the 16th annual meeting of the Cognitive Neuroscience Society. March 21-24, 2009, at the Hyatt Regency San Francisco.*

Further information

Language skills: German (mother tongue), English (very good knowledge), Dutch (basic knowledge), French (basic knowledge), Italian (basic knowledge)

EDV-Kenntnisse: Word, Excel, SPSS, Powerpoint

Bochum, February 18th, 2009

Claudia Wolf

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Declaration

I assure that I wrote this Master's thesis independently, using only the indicated sources and aids. Places and passages inferred from other factories literally or according to the sense are marked under specification of sources as are pictures, tables and figures.

Erklärung

Ich erkläre, dass ich diese Masterarbeit selbständig verfasst, und keine anderen als die angegebenen Quellen und Hilfsmittel verwendet habe. Alle Stellen dieser Arbeit, die im Sinne oder Wortlaut anderen Werken entnommen wurden, sind unter Angabe der Quellen kenntlich gemacht. Selbiges gilt für alle Fotos und Darstellungen.

Bochum, February 18th 2009

Claudia Wolf